# Catalogue Data in Autumn Semester 2015

## Agricultural Science Bachelor

### Agricultural Science Practical

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tbody>
<tr>
<td>751-0200-00L</td>
<td>Agricultural Science Practical</td>
<td>O</td>
<td>14</td>
<td></td>
<td>B. Dorn</td>
</tr>
</tbody>
</table>

**Abstract**: Das agrarwissenschaftliche Praktikum besteht aus dem Betriebsaufenthalt, der Betriebsaufnahme (Betriebsheft) und der agronomischen Fachaufgabe. Die Leistungskontrolle erfolgt über die Rückmeldung zu den einzelnen Bestandteilen des Praktikums.

**Objective**: The farm placement aims to motivate students towards a system oriented approach to agricultural science, connecting science and practice.

**Lecture notes**: Das Betriebsheft zur Betriebsaufnahme und weitere Dokumente werden vom Praktikantendienst nach Anfrage zur Verfügung gestellt.

**Literature**: Merkblätter, Lehrbücher und Software stehen den Studierenden beim Praktikantendienst Agrarwissenschaft zur Verfügung.

### 1. Semester

#### First Year Examinations

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>529-2001-02L</td>
<td>Chemistry I</td>
<td>O</td>
<td>4</td>
<td>2V+2U</td>
<td>W. Uhlig, J. E. E. Buschmann, S. Canonica, P. Funck, E. C. Meister, R. Verel</td>
</tr>
</tbody>
</table>

**Abstract**: General Chemistry I: Chemical bond and molecular structure, chemical thermodynamics, chemical equilibrium.

**Objective**: Introduction to general and inorganic chemistry. Basics of the composition and the change of the material world. Introduction to the thermodynamically controlled physico-chemical processes. Macroscopic phenomena and their explanation through atomic and molecular properties. Using the theories to solve qualitatively and quantitatively chemical and ecologically relevant problems.

**Content**: 1. Stoichiometry
2. Atoms and Elements (Quantenmechanical Model of the Atom)
3. Chemical Bonding
4. Thermodynamics
5. Chemical Kinetics
6. Chemical Equilibrium (Acids and Bases, Solubility Equilibria)

**Lecture notes**: ca. 360 Seiten mit vielen Figuren und durchgerechneten Beispielen.

- Brown, LeMay, Bursten CHEMIE (deutsch)
- Housecroft and Constable, CHEMISTRY (englisch)
- Oxtoby, Gillis, Nachtrieb, MODERN CHEMISTRY (englisch)

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<tr>
<td>401-0251-00L</td>
<td>Mathematics I</td>
<td>O</td>
<td>6</td>
<td>4V+2U</td>
<td>A. Cannas da Silva</td>
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</tbody>
</table>

**Abstract**: This course covers mathematical concepts and techniques necessary to model, solve and discuss scientific problems - notably through ordinary differential equations.

**Objective**: Mathematics is of ever increasing importance to the Natural Sciences and Engineering. The key is the so-called mathematical modelling cycle, i.e. the translation of problems from outside of mathematics into mathematics, the study of the mathematical problems (often with the help of high level mathematical software packages) and the interpretation of the results in the original environment.

The goal of Mathematics I and II is to provide the mathematical foundations relevant for this paradigm. Differential equations are by far the most important tool for modelling and are therefore a main focus of both of these courses.

**Content**: 1. Single-Variable Calculus:
2. Linear Algebra and Complex Numbers:
3. Ordinary Differential Equations:

- Bretscher, O.: Linear Algebra with Applications (Pearson Prentice Hall).

**Prerequisites / notice**:
- Prerequisites: familiarity with the basic notions from Calculus, in particular those of function and derivative.

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<tr>
<td>551-0001-00L</td>
<td>General Biology I</td>
<td>O</td>
<td>3</td>
<td>3V</td>
<td>U. Sauer, A. Widmer</td>
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</tbody>
</table>

**Abstract**: Basics of structure, formation and function of cells and biomacromolecules, principles of metabolism, as well as basic classical and molecular genetics and evolutionary biology. First in a series of two lectures given over two semesters for students of agricultural and food sciences, as well as of environmental sciences.

**Objective**: The understanding of some basic principles of biology: the hierarchy of the structural levels of biological organisation, with particular emphasis on the cell and its functions, as well as metabolism, inheritance and evolution.
The structure and function of biomacromolecules; basics of metabolism; cell biology; membrane structure and function; basic energetics of cellular processes; respiration, photosynthesis; cell cycle, meiosis and sexual life cycles; Mendelian and molecular genetics; animal reproduction and behavior; sensory and motor mechanisms; population biology and evolution; principles of phylogeny.

The Campbell Chapters 1-4 (10th edition) under the heading "The role of chemistry in biology" are expected. We will treat the following Campbell chapters:

5 Biochemistry  Biological Macromolecules and Lipids
7 Cell biology  Cell Structure and Function
8 Cell biology  Cell Membranes
10 Cell biology  Cellular Respiration: An Introduction to Metabolism
10 Cell biology  Cellular Respiration
11 Cell biology  Photosynthesis
12 Cell Biology  Mitosis
13 The Genetic Basis of Life  Sexual Life Cycles and Meiosis
14 The Genetic Basis of Life  Mendelian Genetics
15 The Genetic Basis of Life  Linkage and Chromosomes
20 The Genetic Basis of Life  The Evolution of Genomes
21 Evolution  How Evolution Works
22 Evolution  Phylogenic Reconstruction
23 Evolution  Microevolution
24 Evolution  Species and Speciation
25 Evolution  Macroevolution

Lecture notes
no script

Content
The lecture is the first in a series of two lectures given over two semesters for students with biology as a basic subject.

Literature

Prerequisites / notice
Students are able to
- describe fundamental micro- and macroeconomic issues and theories.
- apply suitable economic arguments to a given theme.
- evaluate economic measures.

Content
Supply and demand behaviour of firm and households; market equilibrium and taxation; national income and indicators; inflation; unemployment; growth; macroeconomic policies

Lecture notes
available on electronic platform

701-0757-00L  Principles of Economics  O  3 credits  2G  R. Schubert
Abstract
This course covers the bases for understanding micro- and macroeconomic issues and theories. Participants are given the tools to argue in economic and political terms and to evaluate the corresponding measures. Group and individual exercises deepen the knowledge gained.

Objective
Students are able to
- describe fundamental micro- and macroeconomic issues and theories.
- apply suitable economic arguments to a given theme.
- evaluate economic measures.

Content
Supply and demand behaviour of firm and households; market equilibrium and taxation; national income and indicators; inflation; unemployment; growth; macroeconomic policies

Prerequisites / notice
Further information:
https://moodle-app2.let.ethz.ch/course/info.php?id=1682

Abstract
This lecture presents an introduction to ecology. It includes basic ecological concepts and the most important levels of complexity in ecological research. Ecological concepts are exemplified by using aquatic and terrestrial systems; corresponding methodological approaches are demonstrated. In a more applied part of the lecture threats to biodiversity and the appropriate management are discussed.

Objective
The objective of this lecture is to teach basic ecological concepts and the different levels of complexity in ecological research: the individual, the population, the community and the ecosystem level.

Content
- Übersicht der aquatischen und terrestrischen Lebensräume mit ihren Bewohnern
- Einfluss von Umweltfaktoren (Temperatur, Strahlung, Wasser, Nährstoffe etc.) auf Organismen; Anpassung an bestimmte Umweltbedingungen
- Populationsdynamik: Ursachen, Beschreibung, Vorhersage und Regulation
- Interaktionen zwischen Arten (Konkurrenz, Koexistenz, Prädation, Parasitismus, Nahrungsnetze)
- Lebensgemeinschaften: Struktur, Stabilität, Sukzession
- Ökosysteme: Kompartimente, Stoff- und Energieflusse
- Biodiversität: Variation, Ursachen, Gefährdung und Erhaltung
- Aktuelle Naturschutzprobleme und -massnahmen
- Evolutionäre Ökologie: Methodik, Spezialisierung, Koevolution

Lecture notes
Unterlagen, Vorlesungsschreiben und relevante Literatur sind in der Lehrdokumentenablage abrufbar. Die Unterlagen für die nächste Vorlesung stehen jeweils spätestens am Freitagmorgen zur Verfügung.

Literature
Generelle Ökologie:
Aquatische Ökologie:
Lampert & Sommer 1999. Limnökologie. Thieme, 2. Aufl., ca. Fr. 55.-;
Bohle 1995. Limnische Systeme. Springer, ca. Fr. 50.-
Naturschutzbiologie:
Informatics


Knowledge about the World Food System will be provided, based on case studies along food value chains in countries with various development stages and dependent on multiple boundary conditions. This shall generate profound understanding of the associated global challenges especially food scarcity, suboptimal diet and nutrition, food quality and safety as well as effects on the environment.

Attending this course, the students will recognize the elements of the World Food System (WFS) approach and the problems it is supposed to treat. They will especially comprehend the four pillars of global food security, namely (I) food availability (including sustainable production and processing), (II) access to food (physical and monetary), (III) food use (including quality and safety as well as the impact on human health and well being) and (IV) resilience to the boundary conditions (environmental, economic and political). This insight will make them aware of the global driving forces behind our ETH research on food security and is expected to alleviate motivation and understanding for the association of subsequent specific courses within a general context. The course equivalently implements agricultural and food sciences, thus supporting the interdisciplinary view on the WFS scope.

Case studies on certain foods of plant and animal origin serve to demonstrate the entire food value chain from the production of raw material to processed food and its consumer relevant property functions. In doing so, important corresponding aspects for developed, emerging and developing countries are demonstrated, by use of engineering as well as natural and social science approaches.

Handouts and links are provided online.

Information on books and other literature references is communicated during the course.

The course shall particularly elucidate the cross section of Agro- and Food Sciences in the context of important global problems to be solved. Furthermore the students in the first year of studies shall be given some insight and outlook supporting the development of their views and interests in agricultural and food sciences further.

The course is part of the block exam after the first study year. Paper copies can be used ("Open Book") during the on-line exam, but no other means are not allowed. The course is taught in German.

### Additional First Year Courses

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<tr>
<th>Number</th>
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<th>ECTS</th>
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<tbody>
<tr>
<td>751-0801-00L</td>
<td>Biology I: Laboratory Exercises</td>
<td>O</td>
<td>1</td>
<td>2U</td>
<td>E. B. Truernit</td>
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<tr>
<td>Objective</td>
<td>Capability of preparing biological specimen, microscopy and documentation. Understanding the correlation between plant structure and function at the level of organs, tissues and cells. Awareness of the link between plant anatomy, systematics, physiology, ecology, and development.</td>
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<tr>
<td>Literature</td>
<td>Handouts</td>
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<tr>
<td>Prerequisites / notice</td>
<td>For further reading (not obligatory): Gerhard Wanner: Mikroskopisch-Botanisches Praktikum, Georg Thieme Verlag, Stuttgart.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Groups of a maximum of 30 students.</td>
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<tr>
<td>751-0001-00L</td>
<td>Introduction to the Study Program</td>
<td>E-</td>
<td>0</td>
<td>1V</td>
<td>Lecturers</td>
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<tr>
<td>Abstract</td>
<td>Technical and organizational guidance to Freshmen. Support to Freshmen in Agricultural Science and Food Sciences Information on: Program structure, regulations, bachelor thesis, project work, practice and the importance of first year basics. Organization: department, institutes, professorships and research, students' associations.</td>
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<tr>
<td>Objective</td>
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<tr>
<td>Content</td>
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<tr>
<td>Literature</td>
<td>The script will be published on the web. Details will be provided on the first day of the semester.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>A thorough study of all script materials is requested before the course starts.</td>
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<tr>
<th>Number</th>
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<tr>
<td>529-0030-00L</td>
<td>Laboratory Course: Elementary Chemical Techniques</td>
<td>O</td>
<td>3</td>
<td>6P</td>
<td>N. Kober, M. Morbidelli</td>
</tr>
<tr>
<td>Abstract</td>
<td>This practical course provides an introduction to elementary laboratory techniques. The experiments cover a wide range of techniques, including analytical and synthetic techniques (e. g. investigation of soil and water samples or the preparation of simple compounds). Furthermore, the handling of gaseous substances is practised.</td>
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<tr>
<td>Objective</td>
<td>This course is intended to provide an overview of experimental chemical methods. The handling of chemicals and proper laboratory techniques represent the main learning targets. Furthermore, the description and recording of laboratory processes is an essential part of this course.</td>
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<tr>
<td>Content</td>
<td>The classification and analysis of natural and artificial compounds is a key subject of this course. It provides an introduction to elementary laboratory techniques, and the experiments cover a wide range of analytic and synthetic tasks: Selected samples (e.g. soil and water) will be analysed with various methods, such as titrations, spectroscopy or ion chromatography. The chemistry of aqueous solutions (acid-base equilibria and solvation or precipitation processes) is studied. The synthesis of simple inorganic complexes or organic molecules is practised. Furthermore, the preparation and handling of environmentally relevant gaseous species like carbon dioxide or nitrogen oxides is a central subject of the Praktikum.</td>
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<tr>
<td>Literature</td>
<td>The script will be published on the web. Details will be provided on the first day of the semester.</td>
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<td>Prerequisites / notice</td>
<td>A thorough study of all script materials is requested before the course starts.</td>
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<tr>
<td>252-0839-00L</td>
<td>Informatics</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>L. E. Fässler, H.J. Böckenhauer, M. Dahinden, D. Komn</td>
</tr>
<tr>
<td>Abstract</td>
<td>Students learn to apply selected concepts and tools from computer science for working on interdisciplinary projects. The following topics are covered: publishing over the internet, processing and visualizing time series, visualizing multi-dimensional data, managing data with lists and tables and with relational databases, introduction to macro programming, universal methods for algorithm design.</td>
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</table>
Objective

The students learn to
- choose and apply appropriate tools from computer science,
- process and analyze real-world data from their subject of study,
- handle the complexity of real-world data,
- know universal methods for algorithm design.

Content

1. Simulation and Modeling
2. Visualizing multidimensional data
3. Data management with lists and tables
4. Data management with a relational database
5. Introduction to macro programming
6. Introduction to programming with Python

Lecture notes

All materials for the lecture are available at www.evim.ethz.ch

Prerequisites / notice

This course is based on application-oriented learning. The students spend most of their time working through electronic tutorials and discussing their results with teaching assistants

3. Semester

Basic Courses II: Examination Block 1

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<tr>
<th>Number</th>
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<tr>
<td>402-0063-00L</td>
<td>Physics II</td>
<td>O</td>
<td>5</td>
<td>3V+1U</td>
<td>A. Vaterlaus</td>
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<tr>
<td>Abstract</td>
<td>Introduction to the &quot;way of thinking&quot; and the methodology in Physics, with the help of demonstration experiments. The Chapters treated are Electromagnetism, Refraction and Diffraction of Waves, Elements of Quantum Mechanics with applications to Spectroscopy, Thermodynamics, Phase Transitions, Transport Phenomena. Whenever possible, examples relevant to the students' main field of study are given.</td>
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<tr>
<td>Objective</td>
<td>Introduction to the scientific methodology. The student should develop his/her capability to turn physical observations into mathematical models, and to solve the latter.</td>
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<tr>
<td>Content</td>
<td>Elektromagnetismus, Elektromagnetische Wellen, Wellenoptik, Strahlenoptik, Quantenoptik, Quantenmechanik, Thermische Eigenschaften, Transportphänomene, Wärmestrahlung</td>
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<td>Lecture notes</td>
<td>Skript wird verteilt.</td>
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<tr>
<td>Literature</td>
<td>Friedhelm Kuypers</td>
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<td></td>
<td>Physik für Ingenieure und Naturwissenschaftler</td>
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<td>Band 2 Elektrizität, Optik, Wellen</td>
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<td>Verlag Wiley-VCH, 2003, Fr. 77.-</td>
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<td></td>
<td>Douglas C. Giancoli</td>
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<td>Pearson Studium</td>
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<td>Hans J. Paus</td>
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<td></td>
<td>Physik in Experimenten und Beispielen</td>
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<td>Carl Hanser Verlag, München, 2002, 1068 S.</td>
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<td></td>
<td>Paul A. Tipler</td>
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<td>Spektrum Akademischer Verlag, 1998, 1522 S., ca Fr. 120.-</td>
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<td></td>
<td>David Haliday</td>
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<td>Robert Resnick</td>
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<td>Jearl Walker</td>
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<td>Wiley-VCH, 2003, 1388 S., Fr. 87.- (bis 31.12.03)</td>
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<td>dazu gratis Online Ressourcen (z.B. Simulationen): <a href="http://www.halliday.de">www.halliday.de</a></td>
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<tr>
<td>701-0071-00L</td>
<td>Mathematics III: Systems Analysis</td>
<td>O</td>
<td>4</td>
<td>2V+1U</td>
<td>N. Gruber, P. Landschützer</td>
</tr>
<tr>
<td>Abstract</td>
<td>The objective of the systems analysis course is to deepen and illustrate the mathematical concepts on the basis of a series of very concrete examples. Topics covered include: linear box models with one or several variables, non-linear box models with one or several variables, time-discrete models, and continuous models in time and space.</td>
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<tr>
<td>Objective</td>
<td>Learning and applying of concepts (models) and quantitative methods to address concrete problems of environmental relevance. Understanding and applying the systems-analytic approach, i.e., Recognizing the core of the problem - simplification - quantitative approach - prediction.</td>
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<tr>
<td>Content</td>
<td>Content of lectures: <a href="http://www.up.ethz.ch/education/system_analysis/index_DE">http://www.up.ethz.ch/education/system_analysis/index_DE</a></td>
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<td>Homework: <a href="http://www.up.ethz.ch/education/system_analysis/SA2/index_DE">http://www.up.ethz.ch/education/system_analysis/SA2/index_DE</a></td>
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<td>Overhead slides: <a href="http://www.up.ethz.ch/education/system_analysis/index_DE">http://www.up.ethz.ch/education/system_analysis/index_DE</a></td>
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<tr>
<td>752-4001-00L</td>
<td>Microbiology</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>M. Ackermann, M. Schuppler, J. Vorholt-Zambelli</td>
</tr>
<tr>
<td>Abstract</td>
<td>Teaching of basic knowledge in microbiology with main focus on Microbial Cell Structure and Function, Molecular Genetics, Microbial Growth, Metabolic Diversity, Phylogeny and Taxonomy, Prokaryotic Diversity, Human-Microbe Interactions, Biotechnology.</td>
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<tr>
<td>Content</td>
<td>Wird von den jeweiligen Dozenten ausgegeben.</td>
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<td>Lecture notes</td>
<td>Die Behandlung der Themen erfolgt auf der Basis des Lehrbuchs Brock, Biology of Microorganisms</td>
<td></td>
<td></td>
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<tr>
<td>Literature</td>
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</tr>
<tr>
<td>701-0255-00L</td>
<td>Biochemistry</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>H.P. Kohler</td>
</tr>
</tbody>
</table>

Data: 06.02.2019 13:00

Autumn Semester 2015
Abstract
Building on the biology courses in the 1st and 2nd semesters, this course covers basic biochemical knowledge in the areas of enzymology and metabolism. Those completing the course are able to describe and understand fundamental cellular metabolic processes.

Objective
Students are able to understand
- the structure and function of biological macromolecules
- the kinetic bases of enzyme reactions
- thermodynamic and mechanistic basics of relevant metabolic processes
Students are able to describe the relevant metabolic reactions in detail

Content
Program
Introduction, basics, composition of cells, biochemical units, repetition of relevant organic chemistry
Structure and function of proteins
Carbohydrates
Lipids and biological membranes
Enzymes and enzyme kinetics
Catalytic strategies
Metabolism: Basic concepts and design. Repetition of basic thermodynamics
Glycolysis, fermentation
The citric acid cycle
Oxidative phosphorylation
Fatty acid metabolism

Lecture notes
Horton et al. (Pearson) serves as lecture notes.

Prerequisites / notice
Basic knowledge in biology and chemistry is a precondition.

701-0501-00L Pedosphere

Abstract
Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

Objective
Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

Content
Definition of the pedosphere, soil functions, rocks as parent materials, minerals and weathering, soil organisms, soil organic matter, physical soil properties and functions, chemical soil properties and functions, soil formation, principles of soil classification, global soil regions, soil fertility, land use and soil degradation.

Lecture notes
Lecture notes can be purchased during the first lecture (15.- SFr)

Literature

Prerequisites / notice
Prerequisites: Basic knowledge in chemistry, biology and geology.

751-1101-00L Finances and Accounting System

Abstract
To understand accounting as a component of the complex system of the enterprise

Objective
To understand accounting not as an isolated discipline, but as a part of the complex system of the enterprise

Content
Accounting system as part of management economics.
The different steps for scheduling and evaluation of the accountancy will be studied. The main part of the lecture is dedicated to the financial accounting. Nevertheless the fundamentals of the internal cost-accounting will also be presented. The lecture will also include the clarification of concrete cases and the calculation of practical exercises.

Lecture notes
Course documentation and specified educational books

Literature
In the lecture one indicates

752-6003-00L Introduction to Nutritional Science

Abstract
This course introduces basic concepts of micro- and macronutrient nutrition. Micronutrients studied include fat-soluble and water-soluble vitamins, minerals and trace elements. Macronutrients include proteins, fat and carbohydrates.

Objective
To introduce the students to the both the macronutrients and the micronutrients.

Content
The lectures on micronutrients are given by Prof. Zimmermann and the lectures on macronutrients are given by Prof. Wolfrum. Prof. Zimmermann discusses the micronutrients, including fat-soluble vitamins, water-soluble vitamins, minerals and trace elements. Prof. Wolfrum introduces basic nutritional aspects of proteins, fats, carbohydrates and energy metabolism.

Lecture notes
There is no script. Powerpoint presentations will be made available.

Literature
Elmadfa I & Leitzmann C: Ernährung des Menschen
UTB Ulmter, Stuttgart, 4. überarb. Ausgabe 2004

Garrow JS and James WPT: Human Nutrition and Dietetics
Churchill Livingstone, Edinburgh, 11th rev. ed. 2005

---

Basic Courses II: Examination Block 2

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
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<tr>
<td>751-1551-00L</td>
<td>Ressourcen- und Umweltökonomie</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>L. Bretschger, A. Müller</td>
</tr>
</tbody>
</table>

Relationship between economy and environment, market failure, external effects and public goods, contingent valuation, internalisation of externalities; economics of non-renewable resources, economics of renewable resources, cost-benefit analysis, sustainability, and international aspects of resource and environmental economics.
Objective: Understanding of the basic issues and methods in resource and environmental economics; ability to solve typical problems in the field using the appropriate tools, which are concise verbal explanations, diagrams or mathematical expressions.

Topics are:
- Introduction to resource and environmental economics
- Importance of resource and environmental economics
- Main issues of resource and environmental economics
- Normative basis
- Utilitarianism
- Fairness according to Rawls
- Economic growth and environment
- Externalities in the environmental sphere
- Governmental internalisation of externalities
- Private internalisation of externalities: the Coase theorem
- Free rider problem and public goods
- Types of public policy
- Efficient level of pollution
- Tax vs. permits
- Command and Control Instruments
- Empirical data on non-renewable natural resources
- Optimal price development: the Hotelling-rule
- Effects of exploration and Backstop-technology
- Effects of different types of markets.
- Biological growth function
- Optimal depletion of renewable resources
- Social inefficiency as result of over-use of open-access resources
- Cost-benefit analysis and the environment
- Measuring environmental benefit
- Measuring costs
- Concept of sustainability
- Technological feasibility
- Conflicts sustainability / optimality
- Indicators of sustainability
- Problem of climate change
- Cost and benefit of climate change
- Climate change as international ecological externality
- International climate policy: Kyoto protocol
- Implementation of the Kyoto protocol in Switzerland

Content: Economy and natural environment, welfare concepts and market failure, external effects and public goods, measuring externalities and contingent valuation, internalising external effects and environmental policy, economics of non-renewable resources, renewable resources, cost-benefit-analysis, sustainability issues, international aspects of resource and environmental problems, selected examples and case studies.

Lecture notes: The script and lecture material are provided at: https://moodle-app2.let.ethz.ch/course/view.php?id=140

Literature:
- Schubert S 2006 Pflanzenernährung Grundwissen Bachelor Ulmer UTB

751-6101-00L Anatomy and Physiology of Man and Animals I

Objective: Imparts a basic understanding of physiology an anatomy in man and domestic animals, focusing on the interrelations between morphology and function of the organism, in particular of domestic animals. This is fostered by discussing all subjects from a functional point of view. The lecture consists of two consecutive parts.

Content: The aim of these lecture is to present the processes controlling the uptake and transport of nutrients and water by the plant, the assimilation of nutrients in the plant, the effect of nutrients on crop yield and quality, the role of the soil as a source of nutrients for crops, and the basic principles of fertilization of different crop types using mineral and organic fertilizers.

Lecture notes: The aim of these lecture is to present the processes controlling the uptake and transport of nutrients and water by the plant, the assimilation of nutrients in the plant, the effect of nutrients on crop yield and quality, the role of the soil as a source of nutrients for crops, and the basic principles of fertilization of different crop types using mineral and organic fertilizers.

Literature:
- Schubert S 2006 Pflanzenernährung Grundwissen Bachelor Ulmer UTB
- pictures of nutrients deficiency symptoms: http://www.tll.de/visuplant/vp_idx.htm

751-4501-00L Plant Nutrition I

Objective: The aim of these lecture is to present the processes controlling the uptake and transport of nutrients and water by the plant, the assimilation of nutrients in the plant, the effect of nutrients on crop yield and quality, the role of the soil as a source of nutrients for crops, and the basic principles of fertilization of different crop types using mineral and organic fertilizers.

Content: At the end of the lecture, students know how mineral nutrients and water are taken up through roots and circulate in the plants and what their roles in plants are. They understand the importance of nutrients for yield formation and for crop product quality. They are able to propose fertilization plans adapted for field crops growing under Swiss conditions.

Lecture notes: We will distribute a script for the part dealing with the physiology of plant nutrition. For the part on fertilization we will use the booklet of ACW and ART presenting the recommendations for the fertilization of crops and grassland in Switzerland (GRUDAF/DBF).

Literature:
- Schubert S 2006 Pflanzenernährung Grundwissen Bachelor Ulmer UTB
- pictures of nutrients deficiency symptoms: http://www.tll.de/visuplant/vp_idx.htm

751-3401-00L Plant Nutrition I
Objective
At the end of this course in Applied Entomology, students will have (1) an overview on herbivore insects (pests) and their natural antagonists in agroecosystems, combined with an insight into ongoing research, and (2) an in-depth understanding of population dynamics and damage development based on selected examples from the areas of plant, animal and public health.

751-4501-01L Phytomedicine: Plant Pathology

Abstract
Plant Pathology topics: plant diseases in agroecosystems, categories of pathogens, pathogen life histories, pathogen attack and plant defense, gene-for-gene systems, and disease control strategies. Back to top

Objective
Gain an understanding of the causes and consequences of plant diseases in agroecosystems.

Content

Lecture notes
Lecture notes will be available for purchase at the cost of reproduction.

Literature


751-6301-00L Animal Breeding

Abstract
Introduction to basics of animal breeding. Importance of animal production. Species of livestock and their products, performance recording, functional traits, genetic diversity, breeding goals. Qualitative and quantitative traits. Basic knowledge of breeding methods: genetic and environmental variation, heritability, genetic correlation, estimation of breeding values, selection, mating systems.

Objective
Show the importance of animal production for Swiss and international agriculture. Name the livestock species, their products, systematic classification and breeding and production goals. Describe methods to measure animal performance (performance recording) and functional traits. Define the most important parameters and methods in animal breeding.

Content

Lecture notes
Transparencies and single chapters of textbook are made available on homepage.

Literature
Tierzucht (William/Simianer) UTB 3526 (2011)

Additional literature to be announced in the lecture.

Agricultural and Resource Economics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<tr>
<td>751-2001-00L</td>
<td>Area Planning and Regional Development</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>C. Lüscher, B. Buser</td>
</tr>
</tbody>
</table>

Abstract
Introduction into Area Planning in Switzerland, basics, legal aspects and instruments. Overview and state of the art. Practical regional development based on concrete experience and projects; basics, legal aspects and state of the art.

Objective
Goals: The student gets an overview over Area Planning in Switzerland with legal aspects, instruments and the actual state of the art. Awareness rising for complex regional planning and developing questions. Introduction in regional development and politics, based on existing and future regulations and their effects on different political levels.

Content
Area Planning:
- Basics of area planning
- Overview over existing regulations in Switzerland
- State of the art in Switzerland
- links between area planning and environmental protection

regional development:
- Basics for a successful regional development based on personal field experience
- discussion of the different instruments
- stake holders and their role in regional politics
- case studies for developing strategies (in small study groups)

Lecture notes
no script will be delivered, mainly for technical reasons; all necessary stuff will be delivered as papers or via internet.

Literature
no literature

Prerequisites / notice
german spoken (with translation of french and italian technical terms)

751-1651-00L World Food Economy and Agricultural Markets

Abstract
Following microeconomic courses we teach in this course economic aspects of the world food situation and the international and national agricultural markets. It contains aspects of supply, demand, price determination, market structures and instruments of the agricultural trade.

Objective
Economic understanding of agricultural markets and the aspects of the world food problem.

Content
Part I: Principles of agricultural economics
- Microeconomic analysis of supply, demand, and price determination in agricultural markets.

Part II: Aspects of globalization, development, natural resources and public health.

Part III: Analysis of selected agricultural and commodity markets: grains, oilseeds, sugar, ethanol and crude oil, milk and meat.

Lecture notes
Handouts (power point presentations)

Literature
Southgate. D. et al., 2010. The World Food Economy, Blackwell Publishing, Malden MA,USA

5. Semester

Focus Agricultural Natural Sciences

Focus Agricultural Natural Sciences

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>751-4001-00L</td>
<td>Forage Cropping</td>
<td>W+</td>
<td>2 credits</td>
<td>2G</td>
<td>N. Buchmann, A. Lüscher</td>
</tr>
</tbody>
</table>

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 7 of 1434
Abstract
This course is an introduction into forage cropping and grassland sciences. Topics include: extensive/intensive use, grassland evaluation, grassland maintenance, management using fertilization, cutting, etc. Relationships between site, vegetation composition and management will be explored.

Objective
Die Studierenden werden wichtige Mischungen und Pflanzengemeinschaften mitteleuropäischer Graslandökosysteme kennen, klassische und aktuelle Arbeiten der Bestandesökophysiologie kennen, in der Lage sein, den Einfluss von Umweltfaktoren und Bewirtschaftung nicht nur auf Einzelpflanzen sondern auf Pflanzenbestände und ihre Erträge abzuschätzen, und üben, ein wissenschaftliches Thema schriftlich prägnant zusammenzufassen.

Content
In diesem Kurs werden die verschiedenen Typen des Futterbaus und die wichtigsten Mischungen, aber auch natürliche Pflanzengemeinschaften in Mitteleuropa vorgestellt (Bestandesbeurteilung). Basierend auf der Ökophysiologie von Einzelpflanzen wird die Ökophysiologie von Pflanzenbeständen erarbeitet. Es werden verschiedene Arten der Bewirtschaftung vorgestellt (z. B. Bestandeslenkung durch Düngung, Beweidung, Schnitttermine, etc.) und ihre Auswirkungen auf die Bestandeszusammensetzung und auf die Erträge diskutiert. Feedback-Mechanismen zwischen Umwelt und Futterbausystemen werden angesprochen.

Lecture notes
Handouts werden auf dem Netz zur Verfügung gestellt.

Literature
Kurse werden in der Veranstaltung angesprochen.

Prerequisites / notice
Course will be given in German. Course builds on the Ertrags- und Ökophysiologie lecture and provides the basics for the Graslandsysteme.

751-4101-00L Horticulture I
Abstract
Presentation of the central crops of our regions (cereals, oil and fibre plants, legumes, root and tuber plants) with respect to their biology, site requirements, reaction to environmental conditions and farming practice. A few crops of other regions will be discussed for these aspects as well.

Objective
During this course, students acquire essential knowledge on agriculturally relevant aspects of crop biology. Via lectures and 'hands-on' teaching elements, differences between species as well as common aspects of different species will be experienced. Thereby, the foundation will be laid for a more intense examination of alternative crops, cropping systems and of procedures to characterize geno- and phenotype.

Content
The relevance of horticulture at the international level will be treated in the first block. During the semester in autumn (Horticultural Crops I), post harvest aspects in fruit production are discussed in 2 blocks of 4h. Following on this, viticulture (incl. some aspects of wine making) will be looked at in 3 blocks of 4h. During the spring semester (Horticultural Crops II), 3 blocks of 4h deal with vegetable production, and 2 blocks of 4h are addressing berry production.

Lecture notes
Delivered during the lectures by the different teachers. ELBA upload.

Literature
Not needed, maybe specific literature is specified by the different teachers.

Language and script: German or French, maybe selected parts in English.

751-4201-00L System-Oriented Management of Herbivore Insects I
Abstract
The focus will be on the basic principles of biology and ecology of weeds, crop-weed interactions and basic knowledge of chemical, physical and biological weed control with their respective (dis-) advantages. Furthermore students will get an introduction on the mechanisms of weed management in different farming systems and crops.

Objective
The students gain a good understanding of fundamental aspects of pest management in agroecosystems. They will have the ability to assess options for action in view of requirements from the economy, the ecology and the society. Further, they will learn to perform searches on relevant issues in pest management, and to critically evaluate case studies.

Content
- Programmteil Wiederkäuer: Einführung in die Winterfütterungsplanung für Milchkühe, Betriebsbesuch (Erfassung aller notwendigen Daten inkl. Futterprobenentnahme für eine konkrete Planung auf einem Praxisbetrieb), Besonderheiten der Milchviehfütterung (Laktationsverlauf, Jahrestafel, etc.). Einführung in den LBL-Fütterungsplan, Möglichkeiten der Futterbeurteilung und -bewertung mit praktischer Beurteilung der gesammelten Proben, Berechnungen und Besprechung Fütterungsplan, Aufstellung der Mineralstoffbilanz, Vorführung von PC-Software zur Fütterungsplanung Vorstellen und diskutieren des Fütterungsplanes auf dem Praxisbetrieb durch die Gruppe.
- Programmteil Nicht-Wiederkäuer: Der Energie- und spezifische Nährstoffbedarf beim Schwein und Geflügel; Besonderheiten der Fütterung in den verschiedenen Produktionsphasen; Fütterungsempfehlungen und -hinweise. Rationengestaltung und Rezeptoptimierung für Mischfuttermittel anhand verschiedener Beispiele; Einsatzgrenzen von Futtermitteln; technologische Futterbearbeitung.

Lecture notes
Handouts in German language will be provided by each lecturer when starting his part of the lecture.

Literature
Die Dozierenden geben in der Lehrveranstaltung die relevante Literatur bekannt.

Prerequisites / notice
Blockkurs in Halbtagesform; eingeschlossen sind Betriebsbesuche. Fach mit benoteter Semesterleistung.

751-7101-00L Applied Animal Nutrition
Abstract
The focus will be on the principles of biology and ecology of weeds, crop-weed interactions and basic knowledge of chemical, physical and biological weed control with their respective (dis-) advantages. Furthermore students will get an introduction on the mechanisms of weed management in different farming systems and crops.

Objective
The students are able, based on the knowledge they obtain in this course, to deal with problems in the nutrition of ruminants, pigs and poultry on farm.

Content
- Programmteil Wiederkäuer: Einführung in die Winterfütterungsplanung für Milchkühe, Betriebsbesuch (Erfassung aller notwendigen Daten inkl. Futterprobenentnahme für eine konkrete Planung auf einem Praxisbetrieb), Besonderheiten der Milchviehfütterung (Laktationsverlauf, Jahrestafel, etc.). Einführung in den LBL-Fütterungsplan, Möglichkeiten der Futterbeurteilung und -bewertung mit praktischer Beurteilung der gesammelten Proben, Berechnungen und Besprechung Fütterungsplan, Aufstellung der Mineralstoffbilanz, Vorführung von PC-Software zur Fütterungsplanung Vorstellen und diskutieren des Fütterungsplanes auf dem Praxisbetrieb durch die Gruppe.
- Programmteil Nicht-Wiederkäuer: Der Energie- und spezifische Nährstoffbedarf beim Schwein und Geflügel; Besonderheiten der Fütterung in den verschiedenen Produktionsphasen; Fütterungsempfehlungen und -hinweise. Rationengestaltung und Rezeptoptimierung für Mischfuttermittel anhand verschiedener Beispiele; Einsatzgrenzen von Futtermitteln; technologische Futterbearbeitung.

Lecture notes
Handouts in German language will be provided by each lecturer when starting his part of the lecture.

Literature
Die Dozierenden geben in der Lehrveranstaltung die relevante Literatur bekannt.

Prerequisites / notice
Blockkurs in Halbtagesform; eingeschlossen sind Betriebsbesuche. Fach mit benoteter Semesterleistung.

751-7103-00L Animal Feed and Feeding of Ruminant
Abstract
The knowledge of the nutrition of ruminants and of the feeds used is deepened. Particular emphasis is put on the variety of home-grown feeds, their production and conservation and their application in the nutrition of dairy cows, cattle and small ruminants. Finally, information on specific problems of animal nutrition is communicated.
**Objective**  
Purschase of basic skills in agricultural livestock nutrition.

**Content**  

**Lecture notes**  
Script is available in German language and will be provided by each lecturer when starting his part the lecture.

**Literature**  
Eine Literaturliste ist im Skript enthalten.

**Prerequisites / notice**  
Fach mit benoteter Semesterendprüfung

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**751-6121-00L Regulatory Physiology**  
<table>
<thead>
<tr>
<th>W+</th>
<th>2 credits</th>
<th>2V</th>
<th>S. E. Ulbrich, M. C. Härdi-Landerer</th>
</tr>
</thead>
</table>

**Abstract**  
Hormone und Zytokine spielen als Signalmediatoren eine besondere Rolle bei der Regulation der Homöostase von Körperfunktionen (Flüssigkeits-, Temperatur-, Energie-Homöostase, Immunität). Insbesondere im Zusammenhang mit pathologischen Konstellationen (Fieber, Stress, metabolische Imbalance, Schmerzen) wird diese komplexe Funktion verständlich, Vermittlung von Methoden zur Hormonanalytik.

**Objective**  
Die Grundlagen zu aktuellen Problemen der Tiersgesundheit und Tierhaltung werden vor diesem Hintergrund verstanden. Die Studierenden sind fähig, mit fundierten Kenntnissen aktuelle Themen zu diskutieren.

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**751-4504-00L Plant Pathology I**  
| W | 2 credits | 2G | F. Talas, B. McDonald, J. Palma Guerrero, A. Sanchez Vallet |

**Abstract**  
Plant Pathology I will focus on pathogen-plant interactions, epidemiology, disease assessment, and disease development in agroecosystems. Themes will include: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems.

**Objective**  
Students will understand: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems. Themes will include: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems. Topics under the first theme will include pathogen life cycles, disease cycles, and an overview of plant pathogenic nematodes, viruses, bacteria, and fungi. Topics under the second theme will include plant defense strategies, host range, passive and active defenses, and chemical and structural defenses. Topics under the third theme will include the disease triangle and cultural control strategies.

**Lecture Topics and Tentative Schedule**

**Week 1** No Lecture: First day of autumn semester

**Week 2** The nature of plant diseases, symbiosis, parasites, mutualism, biotrophs and necrotrophs, disease cycles and pathogen life cycles. Nemate attack strategies and types of damage.

**Week 3** Viral pathogens, classification, reproduction and transmission, attack strategies and types of damage. Examples TMV, BYDV, plum pox virus. Bacterial pathogens and phytoplasmas, classification, reproduction and transmission. Bacterial attack strategies and symptoms. Example bacterial diseases: fire blight, Agrobacterium crown gall, soft rots.

**Week 4** Fungal pathogens, classification, growth and reproduction, sexual and asexual spores, transmission. Fungal life cycles, disease cycles, infection processes, colonization, phytotoxins and mycotoxins. Attack strategies of fungal necrotrophs and biotrophs.

**Week 5** Symptoms and signs of fungal infection. Example fungal diseases: potato late blight, wheat stem rust, grape powdery mildew, wheat Septoria leaf blotch.

**Week 6** Plant defense mechanisms, host range and non-host resistance. Passive structural and chemical defenses, peroxide chemical defenses. Active structural defense, papilae, active chemical defense, hypersensitive response, pathogenesis-related (PR) proteins, phytoalexins and disease resistance.

**Week 7** Pisatin and pisatin demethylease. Local and systemic acquired resistance, signal molecules.

**Week 8** Pathogen effects on food quality and safety.

**Week 9** Epidemiology: historical epidemics, disease pyramid, environmental effects on epidemiological development. Plant effects on development of epidemics, including resistance, physiology, density, uniformity.

**Week 10** Disease assessment: incidence and severity measures, keys, diagrams, scales, measurement errors. Correlations between incidence and severity.

**Week 11** Molecular detection and diagnosis of pathogens. Host indexing, serology, monoclonal and polyclonal antibodies. ELISA, PCR, rDNA and rep-PCR.

**Week 12** Strategies for minimizing disease risks: principles of disease control and management.

**Week 13** Disease control strategies: economic thresholds, physical control methods.

**Week 14** Cultural control methods: avoidance, tillage practices, crop sanitation, fertilizers, crop rotation.

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**751-5003-00L Sustainable Agroecosystems II**  
| W+ | 2 credits | 2V | J. Six, A. Hofmann |

**Abstract**  
This class is intended to convey methods of agroecological research through selected case studies from current research projects and hands-on exercises. Students will gain an overview on actors in the field of sustainable agricultural development.

**Objective**  
(1) Get to know methods for field and laboratory investigations in agroecology; (2) Analyze case studies from current agroecological research; (3) Place institutions and related projects into the context of sustainable agricultural development.

**Literature**  

**Prerequisites / notice**  
Prior participation in the lecture Nachhaltige Agrärkösysteme I (Sustainable Agroecosystems I) 751-5000-00G (in spring semester) recommended; classes taught mostly in English

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### Complementary Courses in Agricultural Natural Sciences

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
---|---|---|---|---|---
751-1307-00L | Managerial Economics Agri-Food Chain: Strategic Concepts | W | 2 credits | 2G | B. Höltscbi, M. Weber

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*Data: 06.02.2019 13:00  Autumn Semester 2015  Page 9 of 1434*
Abstract
Learn and exercise strategic concepts in the Agri-Food chain, i.e. theories of economics based decision making combined with entrepreneurial practice.

Objective
The main objective is to understand strategic decisions along the value chain in the Agri-Food Chain.

Content
- Basics of strategy & strategic concepts
- Classic process of strategy process
- Selected alternative processes
- Case studies

Lecture notes
Dokuments will be distributed per lecture.

Literature
Lombriser Roman & Aplanalp Peter: Strategisches Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>751-0401-00L</td>
<td>Operations Research: Linear and Non-Linear</td>
<td>W+</td>
<td>2</td>
<td>3G</td>
<td>S. Peter</td>
</tr>
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</table>

P.S.: Indoor work processes: 'Agrartechnik II' spring term 2009

Part 2: Work economics
- work-economics-related guiding figures (time measurements, statistical processing, data recording using a work diary, sources of work-economics-related planning data, application for 'Agroscope FAT' machine costs lists, 'LBL' planning basics, etc.).
- working time models (work and production process level, process comparisons, process optimisation through growth and/or specialising of farm, cooperation with others, work productivity) including PROOF model to calculate time consumption off different procedures
- 'Agroscope FAT' (agricultural research station in Tänikon) work budget (integration of modules in entire farm, available field work days and weather risk, farm management-related work and special tasks, use of a detailed or global work budget, comparison of target and actual situation in terms of work economics

P.S.: Outdoor mechanisation: 'Agrartechnik II' spring term 2009

Focus Agricultural and Resource Economics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<tr>
<td>751-1501-01L</td>
<td>Development Economics II</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>A. C. Crole-Rees, U. Egger</td>
</tr>
<tr>
<td>Abstract</td>
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<td>Objective</td>
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<tr>
<td>Content</td>
<td>Development economics II is a follow-up of &quot;Development economics I&quot;.</td>
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</tr>
<tr>
<td>Literature</td>
<td>PPT and selected articles. A monograph is also distributed.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prerequisite: Attendance of introductory micro- and macroeconomics classes. Development economics I &amp; II are one unit.</td>
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Focus Agricultural and Resource Economics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>751-1501-01L</td>
<td>Development Economics II</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>A. C. Crole-Rees, U. Egger</td>
</tr>
<tr>
<td>Objective</td>
<td>The course</td>
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</tbody>
</table>
Programming

Abstract
Introduction in to the methods of Operations Research to solve conceptual tasks by means of mathematical models

Objective
Gives an introduction in to the methods of Operations Research (OR) aiming to solve conceptual tasks by means of mathematical models.

Content
As a basic course for Operations Research (OR) the most important models and algorithms of OR will be worked out. A first part deals with the theory of linear programming (LP) (incl. duality). Practical exercises as well as on paper as on the computer serve to better understand the theoretical part of the course. The second part is about the basics of non-linear programming (NLP) (FOC, SOC, Lagrange, Kuhn-Tucker). Here as well, exercises help to improve the understanding of theoretical basics.

Lecture notes
In the lecture one indicates

Literature

751-1307-00L Managerial Economics Agri-Food Chain: Strategic Concepts

Abstract
Learn and exercise strategic concepts in the Agri-Food chain, i.e. theories of economics based decision making combined with entrepreneurial practice.

Objective
The main objective is to understand strategic decisions along the value chain in the Agri-Food Chain.

Content
- Basics of strategy & strategic concepts
- Classic process of strategy process
- Selected alternative processes
- Case studies

Lecture notes
Dokuments will be distributed per lecture.

Literature
Lombriser Roman & Aplanalp Peter: Strategisches Management

751-1501-01L Development Economics II

Abstract
The course

Objective
The objectives of this course are to: understand the role of agriculture in the development process; learn about the relevant actors, the small-scale farmers, and how to integrate them into economic development and to be able to derive sound policy measures.

Content
Development economics II is a follow-up of "Development economics I".

The main topic is the role of agriculture and in the development process. The main features of this sector will be presented. In many developing countries that are at the beginning of economic development the largest share of the population is often involved in agriculture. In agriculture the production factor land is more important than in other sectors. Agriculture together with fisheries is the only sector that produces food. Food can either be produced locally or imported.

Farmers, even small-scale farmers, are integrated in the monetary world. Trade is very important for growth, food security and environment conservation.

The following topics will be tackled: role of agriculture in economic development, definition of sustainability, role of the various stakeholders in the agricultural sector.

Lecture notes
PPT and selected articles. A monograph is also distributed.

Literature

Prerequisites / notice
Prerequisite: Attendance of introductory micro- and macroeconomics classes. Development economics I & II are one unit.

752-2120-00L Consumer Behaviour I

Abstract
Introduction in consumer research. The following aspects will be emphasized in the course: Consumer decision making, individual determinants of consumer behavior, environmental influences on consumer behavior, influencing consumer behavior

Objective
Introduction in consumer research. The following aspects will be emphasized in the course: Consumer decision making, individual determinants of consumer behavior, environmental influences on consumer behavior, influencing consumer behavior

751-8001-00L Agricultural Engineering I

Abstract
Presentation of basics in planning of agricultural buildings, work economics. This lecture forms the basis for the Agrartechnik II course (indoor and outdoor work processes).

Objective
Main objectives: The students acquire comprehensive functional knowledge about agricultural engineering systems (including construction) enabling them to plan and assess the use of those systems in practice.

Subobjectives:

- Basics in agricultural construction will show that a professional implementation of functional, animal-friendly, environmentally sound (and economically advantageous) construction of buildings is feasible.
- Profound knowledge of planning tools based on work economics will help the students to correctly plan the substitution of agricultural work by efficient technical solutions.
Die Studierenden werden wichtige Mischungen und Pflanzengemeinschaften mitteleuropäischer Graslandökosysteme kennen, klassische
- Evaluation of typical roof structures in agricultural buildings.
- Loads: snow, wind, dead and live loads
- Physical properties of building materials: timber, steel, concrete.
- Reinforcement of concrete
- Housing systems for cattle, pigs, poultry, horses
- Storage plants for slurry, manure, feed.
- Planning. Space and functioning programme, building concepts, financing, permit of building, detailed plans, contractors
- Planning and designing exercise.

P.S.: Indoor work processes: ‘Agrartechnik II’ spring term 2009

Part 2: Work economics
- work-economics-related guiding figures (time measurements, statistical processing, data recording using a work diary, sources of work-
- working time models (work and production process level, process comparisons, process optimisation through growth and/or specialising
- of farm, cooperation with others, work productivity) including PROOF model to calculate time consumption off different procedures
- ‘Agroscope FAT’ (agricultural research station in Tänikon) work budget (integration of modules in entire farm, available field work days
- and weather risk, farm management-related work and special tasks, use of a detailed or global work budget, comparison of target and
- actual situation in terms of work economics


751-0902-00L Microeconomics II W+ 2 credits 2V S. Briner
Abstract In the lecture different models of individual and firms' decisions are presented. Above all it is discussed how firms behave under special conditions like mono- or oligopolies or under uncertain conditions.
Objective Acquirement of knowledge on advanced microeconomic approaches as well as their applicability on current economic problems and questions of human behavior
Content Theory & Examples on Game Theory, Oligopoly Theory, Asymmetric Information, as well as Production-, Exchange-, and Welfare-Analysis
Lecture notes Documents will be handed out during the seminar

▶▶▶ Complementary Courses in Agricultural and Resource Economics

<table>
<thead>
<tr>
<th>Number</th>
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<tr>
<td>751-4001-00L</td>
<td>Forage Cropping</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>N. Buchmann, A. Lüscher</td>
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<tr>
<td>751-4101-00L</td>
<td>Crops</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>A. Walter, F. Liebis, W. Richner</td>
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<tr>
<td>751-4201-00L</td>
<td>Horticulture</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>L. Bertschinger, F. Gasser, J.L. Spring</td>
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<td>751-0902-00L</td>
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<td>2V</td>
<td>S. Briner</td>
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Data: 06.02.2019 13:00 Autumn Semester 2015 Page 12 of 1434
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Lecture Type</th>
<th>Prerequisites / notice</th>
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<tbody>
<tr>
<td>751-4801-00L</td>
<td>System-Oriented Management of Herbivore Insects I</td>
<td>W 2G</td>
<td>D. Mazzi</td>
<td>Language and script: German or French, maybe selected parts in English.</td>
</tr>
<tr>
<td>Abstract</td>
<td>The focus is on the potential to assess strategies and tactics of pest management, taking into account the demands from the economy, the environment and the society. Significant agricultural approaches will be explained using practical examples, including prevention using natural resources, surveillance and forecasting, resistance management, as well as product registration, incl. ecotoxicology.</td>
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<tr>
<td>Objective</td>
<td>The students gain a good understanding of fundamental aspects of pest management in agroecosystems. They will have the ability to assess options for action in view of requirements from the economy, the ecology and the society. Further, they will learn to perform searches on relevant issues in pest management, and to critically evaluate case studies.</td>
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<tr>
<td>Abstract</td>
<td>The basics of planning of feeding and formulation of diets incl. the implications on nutrient cycles and balances are taught. In the part dealing with ruminants, forage-based diets and the application of feed formulation programs are central and exercised on-farm. With pigs and poultry, the basics of energy and nutrient requirements are deepened through practical examples.</td>
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<tr>
<td>Objective</td>
<td>The students are able, based on the knowledge they obtain in this course, to deal with problems in the nutrition of ruminants, pigs and poultry on farm.</td>
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<tr>
<td>Content</td>
<td>- Programmteil Wiederkäuer: Einführung in die Winterfütterungsplanung für Milchkühe, Betriebsbesuch (Erfassung aller notwendigen Daten inkl. Futterprobenentnahme für eine konkrete Planung auf einem Praxisbetrieb), Besonderheiten der Milchviehhaltung (Laktationsverlauf, Jahreszeit, etc.); Einführung in den LBL-Fütterungsplan, Möglichkeiten der Futterbeurteilung und -bewertung mit praktischer Beurteilung der gesammelten Proben, Berechnungen und Besprechung Fütterungsplan, Aufstellung der Mineralstoffbilanz, Vorführung von PC-Software zur Fütterungsplanung Vorstellen und diskutieren des Fütterungsplanes auf dem Praxisbetrieb durch die Gruppe.</td>
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<td>- Programmteil Nicht-Wiederkäuer: Der Energie- und spezifische Nährstoffbedarf beim Schwein und Geflügel; Besonderheiten der Fütterung in den verschiedenen Produktionsphasen; Fütterungsempfehlungen und -hinweise. Rationengestaltung und Rezeptoptimierung für Mischfuttermittel anhand verschiedener Beispiele; Einsatzgrenzen von Futtermittel; technologische Futterbearbeitung.</td>
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<tr>
<td>Literature</td>
<td>Handouts in German language will be provided by each lecturer when starting his part of the lecture.</td>
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<tr>
<td></td>
<td>Die Dozierenden geben in der Lehrveranstaltung die relevante Literatur bekannt.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Blockkurs in Halbtagesform; eingeschlossen sind Betriebsbesuche. Fach mit benoteter Semesterleistung.</td>
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<tr>
<td>751-5003-00L</td>
<td>Sustainable Agroecosystems II</td>
<td>W 2V</td>
<td>J. Six, A. Hofmann</td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>This class is intended to convey methods of agroecological research through selected case studies from current research projects and hands-on exercises. Students will gain an overview on actors in the field of sustainable agricultural development.</td>
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<tr>
<td>Objective</td>
<td>(1) Get to know methods for field and laboratory investigations in agroecology, (2) Analyze case studies from current agroecological research, (3) Place institutions and related projects into the context of sustainable agricultural development.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prior participation in the lecture Nachhaltige Agrarökosysteme I (Sustainable Agroecosystems I) 751-5000-00G (in spring semester) recommended; classes taught mostly in English</td>
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<tr>
<td>751-4504-00L</td>
<td>Plant Pathology I</td>
<td>W 2G</td>
<td>F. Talas, B. McDonald, J. Palma Guerrero, A. Sanchez Vallet</td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>Plant Pathology I will focus on pathogen-plant interactions, epidemiology, disease assessment, and disease development in agroecosystems. Themes will include: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems.</td>
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<tr>
<td>Objective</td>
<td>Students will understand: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems as a basis for implementing disease management strategies in agroecosystems.</td>
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</table>
Course description: Plant Pathology I will focus on pathogen-plant interactions, epidemiology, disease assessment, and disease development in agroecosystems. Themes will include: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems. Topics under the first theme will include pathogen life cycles, disease cycles, and an overview of plant pathogenic nematodes, viruses, bacteria, and fungi. Topics under the second theme will include plant defense strategies, host range, passive and active defenses, and chemical and structural defenses. Topics under the third theme will include the disease triangle and cultural control strategies.

Lecture Topics and Tentative Schedule

Week 1  No Lecture: First day of autumn semester

Week 2  The nature of plant diseases, symbiosis, parasites, mutualism, biotrophs and necrotrophs, disease cycles and pathogen life cycles. Nematoide attack strategies and types of damage.


Week 5  Symptoms and signs of fungal infection. Example fungal diseases: potato late blight, wheat stem rust, grape powdery mildew, wheat Septoria leaf blotch.

Week 6  Plant defense mechanisms, host range and non-host resistance. Passive structural and chemical defenses, perforemed chemical defenses. Active structural defense, papillae, active chemical defense, hypersensitive response, pathogenesis-related (PR) proteins, phytoalexins and disease resistance.

Week 7  Pisatin and pisatin demethylase. Local and systemic acquired resistance, signal molecules.

Week 8  Pathogen effects on food quality and safety.

Week 9  Epidemiology: historical epidemics, disease pyramid, environmental effects on epidemic development. Plant effects on development of epidemics, including resistance, physiology, density, uniformity.

Week 10  Disease assessment: incidence and severity measures, keys, diagrams, scales, measurement errors. Correlations between incidence and severity.

Week 11  Molecular detection and diagnosis of pathogens. Host indexing, serology, monoclonal and polyclonal antibodies. ELISA, PCR, rDNA and rep-PCR.

Week 12  Strategies for minimizing disease risks: principles of disease control and management.

Week 13  Disease control strategies: economic thresholds, physical control methods.

Week 14  Cultural control methods: avoidance, tillage practices, crop sanitation, fertilizers, crop rotation.

Detailed lecture notes (~160 pages) will be available for purchase at the cost of reproduction at the start of the semester.

Methodical Courses

<table>
<thead>
<tr>
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<tr>
<td>751-1010-00L</td>
<td>Introduction to Scientific Writing in Agricultural Science</td>
<td>O</td>
<td>2 credits</td>
<td>4G</td>
<td>B. Dorn, N. Buchmann, A. K. Gilgen</td>
</tr>
<tr>
<td>751-0441-00L</td>
<td>Scientific Analysis and Presentation of Data</td>
<td>O</td>
<td>2 credits</td>
<td>2G</td>
<td>W. Eugster</td>
</tr>
</tbody>
</table>

Link auf die Webseite mit Informationen und Dokumenten zur Lehrveranstaltung:
http://www.usys.ethz.ch/agr/bachelor/wis
Content

Tentative Programme:
1. Introduction
2. Data acquisition, data organization, data storage, working with data
3. Graphical presentations I - Spreadsheets
5. Correct and problematic graphical data displays
6. Introduction to 'R'
7. Data import and graphical presentation
8. Statistical distribution and confidence intervals
9. Statistical tests - Repetition and hands-on applications
10. Linear regressions
11./12. Analysis of Variance
13. ANOVA - Discussion of results with Prof. E. Frossard

Last week of semester: examination (Leistungskontrolle)

Lecture notes

German

Prerequisites / notice

Theoretical background in ensemble statistics from the mandatory course in the 4th semester; students should have cleared the examination of that fundamental course to be able to follow

Bachelor Thesis

Number Title Type ECTS Hours Lecturers
751-1020-00L Bachelor's Thesis O 14 credits 60D Lecturers

Abstract

Please contact the Study Administration for registration.

Objective

The independent writing of a scientific paper/thesis

Content

It consists of a scientific project carried out independently under the tutorship of a lecturer at the study program in Agricultural Science.

Complementary Courses

No acquisition of credits

Number Title Type ECTS Hours Lecturers
760-0001-00L Colloquium Master in Agricultural Science E- 0 credits 2K Lecturers

Agricultural Science Bachelor - Key for Type

O Compulsory Recommended, not eligible for credits
W+ Eligible for credits and recommended Z Courses outside the curriculum
W Eligible for credits Dr Suitable for doctorate

Key for Hours

V lecture P practical/laboratory course
G lecture with exercise A independent project
U exercise D diploma thesis
S seminar R revision course / private study
K colloquium

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
The focus will be on the book "Intelligenz: Grosse Unterschiede und ihre Folgen" by Stern and Neubauer. Participation at the first meeting

### Thematische Schwerpunkte:

1. Cognitively Activating Instructions in MINT Subjects
   - Literature from the learning sciences is critically discussed with a focus on research methods.

2. Human Intelligence
   - This course looks into scientific theories and also empirical studies on human learning and relates them to the school.
   - Abstract: This course focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.
   - Objective: Anyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.

3. Lecturers
   - E. Stern
   - P. Edelsbrunner
   - B. Rütsche

### Prerequisites / notice

For a smooth semester planning, an early registration and personal presence at the first teaching appointment is requested. Everyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.

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<tr>
<td>851-0240-00L</td>
<td>Human Learning (EW1)</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>E. Stern</td>
</tr>
<tr>
<td></td>
<td>This lecture is only apt for students who intend to enrol in the programs &quot;Teaching Diploma&quot; or &quot;Teaching Certificate&quot;. It is about learning in childhood and adolescence.</td>
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<td>Content: Lernens als Verhaltensänderung und als Informationsverarbeitung: Das menschliche Gedächtnis unter besonderer Berücksichtigung der Verarbeitung symbolischer Information; Lernen als Wissenskonstruktion und Kompetenzerwe enrichment unter besonderer Berücksichtigung des Wissenstransfer; Lernen durch Instruktion und Erklärungen: Die Rolle von Emotion und Motivation beim Lernen; Interindividuelle Unterschiede in der Lernfähigkeit und ihre Ursachen: Intelligenztheorien, Geschlechtsunterschiede beim Lernen</td>
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<td>Lecture notes: Folien werden zur Verfügung gestellt.</td>
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<td></td>
<td>Prerequisites / notice: This lecture is only apt for students who intend to enrol in the programs &quot;Lehrdiplom&quot; or &quot;Didaktisches Zertifikat&quot;. It is about learning in childhood and adolescence.</td>
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<tr>
<td>851-0242-06L</td>
<td>Cognitively Activating Instructions in MINT Subjects</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>R. Schumacher</td>
</tr>
<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<td></td>
<td>Number of participants limited to 30.</td>
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<tr>
<td></td>
<td>Objective: - Get to know cognitively activating instructions in MINT subjects - Get information about recent literature on learning and instruction</td>
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<tr>
<td></td>
<td>Prerequisites / notice: Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.</td>
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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0242-07L</td>
<td>Human Intelligence</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner, B. Rütsche</td>
</tr>
<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<tr>
<td></td>
<td>Number of participants limited to 30.</td>
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<tr>
<td></td>
<td>Abstract: The focus will be on the book &quot;Intelligenz: Grosse Unterschiede und ihre Folgen&quot; by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.</td>
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<tr>
<td></td>
<td>Objective: - Understanding research methods used in the empirical human sciences</td>
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<td></td>
<td>- Getting to know intelligence tests</td>
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<td></td>
<td>- Understanding findings relevant for education</td>
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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler</td>
</tr>
<tr>
<td></td>
<td>Number of participants limited to 30.</td>
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<tr>
<td></td>
<td>Abstract: Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and two further meetings will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.</td>
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<tr>
<td></td>
<td>Objective: - Understand research methods used in the empirical educational sciences - Understand and critically examine information from scientific journals and media - Understand pedagogically relevant findings from the empirical educational sciences</td>
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<tr>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>851-0240-22L</td>
<td>Coping with Psychosocial Demands of Teaching (EW4 W DZ)</td>
<td>W</td>
<td>2</td>
<td>3S</td>
<td>A. Deiglmayr, P. Greutmann, S. Hofer</td>
</tr>
<tr>
<td></td>
<td>Number of participants limited to 20.</td>
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</tbody>
</table>
The successful participation in EW1 ("Human Learning") and EW2 ("Designing Learning Environments for School") is recommended, but not a mandatory prerequisite.

### Subject Didactics and Professional Training

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-9020-00L</td>
<td>Teaching Internship Including Examination Lessons</td>
<td>W</td>
<td>6</td>
<td>13P</td>
<td>G. Kaufmann</td>
</tr>
<tr>
<td></td>
<td>Agricultural Science ■</td>
<td>Only for students who enrolled from HS 2011 on into TC.</td>
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</tbody>
</table>

The teaching internship can just be visited if all other courses of TC are completed. Repetition of the teaching internship is excluded even if the examination lessons are to be repeated.

### Further Subject Didactics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-9005-00L</td>
<td>Mentored Work Specialised Courses in the Respective Subject with an Educational Focus Agricul. Sc A ■</td>
<td>O</td>
<td>2</td>
<td>4A</td>
<td>G. Kaufmann, K. Koch, U. Lerch</td>
</tr>
</tbody>
</table>

The aim is for the students to familiarise themselves with a new topic by obtaining material and studying the sources, so that they can selectively extend their specialist competence in this way.

- To independently develop a text on the topic, with special focus on its mathematical comprehensibility in respect of the level of knowledge of the targeted readers.
- To try out different options for specialist further training in their profession.

### Literature

- Wird von der Praktikumslehrperson bestimmt.

### Prerequisites / notice

**Agricultural Science TC - Key for Type**

<table>
<thead>
<tr>
<th>Type</th>
<th>Notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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Data: 06.02.2019 13:00  Autumn Semester 2015  Page 17 of 1434
<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
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</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
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<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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</tbody>
</table>

ECTS  European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Ruminant Science

**Number** 751-6501-00L  
**Title** Ruminant Science (HS)  
**Type** W+  
**ECTS** 4 credits  
**Hours** 4G  
**Lecturers** M. Kreuzer, M. C. Härdi-Landerer, E. Hillmann, U. Witschi

**Abstract**  
The course provides the scientific basis of the central aspects of reproduction, husbandry and nutrition physiology of ruminants, and of the implications for animal welfare, product quality, breeding programs, and organic livestock systems. Means of knowledge transfer include interdisciplinary approaches, disciplinary parts, web-based learning and self-study.

**Objective**  
At the end of the course the students are able to apply, by a comprehensive understanding of the underlying mechanisms, their knowledge in various fields of ruminant science. They will be able to develop and recommend best strategies for breeding programs, feed formulation, improving forage quality, increasing animal health and welfare etc. They will be trained to carry out interdisciplinary and disciplinary research at the highest level. The course Ruminant Science (FS) offered in spring has a similar structure but is complementary to this course.

**Content**  
**Fields (contact hours)**
- Introduction: 2 h
- Special topics: 12 h
  - Lameness
  - Fertility in Cows
  - Food Intake of Ruminants
- Disciplinary topics: 36 h
  - Ruminant Husbandry: 16 h
  - Ruminant Nutrition Physiology: 10 h
  - Reproduction in Ruminants: 8 h
- Lectures held by the students: 4 h

In summary
- Contact hours: 52 h
- Self-study within semester: 30 h (especially preparation for the interdisciplinary courses and the own lecture)
- Self-study in semester break: 38 h
Total: 120 h

**Lecture notes**  
Documentations, links and other materials will be provided at the start of the course.

**Literature**  
Information on books and other references will be communicated during the course.

**Prerequisites / notice**  
The specialty of this course is that for the first time the animal science disciplines are unified. This is realised with a particular emphasis on interdisciplinary special topics and new forms of teaching. At the same time the essential basics in the central fields are communicated.

The field of Ruminant Science will also be a part of the spring semester (special topics: Organic Ruminant Systems, Tropical Ruminant Systems, Mastitis; disciplinary courses: Cattle, Sheep and Goat Breeding, Ruminant Diseases and Prophylaxis, Ruminant Nutrition and the Environment). However both courses are organized independently.

Conditions for successful participation: Background on animal science from the Bachelor is desired. In order to attend the Minor in Ruminant Science without any animal science background, a realistic self-assessment concerning the need for additional self-study is recommended (e.g. by choosing an appropriate bachelor course which then may be counted as ‘optional courses’ in the master). These efforts depend on the extent to which animal science courses have already been attended in the bachelor.

The control of performance will consist of:
- an own lecture
- a final oral examination with focus on comprehension of the fundamental linkages rather than of specific details

Ruminal Digestion

**Number** 751-7211-00L  
**Title** Ruminal Digestion  
**Type** W+  
**ECTS** 1 credit  
**Hours** 1G  
**Lecturers** A. Schwarm

**Abstract**  
This course broadens the knowledge in one of the most important aspects of ruminant nutrition: the microbial digestion in the rumen (and in the hindgut). For a comprehensive understanding of the rumen microbial ecosystem, the mechanisms of nutrient fermentation and the synthesis of microbial protein, thorough basics are provided. Apart from lectures, laboratory exercises are included.

**Objective**  
The course enables students to understand in detail how ruminal digestion works and how this knowledge can be applied to design optimal feeding diets using highly fibrous forages and a variety of other feeds. The students also are able to show how to modify the most important rumen microbes beneficially by nutritional means.

**Content**  
**Structure of the contact hour part of the course (14 h):**
- 2 h Introduction and blackboard exercise
- 8 h Basic topics in ruminal digestion:
  - Systematics of the microbes involved in microbial digestion
  - Measurement of microbial digestion
  - Interactions of microbes and epithelium of the digestive tract
  - Differences between ruminal and hindgut microbial digestion
  - Microbial nutrient degradation and its modification
  - Efficiency of microbial protein synthesis
  - Manipulation of the ruminal digestion
- 2 h Laboratory exercise with a rumen fistulated cow and the Rumen Simulation Technique
- 2 h Concluding seminary

The non-contact hour part is to comprehend the information given and to prepare either the written report or the oral presentation (cf. "Besonderes").

**Lecture notes**  
A documentation will be provided at the start of the course.

**Literature**  
Will be communicated at the start of the course.
The course is a balanced mixture of blackboard exercise, laboratory exercise, lecture and student seminar presentation
Credit point associated with grade of either a written report or an short oral presentation in the concluding seminary (both on a self-chosen related topic)

Non-Ruminant Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-6601-00L</td>
<td>Pig Science (HS)</td>
<td>W+</td>
<td>3 credits</td>
<td>3V</td>
<td>E. Hillmann, S. Neueneschwander</td>
</tr>
</tbody>
</table>

Abstract
The overall goal of the course is to provide the essential scientific knowledge of the genetic, physiological and special nutritional aspects of pigs metabolism, animal health and behaviour, and of the implications for environment, product quality, housing and animal welfare, and breeding programs.

Objective
Students will
- understand the complex interactions of nutrition, quality traits of products, breeding and reproduction, health management, behaviour and husbandry.
- be trained to understand interdisciplinary and disciplinary research.
- be able to critically analyze published research data.
- be able to present precise scientific reports in oral and written form.

Content
Four main topics in Pig Science:

- Behaviour and Husbandry of pigs: behavioral needs, husbandry related behavioral disorders, design and construction of housing systems in accordance with welfare requirements and legal regulations.
- Planning of reproductive cycle in practice
- welfare monitoring in practice
- pigs in organic farming
- Animal Health and Diseases: animal hygiene, immunology/vaccinations, metabolic diseases, diarrhoe, legisalation, thermoregulation, important infections, prophylaxis.
- poster, exam and evaluation

Lecture notes
Handouts/ scripts are distributed by the lecturers.

Literature
Specific literature is indicated by the lecturers.

Prerequisites / notice
The lecture corresponds with the lecture "Ruminant Science" and knowledge in animal health, nutrition and breedin as wellas applied ethology and animal welfare are recommended.

The lecture usually is in German, but there is always the possibility to change to English.

Livestock in the World Food System

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-6001-00L</td>
<td>Forum: Livestock in the World Food System</td>
<td>W+</td>
<td>2 credits</td>
<td>1S</td>
<td>M. Kreuzer, S. Bauersachs, E. Hillmann, S. Neueneschwander</td>
</tr>
</tbody>
</table>

Abstract
This forum is a platform for the critical reflection of highly relevant topics of livestock in the frame of the world food system comprising issues from basic knowledge to acceptance in society. The exchange is operated by scientific writing and presentation.

Objective
In the Forum "Livestock in the World Food System", a topic of significance for livestock agriculture is selected by the students and subsequently dealt with from various angles (from scientific basis to production systems, environmental aspects and to the acceptance by society). The students learn to present a scientific subject in writing and orally to an audience and to defend the presentation in a discussion.

Content
The Forum "Livestock in the World Food System" will take place in blocks of 2 hours each. Once the general topic has been selected, it comprises two elements:

Element 1. Oral Presentation: The students form small groups and are lecturers. There are chair persons (moderators) from outside of these small groups and they also head the discussion. The remaining students and lecturers are the audience.

Element 2. Scientific writing: Option 1: preparation of a short scientific type of paper from a result table offered by the lecturers; Option 2: preparation of an abstract with limited word count from a scientific paper; Option 3: writing of a critical review of a paper. The students have to select 2 of the three options each. There will be a discussion be a discussion in small groups at two dates.

Introductions to both forms of presentation will be offered by lecturers. The preparation of the oral and written presentations takes place to a small part during the 2-h blocks and mainly outside of this time.

Lecture notes
no scriptum

Prerequisites / notice
Requirements for allocation of the two credit points:
- Theatre presentation (with handout) at the forum
- Delivery of written documents of sufficient quality
- Active participation during the presentations by the other participants

751-7703-00L | Tropical Animal Nutrition         | W+   | 1 credit | 1G    | Does not take place this semester. |

Abstract
Farm animals play an important role in most agro/eco - systems, but conditions for a successful management and nutrition in the tropics are diverse. In this course a wide range of aspects are examined.

Objective
The aim of this course is to know and understand animal production systems in the different zones of the tropics taking into consideration the local and social structure of the population. We will deal with different aspects of animal nutrition in the tropics.

Content
- Introduction to the tropics
- Special problems and challenges in tropical regions
- Importance of livestock in the tropics
- Animal production and livestock production systems in the tropics
- Special challenges for livestock in the tropics
- Feeds available in the tropics
- Tropical pasture systems and their characteristics
- Quality of feeds in the tropics
- Problems and challenges of animal nutrition in the tropics
This course deals with unconventional animals or production forms and specific aspects of for keeping them in Europe or, more specifically, in Switzerland. This includes e.g. rare breeds, wild cattle, deer, camelds, ostrich and fish. Particular emphasis will be given to the regulations and the problems occurring with import, housing and marketing of the products.

At the end of the course the students are able to describe the conditions of keeping unconventional livestock and to develop recommendations for farmers intending to include niche production into the farm enterprise.

The contact hour part of the course (16 h) is conceptually a block course which is subdivided into one day of lecture and one day of excursion.

The non-contact hour part (14 h) is to comprehend the information given and to prepare for the examination.

A documentation will be provided at the start of the course.

Lecture and excursion have the same weight with respect to time allocation.

Scheduled dates of the course for 2011:
- Theory part: Monday 29 October 2012
- Excursion: Monday 5 November 2012

The date of examination is to be coordinated between lecturers and students.
and Inherited Diseases

Neuenschwander, C. Schelling

**Abstract**

Technologies of molecular animal-, immuno- and biochemical genetics will be shown and applied to selected domestic and farm animals. The students will perform laboratory tests for genome analysis (identification of gene loci, gene mapping), gene expression (mRNA, proteins), diagnostics (analysis of hereditary diseases) and verification of animals and animal products (parentage control, forensics).

**Objective**

- Get to know and apply the basic laboratory methods to systematically identify loci controlling important performance and disease traits and analysis of the molecular nature of variation at the loci. At the end of the course the students are able to understand the underlying mechanisms influencing genetic variations and to analyze gene variants in the laboratory. The students know the importance of the technologies for animal breeding, animal health and quality of animal products in Switzerland and internationally.
- The matter is illustrated on practical examples.

**Content**

- Introduction to the course (aims, program, written examination)  
- Porcine E.coli test. Determination of the mutation in FUT1  
- Sequencing of DNA  
- Marker/microsatellite analyses  
- Forensics  
- Cytogenetics  
- Cell cultures  
- Inheritance of coat colour  
- Gene expression and animal biotechnology

**Contact hours:** 42 h
**Self-study (preparation for courses and examination):** additionally

**Lecture notes**

Handouts/scripts will be distributed by the lecturers.

**Literature**


Specific literature will be indicated individually by the lecturers.

<table>
<thead>
<tr>
<th>751-6003-00L</th>
<th>Training Course in Research Groups (Large)</th>
<th>W+</th>
<th>6 credits</th>
<th>13P</th>
<th>M. Kreuzer, E. Hillmann, S. Neuenschwander, S. E. Ulbrich</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>The students will learn the conceptual and methodological background of research in the animal science groups of the Institute of Plant, Animal and Agroecosystem Science. In addition to teaching the theoretical background, the major aim of the course is to integrate the students into the research groups (on job training) and, hence, to focus on the practical application of the knowledge.</td>
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</tbody>
</table>
| **Objective** | - Introduction into the conceptual and methodological basis of research  
- Integration of the students into the research groups (on job training)  
- Application of the gained knowledge |
| **Content** | The students will be integrated into the research groups day-to-day work and will thus deal with all aspects of scientific work. This comprises the planning (conceptually and logistically), execution (data collection, laboratory analyses) and evaluation (statistics, data presentation) of experiments as well as the basics of scientific writing (aim: later publication, Master thesis). The research topics and the range of methodologies vary between the animal science research groups in the Institute of Plant, Animal and Agroecosystem Sciences. |
| **Lecture notes** | None |
| **Literature** | Specific readings after enlisting in a particular research group. |
| **Prerequisites / notice** | The number of training slots in the various groups is limited. It is therefore highly recommended to contact the group leaders early enough (first come first serve). |
| The full integration in a research group often means to work on weekends.  
The total time budget is equivalent to about 180 hours. Active participation in group meetings (discussion, presentation) and short written reports about the work conducted are required for the 6 credit points. There are no grades, it is only pass or fail. |

<table>
<thead>
<tr>
<th>751-6003-01L</th>
<th>Training Course in Research Groups (Small)</th>
<th>W+</th>
<th>3 credits</th>
<th>6P</th>
<th>M. Kreuzer, E. Hillmann, S. Neuenschwander, S. E. Ulbrich</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>The students will learn the conceptual and methodological background of research in the animal science groups of the Institute of Plant, Animal and Agroecosystem Science. In addition to teaching the theoretical background, the major aim of the course is to integrate the students into the research groups (on job training) and, hence, to focus on the practical application of the knowledge.</td>
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</tr>
</tbody>
</table>
| **Objective** | - Introduction into the conceptual and methodological basis of research  
- Integration of the students into the research groups (on job training)  
- Application of the gained knowledge |
| **Content** | The students will be integrated into the research groups day-to-day work and will thus deal with all aspects of scientific work. This comprises the planning (conceptually and logistically), execution (data collection, laboratory analyses) and evaluation (statistics, data presentation) of experiments as well as the basics of scientific writing (aim: later publication, Master thesis). The research topics and the range of methodologies vary between the animal science research groups in the Institute of Plant, Animal and Agroecosystem Sciences. |
| **Lecture notes** | None |
| **Literature** | Specific readings after enlisting in a particular research group. |
| **Prerequisites / notice** | The number of training slots in the various groups is limited. It is therefore highly recommended to contact the group leaders early enough (first come first serve). |
| The full integration in a research group often means to work on weekends.  
The total time budget is equivalent to about 90 hours. Active participation in group meetings (discussion, presentation) and short written reports about the work conducted are required for the 3 credit points. There are no grades, it is only pass or fail. |

|--------------|---------------------------------------------------------------|----|-----------|------|--------------------------------------------------------|
| **Abstract** | In this course, different experimental designs will be discussed and various statistical tools will be applied to research questions in agroecosystem sciences. Both manipulative (field and laboratory) experiments and surveys are addressed and students work with a selection of basic techniques and methods to analyse data using a hands-on approach. Methods range from simple t-tests to multi-factoria  
| **Objective** | Students will know various statistical analyses and their application to science problems in their study area as well as a wide range of experimental design options used in environmental and agricultural sciences. They will practice to use statistical software packages (R), understand pros and cons of various designs and statistics, and be able to statistically evaluate their own results as well as those of published studies. |
The course program uses a learning-by-doing approach ("hands-on minds-on"). New topics are introduced in the lecture hall, but most of the work is done in the computer lab to allow for the different speeds of progress of the student while working with data and analyzing results. In addition to contact hours exercises must be finalized and handed in for grading. The credit points will be given based on successful assessments of selected exercises.

The tentative schedule contains the following topics:

- Introduction To Experimental Design and Applied Statistics
- Introduction to R*/ Revival of R’ Skills
- Designs of Field and Growth Chamber Experiments
- Nonlinear Regression Fits
- Multivariate Techniques: Principle Component Analysis, Canonical Correpondence Analysis (CCA), Cluster Analysis
- ANOVA using linear and mixed effect models
- Error Analysis, Error Propagation and Error Estimation
- Introduction to autoregression and autocorrelations in temporal and spatial data and how to consider them in ANOVA-type analysis

This course does not provide the mathematical background that students are expected to bring along when signing up to this course. Alternatively, students can consider some aspects of this course as a first exposure to solutions in experimental design and applied statistics and then deepen their understanding in follow-up statistical courses.

### Project Management and Presentation Skills

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-3011-00L</td>
<td>Improvement of Oral and Written Skills</td>
<td>W+</td>
<td>4</td>
<td>4S</td>
<td>U. Merz, E. Buff Keller, P. Mayer</td>
</tr>
</tbody>
</table>

**Abstract**
- Searching, analyzing and synthesizing scientific information on a specific subject
- Writing a scientific paper
- Making a scientific oral presentation, alone (with poster) and with the team
- Animating and moderating a discussion (teamwork)

**Objective**
- Searching, analyzing and synthesizing scientific information on a specific subject
- Writing a scientific paper
- Making a scientific oral presentation, alone (poster) and with the team
- Animating and moderating a discussion (teamwork)

**Content**
- Workshops
  - How to make a poster
  - How to present (with video-feedback)
  - How to moderate a discussion
  - Scientific writing (different types of documents)
  - Individual assessment: make a poster and present it
  - Write a review or a statement
  - Team assessment: write a recommendation (executive summary)
  - Present the recommendation
  - Moderate a discussion

**Literature**
See website

### Major in Crop Science

#### Disciplinary Competences

### Cropping Systems

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>751-4203-00L</td>
<td>Horticultural Science: Case Studies (HS)</td>
<td>W+</td>
<td>2</td>
<td>2G</td>
<td>L. Bertschinger, J. Rösti, V. J. U. Zufferey</td>
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</table>

**Abstract**
Lectures address 2 horticultural cropping systems and value chains, each one in 4 2h-lecture blocks. Afterwards, the students split in 2 groups for addressing a case study focusing on one of the cropping systems treated before. An excursion to a research site might be included. In a final colloquium, each group presents a report on their case study and their conclusions.

**Objective**
Achieve a deepened understanding of horticultural value chain challenges relating to ecological intensification, resource efficiency, climate change and healthy and safe food, and the problem solution strategies and scientific principles behind.

**Content**
In the autumn semester, the two addressed cropping systems and value chains are fruit-production and viticulture.
In the spring semester, the two addressed cropping systems and value chains are vegetable-production- and berry-production or glasshouse-horticulture.

**Literature**
Documents handed out during the case studies.

**Prerequisites / notice**
The course builds on basic knowledge delivered in ‘Horticultural Crops I’ and ‘Horticultural Crops II’. If these courses have not been followed by interested participants, equivalent knowledge and experience will greatly support a successful and productive participation of the participating student.
Language: spoken E, G or F, Documents: Preferably English, G/F possible.

### Alternative Crops

**Abstract**
Few crops dominate the crop rotations worldwide. Following the goal of an increased agricultural biodiversity, species such as buckwheat but also medicinal plants might become more important in future. The biology, physiology, stress tolerance and central aspects of the value-added chain of the above-mentioned and of other alternative crops will be depicted.

**Literature**
A selection of suggested additional literature, especially for German speaking students will be presented in the introductory lecture.
Students of this course will discuss current topics from the field of infectious disease biology. From a list of publications, each student will be assigned and downloaded from a web page announced during the lecture. In the first part of the course, we will discuss most important plant breeding tools and concepts. The lectures include lessons on genetic engineering utilizing genetic variation across species; organic plant breeding focussing on the need of organic agriculture; participatory plant breeding involving farmers in the breeding progress as well as genomic selection using a genome-wide coverage of molecular markers to predict the performance of a genotype. You will learn how new marker technologies and breeding tools in combination with precise phenotyping may influence the breeding progress in the future and how knowledge of the genetic architecture of crops can be utilized for selection. Furthermore, we will cover the legislation around the conservation of crop genetic resources for food and agriculture (PGRFA), the plant breeding rights (UPOV), gene patenting and the release of genetically modified organisms into the environment. Differences in legislation on worldwide scale, in Europe and in Switzerland will be highlighted. At the end of this section, you will be able to critically discuss the pros and cons of different concepts of plant breeding ranging from organic and participatory breeding to genetic modification and gene patenting.

In the second part of the course, you will learn the most important aspect of crop evolution and breeding of maize, wheat, rapeseed, sugar beet, potatoes and forage crops. This includes: the most important domestication traits; crop evolution; genetics and cytogenetics; reproductive biology, germplasm resources; major breeding aims and common breeding methods. At the end of this section you will be able to critically discuss the most important achievement of our major crops in a plant breeding context.

Prerequisites / notice

The participation in this course requires a basic understanding of plant breeding as taught in 'Pflanzenzüchtung 1' (formerly Pflanzenzüchtung), or similar lectures at other universities.

### Crop Health

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<tr>
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<tbody>
<tr>
<td>751-5121-00L</td>
<td>Insect Ecology</td>
<td>W+</td>
<td>2</td>
<td>2V+</td>
<td>S. Halloran, C. De Moraes, M. Mescher</td>
</tr>
<tr>
<td>701-0263-01L</td>
<td>Seminar in Evolutionary Ecology of Infectious Diseases</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>D. Croll, S. Bonhoeffer, R. R. Regős</td>
</tr>
<tr>
<td>751-4811-00L</td>
<td>Alien Organisms in Agriculture</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>J. Collatz, M. Meisle</td>
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### Agriculture and Environment

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<tr>
<td>751-5101-00L</td>
<td>Biogeochemistry and Sustainable Management</td>
<td>W+</td>
<td>2</td>
<td>2G</td>
<td>L. Merbold, N. Buchmann</td>
</tr>
</tbody>
</table>
Content
Agroecosystems and forest ecosystems play a major role in all landscapes, either for production purposes, ecological areas or for recreation. The human impact of any management on the environment is mainly driven by effects on biogeochemical cycles. Effects of global change impacts will also act via biogeochemistry at the soil-biosphere-atmosphere-interface. Thus, ecosystem functioning, i.e., the interactions between ecology, biogeochemistry and management of terrestrial systems, is the science topic for this course.

Students will gain profound knowledge about nutrient cycles and population dynamics in managed and unmanaged grassland, cropland and forest ecosystems in the field and in the lab. Responses of agro- and forest ecosystems to the environment, e.g., to climate, anthropogenic deposition, major disturbances, soil nutrients or competition of plants (including invasives) and microorganisms, but also feedback mechanisms of ecosystems on (micro)climate, soils or vegetation patterns will be studied. Different management practices will be investigated and assessed in terms of production and quality of yield (ecosystem goods and services), but also in regard to environmental regulations (including subsidies) and their effect on the environment, e.g., greenhouse gas budgets. Thus, students will learn about the complex interactions of a coupled human-environmental system.

Lecture notes
Handouts will be available on the webpage of the course.

Prerequisites / notice
Prerequisites: Attendance of introductory courses in plant ecophysiology, ecology, and grassland or forest sciences. Course will be taught in English.

751-5115-00L
Current Aspects of Nutrient Cycle in Agro-Ecosystems

W+ 2 credits 1S E. Frossard

Does not take place this semester.

Abstract
The seminar concerns current aspects and research related to nutrient cycles in agro-ecosystems. It offers to deepen the knowledge on a specific theme related to nutrients. It is composed by presentations of national and international speakers and by an excursion. The students write a report where they compile the obtained information, relate it to their own knowledge and include literature.

Objective
Listen and understand expert's presentations. Ask questions and contribute to the discussion during the talk sessions and the excursion. Link the information obtained during the seminar with knowledge from previous lessons and with literature searched to complement the matter. Expand the knowledge on nutrient cycles and nutrient management in the agro-ecosystem.

751-4003-01L
Current Topics in Grassland Sciences (HS)

W+ 2 credits 2S N. Buchmann

Abstract
Research results in agro- and forest ecosystem sciences will be presented by experienced researchers as well as Ph.D. and graduate students. Citation classics as well as recent research results will be discussed. Topics will range from plant ecophysiology, biodiversity and biogeochemistry to management aspects in agro- and forest ecosystems.

Objective
Students will be able to understand and evaluate experimental design and data interpretation of on-going studies, be able to critically analyze published research results, practice to present and discuss results in the public, and gain a broad knowledge of recent research and current topics in agro- and forest ecosystem sciences.

Content
Research results in agro- and forest ecosystem sciences will be presented by experienced researchers as well as Ph.D. and graduate students. Citation classics as well as recent research results will be discussed. Topics will range from plant ecophysiology, biodiversity and biogeochemistry to management aspects in agro- and forest ecosystems.

Lecture notes
none

Prerequisites / notice
Prerequisites: Basic knowledge of plant ecophysiology, terrestrial ecology and management of agro- and forest ecosystems. Course will be taught in English.

751-5001-00L
Agroecologists without Borders

W 2 credits 2S C. Decock, A. Hofmann, J. Six

Abstract
In this seminar students apply their knowledge on sustainable agriculture, tropical soils and land use to a case study related to a current research project from the Sustainable Agroecosystems group. The seminar offers interactions with researchers and extension specialists working in the context of agricultural development.

Objective
(1) Students analyze concrete examples of agricultural development projects in tropical agroecosystems. 
(2) Students broaden their understanding of environmental and socio-economic challenges of smallholder farmers. 
(3) Students articulate complexity and challenges in agricultural development interventions. 
(4) Students develop their science communication skills by producing science communication materials in the context of the given case study.

Prerequisites / notice
Students signing up for this class should have a strong interest in tropical agriculture and science communication.

751-5201-00L
Tropical Soils and Land Use

W 2 credits 2G J. Six

Does not take place this semester.

Methodology Competences

Methods in Agricultural Sciences

Number
Title
Type
ECTS
Hours
Lecturers

751-4506-00L
Plant Pathology III

W 2 credits 2G U. Meier, M. Maurhofer Bringolf

Information: This course was offered as "Transport Systems Evaluation" until FS15.

Abstract
Identification based on host, symptoms and micro-morphology, completed with life cycles and related control measures of the most important fungal diseases and their causal pathogens of annual and perennial crops with agricultural significance.

Objective
The students will learn and train preparation skills for microscopy, acquire knowledge of selected diseases (identification, biology of pathogen, epidemiology) and understand the corresponding integrated control measures practiced in Swiss agriculture.

Content
The course will partly be an e-learning exercise (with computers).

Lecture notes
A script will be used on annual and perennial crops and their most important diseases. It will be updated stepwise

Prerequisites / notice
The course will be in German (spec. nomenclature)

751-4805-00L
Recent Advances in Biocommunication

W+ 2 credits 2S C. De Moraes

Number of participants limited to 25

Abstract
Students will gain insight into the role of sensory cues and signals in mediating interactions within and between species. There will be a primary, but not exclusive, focus on chemical signaling in interactions among plants, insects and microbes. The course will focus on the discussion of current literature addressing key conceptual questions and state-of-the-art research techniques and methods.

Objective
Students will gain insight into the role of sensory cues and signals in mediating interactions within and between species. There will be a primary, but not exclusive, focus on chemical signaling in interactions among plants, insects and microbes. The course will focus on the discussion of current literature addressing key conceptual questions and state-of-the-art research techniques and methods. Students will engage in discussion and critical analyses of relevant papers and present their evaluations in a seminar setting.

751-3405-00L
Radio-Isotopes in Plant Nutrition

W+ 3 credits 2G E. Frossard
Abstract
The course will present the principles underlying the use of radioisotopes in soil/plant systems. It will present how the introduction of an isotope into a system can be done to get some information on the structure of the system. Case studies will be presented to determine element availability. Finally, published studies from other groups will be analyzed and presented by the students.

Objective
At the end of this course the students are familiar with the principles on which radioisotope works are based and they have learned from case studies how radioisotopes can be used to obtain meaningful data. They are aware of the advantages of using radioisotopes in element cycling studies, but also of the risks and open questions related to isotope work.

Content
Radio-isotopes are extensively used at the soil/plant or ecosystem level to quantify the fluxes of elements (phosphorus (P), heavy metals, radionuclides) within a given system and to assess the importance of processes controlling these fluxes (e.g. exchange reactions between the soil solution and the soil solid phase, element turnover through the microbial biomass, organic matter mineralization etc.).

The course will first present the principles, the basic assumptions and the theoretical framework that underlay the work with radioisotopes. It will present how the introduction of an isotope into a system can be done so as to get information on the structure of the system (e.g. number and size of compartments). Secondly, case studies on isotopic dilution and tracer work will be presented for instance on the isotopic exchange kinetics method to determine nutrients or pollutants availability. The case studies will be adapted to the ongoing research of the group of plant nutrition and will thus give an insight into our current research. In addition, published studies will be analyzed and presented by the students. Finally, the advantages and disadvantages of work with radioisotopes will be analyzed and discussed critically.

Lecture notes
Documents will be distributed during the lecture

Literature
Will be given during the lecture

Prerequisites / notice
The lecture will take place at the ETH experimental station in Eschikon Lindau. See the location of the station at: http://www.pe.ipw.agrl.ethz.ch/about/reach


Abstract
This course emphasizes interactions among physicochemical and biological processes and highlights implications for plant nutrition, growth, and health. Nutrient mobilization and acquisition by plants in response to fertilization, other plants, and microbes, are explored in model systems. Newly gained knowledge is applied to understand results of a pot experiment and thereby critically reflected.

Objective
To gain a holistic understanding of resource-driven and regulatory processes in natural and agronomic plant-microbe-soil systems.
To practice abilities to read scientific literature, understand it, present it, and discuss it with peers.
To combine available and newly acquired knowledge from soil physics, chemistry and (micro-)biology, plant physiology, pathology, and ecology and reflect on their relative importance for plant production, bioremediation, and nature conservation when considered together.
To practice manual skills in handling seedlings, soil, plant, and DNA samples, laboratory equipment, and working with different computer software.
To make observations, analyse, display, interpret and present own data.
To get familiar with (bio-)chemical, molecular genetic, and simple bioinformatics analyses.
To prepare as a group of course participants a poster on one selected aspect of a bigger pot experiment, present it, and discuss findings and posters of other course participants.
To combine findings with available knowledge, generate explanatory hypotheses, and identify potentially informative further analyses and experiments.

Content
This course comprised lectures, the set-up, harvest and data analysis of an experiment, soil (bio-)chemical, microbiological and molecular genetic analyses in the laboratory and practical computational data analyses. The focus is set on a better understanding of the role played by spatial and temporal physicochemical and microbiological gradients and various soil organisms in plant mineral nutrition. Mutualistic associations between plant roots and microbes, such as the root symbiosis with mycorrhizal fungi and root nodule-inducing bacteria are discussed. Rhizobia are isolated from field-collected root nodules and characterized, using molecular genetic tools. A short introduction into DNA-based bioinformatics and phylogenetic analyses is given to demonstrate how bacterial species are identified and potential host ranges of isolated rhizobia can be inferred, using so-called functional genes. A pot experiment in the glasshouse on cereal-legume mixed intercropping, including effects of pot size, intra- and interspecific plant competition, and root traits, allows to relate scientifically interesting research topics to practical application, while simultaneously stimulating critical reflections.

Lecture notes
Lecture slides and laboratory protocols are being made available in the directory ‘751-5123-00L Rhizosphere Ecology’ of the electronic document exchange platform ILIAS, LDA-ELBA: https://ilias-app2.let.ethz.ch/ilias.php?ref_id=85894&cmdClass=ilrepositorygui&cmdNode=el&baseClass=ilRepositoryGUI
Students will be familiar with basic and advanced applications of stable isotopes in studies on plants, soils, water and trace gases, know

Stable Isotope Ecology of Terrestrial Ecosystems

This course provides an overview about the applicability of stable isotopes (carbon 13C, nitrogen 15N, oxygen 18O and water 2H) to

R. A. Werner

Arbuscular mycorrhizas in soil nutrient management, e-learning module of Sustainable Plant Systems by Gamper, HA, van der Heijden,

2G

Objective

Students will be familiar with basic and advanced applications of stable isotopes in studies on plants, soils, water and trace gases, know the relevant approaches, concepts and recent results in stable isotope ecology, know how to combine classical and modern techniques to

solve ecophysiological or ecological problems, learn to design, carry out and interpret a small IsoProject, practice to search and analyze

literature as well as to give an oral presentation.

Prerequisites / notice

For students of the Agricultural Sciences of D-USYS: Lectures in Plant Nutrition I and II (Nutrient cycling in agroecosystems by Prof. E. Frossard).

We ask all other course participants to read and understand the e-learning module Plant Nutrition I by Prof. E. Frossard:

https://moodle-app2.let.ethz.ch/course/view.php?id=279

https://www.olat.uzh.ch/olat/auth/1%3A1%3A0%3A0/

Autumn Semester 2015

2 credits

R. S. Siegwolf

Stable Isotope Ecology of Terrestrial Ecosystems

This course provides an overview about the applicability of stable isotopes (carbon 13C, nitrogen 15N, oxygen 18O and water 2H) to

process-oriented ecological research. Topics focus on stable isotopes as indicators for the origin of pools and fluxes, partitioning of

composite fluxes as well as to trace and integrate processes. In addition, students carry out a small project during lab sessions.

Students of the agricultural sciences of D-USYS will be reimbursed for travel expenses upon handover of collected tickets of the public

transport systems, excluding the tax zone of the town of Zurich.

751-5125-00L

Literature

DOI: 10.1002/9780470015902.a0000403.pub2
http://www.wiley.com/WileyCDA/EelsArticle/refId=a0000403.html


http://www.nature.com/scitable/knowledge/plant-soil-interactions-nutrient-uptake-105289112


http://www.crcpress.com/product/isbn/9780849338557


Plant Soil 321, 117-152.
http://link.springer/article/10.1007%2Fs11104-008-9885-9

Kuzaykov Y, Xu X. 2013. Competition between roots and microorganisms for nitrogen: mechanisms and ecological relevance. New
Phytologist 198(3): 656-669.
http://dx.doi.org/10.1111/nph.12235

http://www.plantphysiol.org/content/156/3/1078

1182-9617-2.

Withers PJA, Sylvester-Bradley R, Jones DL, Healey JR, Talboys P.J. 2014. Feed the crop not the soil: rethinking phosphorus management in
the food chain. Environmental Science & Technology: http://dx.doi.org/10.1021/es501670j

How microbes can feed the world (American Academy of Microbiology)
http://academy.asm.org/index.php/browse-all-reports/800-how-microbes-can-help-feed-the-world

Can microbes feed the world? (Society for general microbiology)

Popular science entries to the topic:
http://www.the-scientist.com/?articles/view/articleNo/305150/title/The-Root-of-the-Problem/

Ecological Understanding (Second Edition)

The Nature of Theory and the Theory of Nature:

How microbes can feed the world (American Academy of Microbiology)
http://academy.asm.org/index.php/browse-all-reports/800-how-microbes-can-help-feed-the-world

Can microbes feed the world? (Society for general microbiology)

Popular science entries to the topic:
http://www.the-scientist.com/?articles/view/articleNo/305150/title/The-Root-of-the-Problem/

Ecological Understanding (Second Edition)

The Nature of Theory and the Theory of Nature:
Content
The analyses of stable isotopes often provide insights into ecophysiological and ecological processes that otherwise would not be available with classical methods only. Stable isotopes proved useful to determine origin of pools and fluxes in ecosystems, to partition composite fluxes and to integrate processes spatially and temporally.

This course will provide an introduction to the applicability of stable isotopes to ecological research questions. Topics will focus on carbon (13C), nitrogen (15N), oxygen (18O) and hydrogen (2H) at natural isotope abundance and tracer levels. Lectures will be supplemented by intensive laboratory sessions, short presentations by students and computer exercises.

Lecture notes
Handouts will be available on the webpage of the course.

Literature
Will be discussed in class.

Prerequisites / notice
This course is based on fundamental knowledge about plant ecophysiology, soil science, and ecology in general. Course will be taught in English.

Design, Analysis and Communication of Science

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<tr>
<td>751-3011-00L</td>
<td>Improvement of Oral and Written Skills</td>
<td>W+</td>
<td>4 credits</td>
<td>4S</td>
<td>U. Merz, E. Buff Keller, P. Mayer</td>
</tr>
</tbody>
</table>

Abstract
Acquiring competence in
- searching, analyzing and synthesizing scientific information on a specific subject
- writing a scientific paper
- making a scientific oral presentation, alone (with poster) and with the team
- animating and moderating a discussion (teamwork)

Objective
Acquiring competence in
- searching, analyzing and synthesizing scientific information on a specific subject
- writing a scientific paper
- making a scientific oral presentation, alone (poster) and with the team
- animating and moderating a discussion (teamwork)

Content
- Workshops
  - how to make a poster
  - how to present (with video-feedback)
  - how to moderate a discussion
  - scientific writing (different types of documents)
  - individual assessment:
    - make a poster and present it
    - write a review or a statement
    - team assessment:
      - write a recommendation (executive summary)
      - present the recommendation
      - moderate a discussion

Lecture notes
No script, but div. Instructions see website

Experimental Design and Applied Statistics in Agroecosystem Science

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Abstract
In this course, different experimental designs will be discussed and various statistical tools will be applied to research questions in agroecosystem sciences. Both manipulative (field and laboratory) experiments and surveys are addressed and students work with a selection of basic techniques and methods to analyse data using a hands-on approach. Methods range from simple t-tests to multi-factorial analyses.

Objective
Students will know various statistical analyses and their application to science problems in their study area as well as a wide range of experimental design options used in environmental and agricultural sciences. They will practice to use statistical software packages (R), understand pros and cons of various designs and statistics, and be able to statistically evaluate their own results as well as those of published studies.

Content
The course program uses a learning-by-doing approach ("hands-on minds-on"). New topics are introduced in the lecture hall, but most of the work is done in the computer lab to allow for the different speeds of progress of the student while working with data and analyzing results. In addition to contact hours exercises must be finalized and handed in for grading. The credit points will be given based on successful assessments of selected exercises.

The tentative schedule containst the following topics:

- Introduction To Experimental Design and Applied Statistics
- Introduction to R / Revival of 'R' Skills
- Designs of Field and Growth Chamber Experiments
- Nonlinear Regression Fits
- Multivariate Techniques: Principle Component Analysis, Canonical Correspondence Analysis (CCA), Cluster Analysis
- ANOVA using linear and mixed effect models
- Error Analysis, Error Propagation and Error Estimation
- Introduction to autoregression and autocorrelations in temporal and spatial data and how to consider them in ANOVA-type analysis
- This course does not provide the mathematical background that students are expected to bring along when signing up to this course. Alternatively, students can consider some aspects of this course as a first exposure to solutions in experimental design and applied statistics and then deepen their understanding in follow-up statistical courses.

Major in Food and Resource Use Economics

Disciplinary Competences

Decision Making in Food Value Chains

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<th>Number</th>
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<tr>
<td>751-1555-00L</td>
<td>Food Economics</td>
<td>W+</td>
<td>2 credits</td>
<td>2G</td>
<td>A. Champetier de Ribes</td>
</tr>
</tbody>
</table>

Abstract
Food Economics proposes to explore important issues in food production, supply, and consumption using the concepts and tools of microeconomics.
The course is balanced between presentation of economics concepts and illustration by case-studies. The lecture titles include:

- Demand for food.
- Matching demand with supply.
- Industrial organization in the food supply chain.
- Non-quality attributes of food.
- When information is costly.
- Food production and the environment.
- The food sector within human economies.

In addition, the students collectively identify and address an applied research question. We implement an empirical strategy to tackle the question before results are discussed individually by students during the final written examination.

Lecture notes
Lecture notes are made available after each lecture.

Literature
Readings in the standard economics literature include:
Coase 1937,
Musson Rosen 1978,
Lancaster 1966,
Akerlof 1970.

Prerequisites / notice
Students are expected to master basic microeconomics concepts such as demand, supply, or consumer and producer surplus. We will review and calculate elasticities, tax and quota impacts on prices etc... but the class focuses on applications of these tools rather than on basic understanding. Students are expected to have taken at least one intermediary microeconomics class.

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### Environmental and Resource Use Economics

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<tr>
<td>701-1561-00L</td>
<td>Environmental Governance</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>E. Lieberrher, G. de Buren</td>
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The course addresses environmental policies, focusing on new approaches, which are generally summarized as environmental governance. The course also provides a broader introduction to social science concepts to provide students with tools to analyze environmental policy processes and assesses the key features of environmental governance by examining various practical environmental policy examples.

To understand how an environmental problem may (or not) become a policy and explain political processes, using basic concepts and techniques from political science.

To analyze the evolution as well as the key elements of environmental governance.

In this course, we will address both the practical aspects of as well as the scientific debate on environmental governance. The course gives future environmental experts a strong basis to position themselves in the governance debate, which does not preclude government but rather involves a spectrum from government to governance.

Key questions that this course seeks to answer: What are the core characteristics of environmental challenges from a policy perspective? What are key elements of "environmental governance" and how legitimate and effective are these approaches in addressing persistent environmental challenges?

Lecture notes
Lecture slides and additional course material will be provided throughout the semester.
Objectives

The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics; (2) analyze the impact of policy instruments on welfare and distribution; (3) gain an overview of important global and regional environmental problems.

Content

This course deals with how and why international cooperation in environmental politics emerges, and under what circumstances such cooperation is effective and efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental politics are discussed: the management of international water resources, the political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

Abstract

The course is open to all ETH students. Participation does not require previous coursework in the social sciences.

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 4 ECTS credit points. The workload is around 120 hours (meetings, reading assignments, preparation of test).

Prerequisites / notice

We recommend that students have (a) Three-years BSc education of a (technical) university; (b) Successfully completed Bachelor introductory course to environmental policy (Entwicklungen nationaler Umweltpolitik (or equivalent)) and (c) Familiarity with key issues in environmental policy and some fundamental knowledge of one social science or humanities discipline (political science, economics, sociology, history, psychology, philosophy)

851-0594-00L International Environmental Politics  W  4 credits  2V  T. Bernauer

Abstract

This course focuses on the conditions under which cooperation in international environmental politics emerges and the conditions under which such cooperation and the respective public policies are effective and/or efficient.

Objective

The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a social sciences viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems.

Content

This course deals with how and why international cooperation in environmental politics emerges, and under what circumstances such cooperation is effective and efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental politics are discussed: the management of international water resources, the political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

The course is open to all ETH students. Participation does not require previous coursework in the social sciences.

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 4 ECTS credit points. The workload is around 120 hours (meetings, reading assignments, preparation of test).

Prerequisites / notice

We recommend that students have (a) Three-years BSc education of a (technical) university; (b) Successfully completed Bachelor introductory course to environmental policy (Entwicklungen nationaler Umweltpolitik (or equivalent)) and (c) Familiarity with key issues in environmental policy and some fundamental knowledge of one social science or humanities discipline (political science, economics, sociology, history, psychology, philosophy)

851-0594-00L International Environmental Politics  W  4 credits  2V  T. Bernauer

Abstract

This course focuses on the conditions under which cooperation in international environmental politics emerges and the conditions under which such cooperation and the respective public policies are effective and/or efficient.

Objective

The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a social sciences viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems.

Content

This course deals with how and why international cooperation in environmental politics emerges, and under what circumstances such cooperation is effective and efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental politics are discussed: the management of international water resources, the political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

The course is open to all ETH students. Participation does not require previous coursework in the social sciences.

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 4 ECTS credit points. The workload is around 120 hours (meetings, reading assignments, preparation of test).

Prerequisites / notice

We recommend that students have (a) Three-years BSc education of a (technical) university; (b) Successfully completed Bachelor introductory course to environmental policy (Entwicklungen nationaler Umweltpolitik (or equivalent)) and (c) Familiarity with key issues in environmental policy and some fundamental knowledge of one social science or humanities discipline (political science, economics, sociology, history, psychology, philosophy)
Students will know various statistical analyses and their application to science problems in their study area as well as a wide range of methods to analyse data using a hands-on approach. Methods range from simple t-tests to multi-factorial designs of field and growth chamber experiments. The course does not provide the mathematical background that students are expected to bring along when signing up to this course. Alternatively, students can consider some aspects of this course as a first exposure to solutions in experimental design and applied statistics and then deepen their understanding in follow-up statistical courses.

The tentative schedule contains the following topics:

- Introducing the course
- Introduction to R
- Design of Field and Growth Chamber Experiments
- Nonlinear Regression Fits
- Multivariate Techniques: Principle Component Analysis, Canonical Correpondence Analysis (CCA), Cluster Analysis
- ANOVA using linear and mixed effect models
- Error Analysis, Error Propagation and Error Estimation
- Introduction to autoregression and autocorrelations in temporal and spatial data and how to consider them in ANOVA-type analysis

This course uses a learning-by-doing approach ("hands-on minds-on"). New topics are introduced in the lecture hall, but most of the work is done in the computer lab to allow for the different speeds of progress of the student while working with data and analyzing results. In addition to contact hours exercises must be finalized and handed in for grading. The credit points will be given based on successful assessments of selected exercises.

The students are to...

- be capable to conduct evaluations and critically reflect evaluation results
- get insights in agricultural economic research of the national research institutions by visiting Agroscope Reckenholz-Tänikon ART and the Research Institute of Organic Agriculture (FiBL)
- have a critical look at different angles of agri-economic research
- study scientific literature of the focus theme
- consider strengths, weaknesses and the application of research approaches
- apply knowledge gained from other courses with respect to the focus theme
- understand why most real problems are not simple, but require solution methods that go beyond algorithmic and mathematical approaches
- determine, demand, production functions, investment and consumption
- be capable to conduct evaluations and critically reflect evaluation results

### Methodology Competences

- A successful participant of the course is able to:
  - understand why most real problems are not simple, but require solution methods that go beyond algorithmic and mathematical approaches
  - apply the problem solving cycle as a systematic approach to identify problems and their solutions
  - calculate project schedules according to the critical path method
  - set up and run systems dynamics models by means of the Vensim software
  - identify feedback cycles and reasons for unintended systems behavior
  - analyse the stability of nonlinear dynamical systems and apply this to macroeconomic dynamics

### Methods in Food and Resource Use Economics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

Abstract

In this course, different experimental designs will be discussed and various statistical tools will be applied to research questions in agroecosystem sciences. Both manipulative (field and laboratory) experiments and surveys are addressed and students work with a selection of basic techniques and methods to analyse data using a hands-on approach. Methods range from simple t-tests to multi-factorial designs of field and growth chamber experiments. Students will learn various statistical analyses and their application to science problems in their study area as well as a wide range of experimental design options used in environmental and agricultural sciences. They will practice to use statistical software packages (R), understand pros and cons of various designs and statistics, and be able to statistically evaluate their own results as well as those of published studies.

A successful participant of the course is able to:

- understand why most real problems are not simple, but require solution methods that go beyond algorithmic and mathematical approaches
- apply the problem solving cycle as a systematic approach to identify problems and their solutions
- calculate project schedules according to the critical path method
- set up and run systems dynamics models by means of the Vensim software
- identify feedback cycles and reasons for unintended systems behavior
- analyse the stability of nonlinear dynamical systems and apply this to macroeconomic dynamics

### Literature

1) Bussmann Werner, Klöti Ulrich und Knoepfel Peter, 2004 (Hrsg). Einführung in die Politikevaluation. Helbling & Lichtenhahn. In German language. Will be provided by the lectures in unit 01.


**Notice**

Unit 08: 1 day course at ART in Tänikon, 8356 Ettenhausen, www.art.admin.ch
Unit 09: 1 day course at FiBL in 5070 Frick, www.fibl.org
Why are problems not simple? Why do some systems behave in an unintended way? How can we model and control their dynamics? The course provides answers to these questions by using a broad range of methods encompassing systems oriented management, classical systems dynamics, nonlinear dynamics and macroeconomic modeling.

The course is structured along three main tasks:
1. Finding solutions
2. Implementing solutions
3. Controlling solutions

PART 1 introduces complexity as a system immanent property that cannot be simplified. It introduces the problem solving cycle, used in systems oriented management, as an approach to structure problems and to find solutions.

PART 2 discusses selected problems of project management when implementing solutions. Methods for identifying the critical path of subtasks in a project and for calculating the allocation of resources are provided. The role of quality control as an additional feedback loop and the consequences of small changes are discussed.

PART 3, by far the largest part of the course, provides more insight into the dynamics of existing systems. Examples come from biology (population dynamics), management (inventory modeling, technology adoption, production systems) and economics (supply and demand, investment and consumption). For systems dynamics models, the software program VENSIM is used to evaluate the dynamics. For economic models analytical approaches, also used in nonlinear dynamics and control theory, are applied. These together provide a systematic understanding of the role of feedback loops and instabilities in the dynamics of systems. Emphasis is on oscillating phenomena, such as business cycles and other life cycles.

### Lecture notes

Weekly self-study tasks are used to apply the concepts introduced in the lectures and to come to grips with the software program VENSIM. The lecture slides are provided as handouts - including notes and literature sources - to registered students only. All material is to be found on the Moodle platform. More details during the first lecture.

### Prerequisites / notice

Self-study tasks (discussion exercises, Vensim exercises), are provided as home work. Weekly exercise sessions (45 min) are used to discuss selected solutions. Regular participation in the exercises is an efficient way to understand the concepts relevant for the final exam.

### Content

**Risk Analysis**

*W*+ 5 credits 2V+1U  R. Zenklusen

*Abstract*

Introduction to basic techniques and problems of mathematical optimization.

*Objective*

- The goal is to get a good understanding of some of the most important mathematical optimization techniques used to solve linear programs and basic combinatorial optimization problems.
- The lecture notes provide the theoretical background and practical solutions of several exercises. Regular participation in the exercises is an efficient way to understand the concepts relevant for the final exam.

- Topics covered in this course include: Linear programming (simplex method, duality theory, shadow prices, ...); Basic combinatorial optimization problems (spanning trees, network flows, knapsack problem, ...).

- Literature

  Information about relevant literature will be given in the lecture.

- Prerequisites / notice

  This course is meant for students who did not already attend the course "Mathematical Optimization", which is a more advance lecture covering similar topics and more.

**Econometrics II**

*W*+ 2 credits 2G  P. Stalder

*Abstract*

Introduction to Econometrics with practical work on the PC. The lecture builds on Econometrics I (regression analysis, autocorrelated and heteroscedastic disturbances) and addresses the problem of multicollinearity, the estimation of error-correction models, simultaneous equation models and the Probit model.

*Objective*

- Practical comprehension of econometric methods and models
- The lecture builds on Econometrics I (regression analysis, autocorrelated and heteroscedastic disturbances) and addresses four topics: (1) the problem of Multicollinearity; (2) the concept of Stationarity and Cointegration of time series and the related estimation of Error-correction models; (3) Simultaneous equation models; (4) Probit models. Practical exercises on the PC enhance the understanding (Program EViews).

*Content*

- Introduction to Econometrics with practical work on the PC.
- Practical comprehension of econometric methods and models
- Summary handouts for the lecture are available in the Teaching documents repository.

*Literature*


*Prerequisites / notice*


**Dynamic Simulation in Agricultural and Regional Economics**

*W* 1 credit 1V  B. Kopainsky

*Abstract*

Students in this class develop a dynamic simulation model that represents the basic mechanisms underlying food security in developing countries in a highly aggregated way. Students then proceed to extending the simulation model with one policy to improve food security and they analyze the dynamic impacts of this policy on production and environmental outcomes.

*Objective*

- Students learn the basic theory and practice of dynamic simulation
- Students can develop, analyze and extend a dynamic simulation model and interpret its results.
- By applying the developed simulation model, students gain insights into food security issues. They also learn to recognize the benefits and pitfalls of dynamic simulation, both from a theoretical and an applied perspective.

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Data: 06.02.2019 13:00  Autumn Semester 2015  Page 32 of 1434
Improvements in environmental quality and sustainable management of natural resources cannot be achieved through technical solutions alone. However, this often also involves governance, which includes the interplay between governmental and non-governmental actors, the use of diverse tools such as emission standards or financial incentives to steer actors' behavior and can occur at the local, regional, national or international level.

In this course, we will address both the practical aspects of as well as the scientific debate on environmental governance. The course gives future environmental experts a strong basis to position themselves in the governance debate, which does not preclude government but rather involves a spectrum from government to governance.

Key questions that this course seeks to answer: What are the core characteristics of environmental challenges from a policy perspective? What are key elements of 'environmental governance' and how legitimate and effective are these approaches in addressing persistent environmental challenges?

To analyze the evolution as well as the key elements of environmental governance.

To be able to identify the main challenges and opportunities for environmental governance and to critically discuss them with reference to various practical policy examples.

In this course, we will also develop your skills in various areas such as:

- searching, analyzing and synthesizing scientific information on a specific subject
- writing a scientific paper
- making a scientific oral presentation, alone (with poster) and with the team
- animating and moderating a discussion (teamwork)
- how to present (with video-feedback)
- how to moderate a discussion
- scientific writing (different types of documents)
- individual assessment:
  - make a poster and present it
  - write a review or a statement
  - team assessment:
    - write a recommendation (executive summary)
    - present the recommendation
    - moderate a discussion
- how to make a poster
- how to moderate a discussion
- how to present (with video-feedback)

Lecture notes
No script, but div. Instructions

Literature
see website

Number of participants limited to 21.

Students are involved in the working our of a PhD research plan.

Number of participants limited to 21.

Students are involved in the working our of a PhD research plan.

Number of participants limited to 21.
### 751-2401-00L Food and Agricultural Trade Policy

**Objective**

The course focuses on the role of agricultural trade in a rapidly globalizing world. We analyze the impact of trade policy instruments on welfare and distribution.

**Content**

By means of case studies the following specific aspects of agricultural trade are analyzed: trade and food security; trade and environment/natural resources; trade and development.

**Lecture notes**

Handouts (power point presentations)

**Literature**


**Prerequisites**

Basic knowledge in management concepts (e.g. lecture "Management" in D-USYS).

- Transfer and adaption of the models to organizations in the Agri-Food Chain.

- A basic framework for shaping and governing intelligent organizations.

- Be capable to conduct evaluations and critically reflect evaluation results

- Are able to deepen the relevant topics in an autonomous way.

- Know possible practical applications and examples of the treated contents to organizations in the Agri-Food Chain.

- Know and can apply selected comprehensive models for managing in complex situations.

- Know the characteristics and consequences of complexity in the organizational world.

- Transfer and adaption of the models to organizations in the Agri-Food Chain.

**Evaluation**

01: Introduction in the issue of policy evaluation

02: The normative frame for policy evaluation

03: Evaluation of public policies

04: Context and use of evaluations

05: Quantitative policy evaluation

06: Qualitative policy evaluation

07: Group work

08: Agricultural Economics Research at ART

09: Agricultural Economics Research at FiBL

10: Examination, Feedback

**Data: 06.02.2019 13:00  Autumn Semester 2015**
In this seminar students apply their knowledge on sustainable agriculture, tropical soils and land use to a case study related to a current research project from the Sustainable Agroecosystems group. The seminar offers interactions with researchers and extension specialists working in the context of agricultural development.

Objective

1. Students analyze concrete examples of agricultural development projects in tropical agroecosystems.
2. Students broaden their understanding of environmental and socio-economic challenges of smallholder farmers.
4. Students develop their science communication skills by producing science communication materials in the context of the given case study.

Prerequisites / notice

Students signing up for this class should have a strong interest in tropical agriculture and science communication.

851-0594-00L International Environmental Politics

Type: W 4 credits 2V T. Bernauer

Abstract

This course focuses on the conditions under which cooperation in international environmental politics emerges and the conditions under which such cooperation and the respective public policies are effective and/or efficient.

Objective

The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a social sciences viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems.

Content

This course deals with how and why international cooperation in environmental politics emerges, and under what circumstances such cooperation is effective and efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental politics are discussed: the management of international water resources, the problem of unsafe nuclear power plants in eastern Europe, political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

The course is open to all ETH students. Participation does not require previous coursework in the social sciences.

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 4 ECTS credit points. The workload is around 120 hours (meetings, reading assignments, preparation of test).

Lecture notes

Slides and reading material will be made available at www.ib.ethz.ch (teaching, materials, then menu on the left side of the screen). They are password protected. Use your Netzhz username and password to access the material.

Literature

See www.ib.ethz.ch (teaching, materials). Students from ETH will receive 4 ECTS credit points if they attend classes regularly and obtain a grade of 4.0 or higher for the written exam in the final week of the semester. Students who obtain a grade of less than 4.0 for the end-of-semester test will have a second chance in the first week of the following semester. The rules of the game are defined in detail on the course syllabus. Students who do not participate in the end of semester test will not have access to the repeat exam unless they submit compelling and documented reasons for why they were unable to participate in the first test. Except for language dictionaries, no additional materials and no laptops and mobile phones are allowed during the exam.

Carin Halloran

Recent Advances in Biocommunication

This is an introductory course in insect ecology. Students will learn about the ways in which insects interact with and adapt to their abiotic & biotic environments and their roles in diverse ecosystems. The course will entail lectures, outside readings, and critical analysis of contemporary literature.

Objective

Students completing this course should become familiar with the application of ecological principles to the study of insects, as well as major areas of inquiry in this field. Highlighted topics will include insect behavior, chemical and sensory ecology, physiological responses to biotic and abiotic stressesors, plant-insect interactions, community and food-web dynamics, and disease ecology. The course will emphasize insect evolution and adaptation in the context of specific interactions with other organisms and the abiotic environment. Examples from the literature incorporated into lectures will highlight the methods used to study insect ecology.

Lecture notes

Provided to students through ILIAS

Literature

Selected required readings (peer reviewed literature, selected book chapters). Optional recommended readings with additional information.
Students of this course will discuss current topics from the field of infectious disease biology. From a list of publications, each student chooses some themes that he/she is going to explain and discuss with all other participants and under supervision. The actual topics will change from year to year corresponding to the progress and new results occurring in the field.

Objective

This is an advanced course that will require significant student participation. Students will learn how to evaluate and present scientific literature and trace the development of ideas related to understanding the ecology and evolutionary biology of infectious diseases.

Content

A core set of ~10 classic publications encompassing unifying themes in infectious disease ecology and evolution, such as virulence, resistance, metapopulations, networks, and competition will be presented and discussed. Pathogens will include bacteria, viruses and fungi. Hosts will include animals, plants and humans.

Lecture notes

Papers will be assigned and downloaded from a web page announced during the lecture.

Literature

Publications and class notes can be downloaded from a web page announced during the lecture.

Alien Organisms in Agriculture

W 2 credits 2G J. Collatz, M. Melisale

Abstract

The course focuses on alien organisms in agriculture as well as the scientific assessment and regulatory management of their effects on the environment and agricultural production.

Objective

Students will understand the consequences arising from the unintentional or deliberate introduction of alien organisms into agricultural systems. They will be able to understand the concept of environmental risk assessment and be able to evaluate risk management options.

Content

Alien organisms in agriculture is a topic that receives an increasing awareness among farmers, agricultural scientists, regulators and the general public. Students of this course will learn about the nature of alien organisms such as invasive species, biocontrol organisms and genetically modified organisms. With a particular focus on arthropods, plants and their interactions we will look at the potential threats the novel organisms pose, the benefits they provide and how both of these effects can be scientifically assessed. Students will learn how the topic of alien organisms in agriculture is intrinsically tied to policy making and regulation and get to know current examples and future challenges in research. In the last part of the course students will be able to apply the acquired knowledge in a practical exercise (case study).

Lecture notes

Material will be distributed during the course.

Agroecologists without Borders

W 2 credits 2S C. Decock, A. Hofmann, J. Six

Abstract

In this seminar students apply their knowledge on sustainable agriculture, tropical soils and land use to a case study related to a current research project from the Sustainable Agroecosystems group. The seminar offers interactions with researchers and extension specialists working in the context of agricultural development.

Objective

(1) Students analyze concrete examples of agricultural development projects in tropical agroecosystems.
(2) Students broaden their understanding of environmental and socio-economic challenges of smallholder farmers.
(3) Students articulate complexity and challenges in agricultural development interventions.
(4) Students develop their science communication skills by producing science communication materials in the context of the given case study.

Prerequisites / notice

Students signing up for this class should have a strong interest in tropical agriculture and science communication.

Environmental Crop Physiology

Number  Title  Type  ECTS  Hours  Lecturers
751-3405-00L  Radio-Isotopes in Plant Nutrition  W+  3 credits 2G  E. Frossard

Abstract

The course will present the principles underlying the use of radioisotopes in soil/plant systems. It will present how the introduction of an isotope into a system can be done to get some information on the structure of the system. Case studies will be presented to determine element availability. Finally, published studies from other groups will be analyzed and presented by the students.

Objective

At the end of the course the students are familiar with the principles on which radioisotope works are based and they have learned from case studies how radioisotopes can be used to obtain meaningful data. They are aware of the advantages of using radioisotopes in element cycling studies, but also of the risks and open questions related to isotope work.

Content

Radio-isotopes are extensively used at the soil/plant or ecosystem level to quantify the fluxes of elements (phosphorus (P), heavy metals, radionuclides) within a given system and to assess the importance of processes controlling these fluxes (e.g. exchange reactions between the soil solution and the soil solid phase, element turnover through the microbial biomass, organic matter mineralization etc.). The course will present the principles, the basic assumptions and the theoretical framework that underlay the work with radioisotopes. It will present how the introduction of an isotope into a system can be done so as to get information on the structure of the system (e.g. number and size of compartments). Secondly, case studies on isotopic dilution and tracer work will be presented for instance on the isotopic exchange kinetics method to determine nutrients or pollutants availability. The case studies will be adapted to the ongoing research of the group of plant nutrition and will thus give an insight into our current research. In addition, published studies will be analyzed and presented by the students. Finally, the advantages and disadvantages of work with radioisotopes will be analyzed and discussed critically.

Lecture notes

Documents will be distributed during the lecture.

Literature

Will be given during the lecture.

Prerequisites / notice

The lecture will take place at the ETH experimental station in Eschikon Lindau. See the location of the station at: http://www.pplw.agr.ethz.ch/about/reach

Current Topics in Grassland Sciences (HS)

W+  2 credits 2S  N. Buchmann

Abstract

Research results in agro- and forest ecosystem sciences will be presented by experienced researchers as well as Ph.D. and graduate students. Citation classics as well as recent research results will be discussed. Topics will range from plant ecophysiology, biodiversity and biogeochemistry to management aspects in agro- and forest ecosystems.

Objective

Students will be able to understand and evaluate experimental design and data interpretation of on-going studies, be able to critically analyze published research results, practice to present and discuss results in the public, and gain a broad knowledge of recent research and current topics in agro- and forest ecosystem sciences.

Content

Research results in agro- and forest ecosystem sciences will be presented by experienced researchers as well as Ph.D. and graduate students. Citation classics as well as recent research results will be discussed. Topics will range from plant ecophysiology, biodiversity and biogeochemistry to management aspects in agro- and forest ecosystems.

Lecture notes

none

Prerequisites / notice

Prerequisites: Basic knowledge of plant ecophysiology, terrestrial ecology and management of agro- and forest ecosystems. Course will be taught in English.

Alternative Crops

W 2 credits 2V  A. Walter, B. Bütler

Abstract

Few crops dominate the crop rotations worldwide. Following the goal of an increased agricultural biodiversity, species such as buckwheat but also medicinal plants might become more important in future. The biology, physiology, stress tolerance and central aspects of the value-added chain of the above-mentioned and of other alternative crops will be depicted.
Objective
During this course, students learn to assess the potential of different minor or alternative crops compared to the dominant major crops based on their biological and agronomical features. Each student will assess and present a specific alternative crop of his or her choice based on information from scientific articles and Wikipedia. Wikipedia-entries will be generated.

751-4203-00L Horticultural Science: Case Studies (HS) W 2 credits 2G L. Bertschinger, J. Rösti, V. J. U. Zufferey

Abstract
Lectures address 2 horticultural cropping systems and value chains, each one in 4 2h-lecture blocks. Afterwards, the students split in 2 groups for addressing a case study focusing on one of the cropping systems treated before. An excursion to a research site might be included. In a final colloquium, each group presents a report on their case study and their conclusions.

Objective
Achieve a deepened understanding of horticultural value chain challenges relating to ecological intensification, resource efficiency, climate change and healthy and safe food, and the problem solution strategies and scientific principles behind. Deliver in a team effort a report and a presentation providing a comprehensive insight into a problem of the horticultural value chain and its science-based solution strategy.

Content
In the autumn semester, the two addressed cropping systems and value chains are fruit-production and viticulture. In the spring semester, the two addressed cropping systems and value chains are vegetable-production- and berry-production or glasshouse-horticulture. The selected topics address challenges with regard to ecological intensification, resource efficiency or climate change and branch into ongoing research and development projects.

Lecture notes
Documents handed out during the case studies.

Literature
As provided by the case study leaders.

Prerequisites / notice
The course builds on basic knowledge delivered in ‘Horticultural Crops I’ and ‘Horticultural Crops II’. If these courses have not been followed by interested participants, equivalent knowledge and experience will greatly support a successful and productive participation of the participating students.

Language: spoken E, G or F. Documents: Preferably English, G/F possible.

751-5101-00L Biogeochemistry and Sustainable Management W+ 2 credits 2G L. Merbold, N. Buchmann

Abstract
This course focuses on the interactions between ecology, biogeochemistry and management of agro- and forest ecosystems, thus, coupled human-environmental systems. Students learn how human impacts on ecosystems via management or global change are mainly driven by effects on biogeochemical cycles and thus ecosystem functioning, but also about feedback mechanisms of terrestrial ecosystems.

Objective
Students will know and understand the complex and interacting processes of ecology, biogeochemistry and management of agro- and forest ecosystems, be able to analyze and evaluate the various impacts of different management practices under different environmental conditions, search literature, write and evaluate scientific reports, and be able to coordinate and work successfully in small (interdisciplinary) teams.

Content
Agroecosystems and forest ecosystems play a major role in all landscapes, either for production purposes, ecological areas or for recreation. The human impact of any management on the environment is mainly driven by effects on biogeochemical cycles. Effects of global change impacts will also act via biogeochemistry at the soil-biosphere-atmosphere-interface. Thus, ecosystem functioning, i.e., the interactions between ecology, biogeochemistry and management of terrestrial systems, is the science topic for this course.

Students will gain profound knowledge about nutrient cycles and population dynamics in managed and unmanaged grassland, cropland and forest ecosystems in the field and in the lab. Responses of agro- and forest ecosystems to the environment, e.g., to climate, anthropogenic deposition, major disturbances, soil nutrients or competition of plants (including invasives) and microorganisms, but also feedback mechanisms of ecosystems on (micro)climate, soils or vegetation patterns will be studied. Different management practices will be investigated and assessed in terms of production and quality of yield (ecosystem goods and services), but also in regard to environmental regulations (including subsidies) and their effect on the environment, e.g., greenhouse gas budgets. Thus, students will learn about the complex interactions of a coupled human-environmental system.

Lecture notes
Handouts will be available on the webpage of the course.

Literature
Will be discussed in class.

Prerequisites / notice
Prerequisites: Attendance of introductory courses in plant ecophysiology, ecology, and grassland or forest sciences. Course will be taught in English.

751-5115-00L Current Aspects of Nutrient Cycle in Agro-Ecosystems Does not take place this semester. W+ 2 credits 1S E. Frossard

Abstract
The seminar concerns current aspects and research related to nutrient cycles in agro-ecosystems. It offers to deepen the knowledge on a specific theme related to nutrients. It is composed by presentations of national and international speakers and by an excursion. The students write a report where they compile the obtained information, relate it to their own knowledge and include literature.

Objective
Listen and understand expert's presentations. Ask questions and contribute to the discussion during the talk sessions and the excursion. Link the information obtained during the seminar with knowledge from previous lessons and with literature searched to complement the material. Expand the knowledge on nutrient cycles and nutrient management in the agro-ecosystem.

751-5123-00L Rhizosphere Ecology W+ 4 credits 4G H. A. Gamper, E. K. Bünemann König, T. I. McLaren

Abstract
This course emphasizes interactions among physicochemical and biological processes and highlights implications for plant nutrition, growth, and health. Nutrient mobilization and acquisition by plants in response to fertilization, other plants, and microbes, are explored in model systems. Newly gained knowledge is applied to understand results of a pot experiment and thereby critically reflected.

Objective
To gain a holistic understanding of resource-driven and regulatory processes in natural and agronomic plant-microbe-soil systems. To practice abilities to read scientific literature, understand it, present it, and discuss it with peers. To combine available and newly acquired knowledge from soil physics, chemistry and (micro-)biology, plant physiology, pathology, and ecology and reflect on their relative importance for plant production, bioremediation, and nature conservation when considered together. To practice manual skills in handling seedlings, soil, plant, and DNA samples, laboratory equipment, and working with different computer software. To make observations, analyse, display, interpret and present own data. To get familiar with (bio-)chemical, molecular genetic, and simple bioinformatics analyses. To prepare as a group of course participants a poster on one selected aspect of a bigger pot experiment, present it, and discuss findings and posters of other course participants. To combine findings with available knowledge, generate explanatory hypotheses, and identify potentially informative further analyses and experiments.
This course comprised lectures, the set-up, harvest and data analysis of an experiment, soil (bio-)chemical, microbiological and molecular genetic analyses in the laboratory and practical computational data analyses. The focus is set on a better understanding of the role played by spatial and temporal physicochemical and microbiological gradients and various soil organisms in plant mineral nutrition. Mutualistic associations between plant roots and microbes, such as the root symbiosis with mycorrhizal fungi and root nodule-inducing bacteria are discussed. Rhizobia are isolated from field-collected root nodules and characterized, using molecular genetic tools. A short introduction into DNA-based bioinformatics and phylogenetic analyses is given to demonstrate how bacterial species are identified and potential host ranges of isolated rhizobia can be inferred, using so-called functional genes. A pot experiment in the glasshouse on cereal-legume mixed intercropping, including effects of pot size, intra- and interspecific plant competition, and root traits, allows to relate scientifically interesting research topics to practical application, while simultaneously stimulating critical reflections.

Lecture slides and laboratory protocols are being made available in the directory ‘751-5123-00L Rhizosphere Ecology’ of the electronic document exchange platform ILIAS, LDA-ELBA: https://ilias-app2.let.ethz.ch/ilias.php?ref_id=85894&cmdClass=irepositorygui&cmdNode=el&baseClass=ilRepositoryGUI


http://www.nature.com/scitable/knowledge/library/plant-soil-interactions-nutrient-uptake-105289112


http://www.cropress.com/product/isbn/9780849338557


http://link.springer.com/article/10.1007%2Fs11104-008-9885-9

http://dx.doi.org/10.1111/nph.12235

http://www.plantphysiol.org/content/156/3/1078


How microbes can feed the world (American Academy of Microbiology)
http://academy.asm.org/index.php/browse-all-reports/800-how-microbes-can-help-feed-the-world

Can microbes feed the world? (Society for general microbiology)

Popular science entries to the topic:
http://www.the-scientist.com/?articles/view/articleNo/30950/title/The-Root-of-the-Problem/

Ecological Understanding (Second Edition)
The Nature of Theory and the Theory of Nature:
http://www.scienceblog.com/index.php/2007/01/18/the-ecological-understanding-

Prerequisites / notice
For students of the Agricultural Sciences of D-USYS: Lectures in Plant Nutrition I and II (Nutrient cycling in agroecosystems) by Prof. E. Frossard.
We ask all other course participants to read and understand the e-learning module Plant Nutrition I by Prof. E. Frossard:
https://moodle-app2.let.ethz.ch/course/view.php?id=279

This course on Rhizosphere Ecology is complementary to those on Radioisotopes in Plant Nutrition, and Nutrient Fluxes in Soil-Plant Systems. However, a limited number of thematic overlaps cannot be avoided. Particular emphasis is given to the ecophysiology of interacting organisms and detection, enumeration, culturing, and molecular genetic identification of root-associated microbes.
A written closed book exam will take place on Friday January 8, 2016, from 10.15-12.15am in Eschikon.
Maximum number of participants: 18.
Students of the agricultural sciences of D-USYS will be reimbursed for travel expenses upon handover of collected tickets of the public transport systems, excluding the tax zone of the city of Zurich.
In the autumn semester, the two addressed cropping systems and value chains are fruit-production and viticulture. Achieve a deepened understanding of horticultural value chain challenges relating to ecological intensification, resource efficiency, climate change and healthy and safe food, and the problem solution strategies and scientific principles behind. Deliver in a team effort a report and a presentation providing a comprehensive insight into a problem of the horticultural value chain and its science-based solution strategy.

### General Crop Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-4203-00L</td>
<td>Horticultural Science: Case Studies (HS)</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>L. Bertschinger, J. Rösti, V. J. U. Zufferey</td>
</tr>
<tr>
<td>751-5101-00L</td>
<td>Biogeochemistry and Sustainable Management</td>
<td>W+</td>
<td>2</td>
<td>2G</td>
<td>L. Merbold, N. Buchmann</td>
</tr>
</tbody>
</table>

Abstract: This course provides an overview about the applicability of stable isotopes (carbon 13C, nitrogen 15N, oxygen 18O and water 2H) to process-oriented ecological research. Topics focus on stable isotopes as indicators for the origin of pools and fluxes, partitioning of composite fluxes as well as to trace and integrate processes. In addition, students carry out a small project during lab sessions.

Objective: Students will be familiar with basic and advanced applications of stable isotopes in studies on plants, soils, water and trace gases, know the relevant approaches, concepts and recent results in stable isotope ecology, know how to combine classical and modern techniques to solve ecophysiological or ecological problems, learn to design, carry out and interpret a small IsoProject, practice to search and analyze literature as well as to give an oral presentation.

Content: The analyses of stable isotopes often provide insights into ecophysiological and ecological processes that otherwise would not be available with classical methods only. Stable isotopes proved useful to determine origin of pools and fluxes in ecosystems, to partition composite fluxes and to integrate processes spatially and temporally.

Lecture notes: Handouts will be available on the webpage of the course.

Literature: Will be discussed in class.

Prerequisites / notice: This course is based on fundamental knowledge about plant ecophysiology, soil science, and ecology in general. Course will be taught in English.
**Objective**

Students will know and understand the complex and interacting processes of ecology, biogeochemistry and management of agro- and forest ecosystems, be able to analyze and evaluate the various impacts of different management practices under different environmental conditions, search literature, write and evaluate scientific reports, and be able to coordinate and work successfully in small (interdisciplinary) teams.

**Content**

Agroecosystems and forest ecosystems play a major role in all landscapes, either for production purposes, ecological areas or for recreation. The human impact of any management on the environment is mainly driven by effects on biogeochemical cycles. Effects of global change impacts will also act via biogeochemistry at the soil-biosphere-atmosphere-interface. Thus, ecosystem functioning, i.e., the interactions between ecology, biogeochemistry and management of terrestrial systems, is the science topic for this course.

Students will gain profound knowledge about nutrient cycles and population dynamics in managed and unmanaged grassland, cropland and forest ecosystems in the field and in the lab. Responses of agro- and forest ecosystems to the environment, e.g., to climate, anthropogenic deposition, major disturbances, soil nutrients or competition of plants (including invasives) and microorganisms, but also feedback mechanisms of ecosystems on (micro)climate, soils or vegetation patterns will be studied. Different management practices will be investigated and assessed in terms of production and quality of yield (ecosystem goods and services), but also in regard to environmental regulations (including subsidies) and their effect on the environment, e.g., greenhouse gas budgets. Thus, students will learn about the complex interactions of a coupled human-environmental system.

**Lecture notes**

Handouts will be available on the webpage of the course.

**Literature**

Will be discussed in class.

**Prerequisites / notice**

Prerequisites: Attendance of introductory courses in plant ecophysiology, ecology, and grassland or forest sciences. Course will be taught in English.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>751-5115-00L</td>
<td>Current Aspects of Nutrient Cycle in Agro-Ecosystems</td>
<td>W+</td>
<td>2 credits</td>
<td>1S</td>
<td>E. Frossard</td>
</tr>
<tr>
<td>751-5001-00L</td>
<td>Agroecologists without Borders</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>C. Decock, A. Hofmann, J. Six</td>
</tr>
</tbody>
</table>

**Non-Ruminant Science**

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-6001-00L</td>
<td>Forum: Livestock in the World Food System</td>
<td>W</td>
<td>2 credits</td>
<td>1S</td>
<td>M. Kreuzer, S. Bauersachs, E. Hillmann, S. Neuenschwander</td>
</tr>
</tbody>
</table>

**Abstract**

In this seminar students apply their knowledge on sustainable agriculture, tropical soils and land use to a case study related to a current research project from the Sustainable Agroecosystems group. The seminar offers interactions with researchers and extension specialists working in the context of agricultural development.

**Objective**

1. Students analyze concrete examples of agricultural development projects in tropical agroecosystems.
2. Students broaden their understanding of environmental and socio-economic challenges of smallholder farmers.
4. Students develop their science communication skills by producing science communication materials in the context of the given case study.

**Prerequisites / notice**

Students signing up for this class should have a strong interest in tropical agriculture and science communication.

**Lecture notes**

No scriptum

**Prerequisites / notice**

Requirements for allocation of the two credit points:
- Theatre presentation (with handout) at the forum
- Delivery of written documents of sufficient quality
- Active participation during the presentations by the other participants

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>751-6305-00L</td>
<td>Livestock Breeding and Genomics I</td>
<td>W</td>
<td>2 credits</td>
<td>1V</td>
<td>B. Gredler, P. von Rohr</td>
</tr>
</tbody>
</table>

**Abstract**

Methods for analysing livestock data, in particular for the estimation of breeding values: principles of selection index, correction of records for fixed effects, introduction to BLUP, application of common models used, relationship matrix, methods for the estimation of variance components. The material will be illustrated via exercises and assignments.

**Objective**

The students are able to estimate breeding values for the most common population structures using the selection index. They are able to set up design matrices, the relationship matrix and its inverse as well as the Mixed Model equations to estimate BLUP breeding values for smaller examples.

**Content**

- Selection index (various sources of information, one trait, multiple traits)
- Relationship matrix and its inverse
- Correction of fixed effects
- BLUP: one trait, repeated observations, multiple traits, economic indices
- Introduction to methods for the estimation of variance components
- Asymptotics

**Lecture notes**

Copies of the slides are available on the net.
**ECTS Lecturers**

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-6601-00L</td>
<td>Pig Science (HS)</td>
<td>W</td>
<td>3</td>
<td></td>
<td>E. Hillmann, M. C. Härdi-Landerer</td>
</tr>
<tr>
<td>751-7603-00L</td>
<td>Livestock Breeding and Genomics II</td>
<td>W</td>
<td>1</td>
<td></td>
<td>B. Gredler, P. von Rohr</td>
</tr>
<tr>
<td>751-7703-00L</td>
<td>Tropical Animal Nutrition</td>
<td>W</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>751-6113-00L</td>
<td>Endocrinology and Biology of Reproduction</td>
<td>W</td>
<td>3</td>
<td></td>
<td>S. E. Ulbrich</td>
</tr>
</tbody>
</table>

**Content**

- **Pig Science (HS)**
  - The overall goal of the course is to provide the essential scientific knowledge of the genetic, physiological and special nutritional aspects of pigs’ metabolism, animal health and behavior, and of the implications for environment, product quality, housing and animal welfare, and breeding programs.

- **Livestock Breeding and Genomics II**
  - The course provides methods to use molecular genetics information in livestock breeding. First, linkage disequilibrium, its measurement and applications are introduced. Genomic selection, genome wide association studies, and estimation of breeding values are further topics.

- **Tropical Animal Nutrition**
  - The aim of this course is to know and understand animal production systems in the different zones of the tropics taking into consideration the local and social structure of the population. We will deal with different aspects of animal nutrition in the tropics.

**Objective**

- Students will
  - understand the complex interactions of nutrition, quality traits of products, breeding and reproduction, health management, behaviour and husbandry.
  - be trained to understand interdisciplinary and disciplinary research.
  - be able to critically analyze published research data.
  - be able to present precise scientific reports in oral and written form.

- FS
  - Special Physiology of Pig Nutrition: food intake; growth; metabolism and digestion at different growth stages; energy and specific nutritional requirements; feeding systems; environmental aspects, etc.
  - Genetics: Breeding systems, reproductive techniques, performance tests and recording, etc.

- Oral presentation, exam, evaluation

- Handouts/scripts are distributed by the lecturers.

**Literature**

- Specific literature is indicated by the lecturers.

**Prerequisites / notice**

- The lecture corresponds with the lecture "Ruminant Science" and knowledge in animal health, nutrition and breeding as well as applied ethology and animal welfare are recommended.

The lecture usually is in German, but there is always the possibility to change to English.

### Ruminant Science

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>751-6001-00L</td>
<td>Forum: Livestock in the World Food System</td>
<td>W</td>
<td>2</td>
<td></td>
<td>M. Kreuzer, S. Bauersachs, E. Hillmann, S. Neuenschwander</td>
</tr>
</tbody>
</table>

**Abstract**

This forum is a platform for the critical reflection of highly relevant topics of livestock in the frame of the world food system comprising issues from basic knowledge to acceptance in society. The exchange is supported by scientific writing and presentation.

**Objective**

In the Forum "Livestock in the World Food System", a topic of significance for livestock agriculture is selected by the students and subsequently dealt with from various angles (from scientific basis to production systems, environmental aspects and to the acceptance by society). The students learn to present a scientific subject in writing and orally to an audience and to defend the presentation in a discussion.
The course provides the scientific basis of the central aspects of reproduction, husbandry and nutrition physiology of ruminants, and of the

The course enables students to understand in detail how ruminal digestion works and how this knowledge can be applied to design optimal

Documentations, links and other materials will be provided at the start of the course

4G
Livestock Breeding and Genomics I
M. Kreuzer
Information on books and other references will be communicated during the course

The students are able to estimate breeding values for the most common population structures using the selection index. They are able to

W+
1G
- Selection index (various sources of information, one trait, multiple traits)
- Relationship matrix and its inverse
- Correction of fixed effects
- BLUP: one trait, repeated observations, multiple traits, economic indices
- Introduction to methods for the estimation of variance components
- Assignments

To be announced in the lectures.

W
At the end of the course the students are able to apply, by a comprehensive understanding of the underlying mechanisms, their knowledge

Fields (contact hours)
- Introduction: 2 h
- Special topics: 12 h
  - Lameness
  - Fertility in Cows
- Food Intake of Ruminants
- Disciplinary topics: 36 h
- Ruminant Husbandry: 16 h
- Ruminant Nutrition Physiology: 10 h
- Reproduction in Ruminants: 8 h
- Lectures held by the students: 4 h

In summary
- Contact hours: 92 h
- Self-study within semester: 30 h (especially preparation for the interdisciplinary courses and the own lecture)
- Self-study in semester break: 38 h
Total: 120 h

The field of Ruminant Science will also be a part of the spring semester (special topics: Organic Ruminant Systems, Tropical Ruminant Systems, Mastitis; disciplinary courses: Cattle, Sheep and Goat Breeding, Ruminant Diseases and Prophylaxis, Ruminant Nutrition and the Environment). However both courses are organized independently.

Prerequisites /
Prerequisites /
notice
notice

Copies of the slides are available on the net.

Ruminant Science without any animal science background, a realistic self-assessment concerning the need for additional self-study is

Conditions for successful participation: Background on animal science from the Bachelor is desired. In order to attend the Minor in

The control of performance will consist of:

- an own lecture
- a final oral examination with focus on comprehension of the fundamental linkages rather than of specific details

The course broadens the knowledge in one of the most important aspects of ruminant nutrition: the microbial digestion in the rumen (and in the hindgut). For a comprehensive understanding of the rumen microbial ecosystem, the mechanisms of nutrient fermentation and the synthesis of microbial protein, thorough basics are provided. Apart from lectures, laboratory exercises are included.

The course enables students to understand in detail how ruminal digestion works and how this knowledge can be applied to design optimal feeding diets using highly fibrous forages and a variety of other feeds. The students also are able to show how to modify the most important rumen microbes beneficially by nutritional means.
The aim of this course is to know and understand animal production systems in the different zones of the tropics taking into consideration the local and social structure of the population. We will deal with different aspects of animal nutrition in the tropics. Does not take place this semester.

The two objectives of the class are:
- to provide an overview of the important issues related to food markets and supply chains.
- to present the economics concepts and tools that are useful to understand the functioning of food supply chains under various governance regimes or policies (emphasis on welfare analysis)

Objective

Content
- Introduction to the tropics
- Special problems and challenges in tropical regions
- Importance of livestock in the tropics
- Animal production and livestock production systems in the tropics
- Special challenges for livestock in the tropics
- Feeds available in the tropics
- Tropical pasture systems and their characteristics
- Quality of feeds in the tropics
- Problems and challenges of animal nutrition in the tropics

Lecture notes

Literature

Prerequisites / notice

ECTS

The course is a balanced mixture of blackboard exercise, laboratory exercise, lecture and student seminar presentation

Credit point associated with grade of either a written report or an short oral presentation in the concluding seminary (both on a self-chosen related topic)

751-770-00L

Livestock Breeding and Genomics II

W

1 credit

1V

B. Gredler, P. von Rohr

Abstract

The course provides methods to use molecular genetics information in livestock breeding. First, linkage disequilibrium, its measurement and applications are introduced. Genomic selection, genome wide association studies, and estimation of breeding values are further topics. The theory is applied in assignments.

Objective

The students are able to interpret and apply linkage disequilibrium. They are able to discuss the principles of genomic selection, genome wide association studies and breeding value estimation.

Content

- Linkage disequilibrium
- Genomic selection and estimation of breeding values
- Genomewide association studies
- Assignments

Lecture notes

Copies of the slides are available on the net.

Literature

To be announced in the lectures.

751-7703-00L

Tropical Animal Nutrition

W

1 credit

1G

Abstract

Farm animals play an important role in most agro/eco - systems, but conditions for a successful management and nutrition in the tropics are diverse. In this course a wide range of aspects are examined.

Objective

The aim of this course is to know and understand animal production systems in the different zones of the tropics taking into consideration the local and social structure of the population. We will deal with different aspects of animal nutrition in the tropics.

Content

- Introduction to the tropics
- Special problems and challenges in tropical regions
- Importance of livestock in the tropics
- Animal production and livestock production systems in the tropics
- Special challenges for livestock in the tropics
- Feeds available in the tropics
- Tropical pasture systems and their characteristics
- Quality of feeds in the tropics
- Problems and challenges of animal nutrition in the tropics

Lecture notes

Literature

Prerequisites / notice

ECTS

The course is balanced between presentation of economics concepts and illustration by case-studies. The lecture titles include:

Demand for food.
Matching demand with supply.
Industrial organization in the food supply chain.
Non-quality attributes of food.
When information is costly.
Food production and the environment.
The food sector within human economies.

In addition, the students collectively identify and address an applied research question. We implement an empirical strategy to tackle the question before results are discussed individually by students during the final written examination.

Lecture notes

Lecture notes are made available after each lecture.
Students are expected to master basic microeconomics concepts such as demand, supply, or consumer and producer surplus. We will review how to calculate elasticities, tax and quota impacts on prices etc...but the class focuses on applications of these tools rather than on basic understanding. Students are expected to have taken at least one intermediary microeconomics class.

**Prerequisites / notice**

Students are expected to have taken at least one intermediary microeconomics class.

**Abstract**

The course focuses on food consumer behavior, consumer's decision-making processes and consumer's attitudes towards food products.

**Objective**

The course provides an overview about the following topics: Factors influencing consumer's food choice, food and health, attitudes towards new foods and food technologies, labeling and food policy issues.

**Content**

Readings in the standard economics literature include:

- Coase 1937,
- Mussa Rosen 1978,
- Lancaster 1966,

**Literature**

- Coase 1937,
- Mussa Rosen 1978,
- Lancaster 1966,

**Prerequisites / notice**

Students are expected to master basic microeconomics concepts such as demand, supply, or consumer and producer surplus. We will review how to calculate elasticities, tax and quota impacts on prices etc...but the class focuses on applications of these tools rather than on basic understanding. Students are expected to have taken at least one intermediary microeconomics class.

**Prerequisites / notice**

Students are expected to master basic microeconomics concepts such as demand, supply, or consumer and producer surplus. We will review how to calculate elasticities, tax and quota impacts on prices etc...but the class focuses on applications of these tools rather than on basic understanding. Students are expected to have taken at least one intermediary microeconomics class.

**Abstract**

This forum is a platform for the critical reflection of highly relevant topics of livestock in the frame of the world food system comprising issues from basic knowledge to acceptance in society. The exchange is operated by scientific writing and presentation.

**Objective**

In the Forum "Livestock in the World Food System", a topic of significance for livestock agriculture is selected by the students and subsequently dealt with from various angles (from scientific basis to production systems, environmental aspects and to the acceptance by society). The students learn to present a scientific subject in writing and orally to an audience and to defend the presentation in a discussion.
Content
The Forum "Livestock in the World Food System" will take place in blocks of 2 hours each. Once the general topic has been selected, it comprises two elements:

Element 1. Oral Presentation: The students form small groups and are lecturers. There are chair persons (moderators) from outside of these small groups and they also head the discussion. The remaining students and lecturers are the audience.

Element 2. Scientific writing: Option 1: preparation of a short scientific type of paper from a result table offered by the lecturers; Option 2: preparation of an abstract with limited word count from a scientific paper; Option 3: writing of a critical review of a paper. The students have to select 2 of the three options each. There will be a discussion be a discussion in small groups at two dates.

Introductions to both forms of presentation will be offered by lecturers.
The preparation of the oral and written presentations takes place to a small part during the 2-h blocks and mainly outside of this time.

Lecture notes
no scriptum

Prerequisites / notice
Requirements for allocation of the two credit points:
- Theatre presentation (with handout) at the forum
- Delivery of written documents of sufficient quality
- Active participation during the presentations by the other participants

752-5111-00L Gene Technology in Foods W 3 credits 2V L. Meile

Abstract
This course will increase basic knowledge on biotechnological constructions and application of genetically modified organisms (GMO) which are used worldwide in food production systems. The course discusses health issues, the legislation frame and food safety aspects of GMO applications in agriculture, food production and consumption in Switzerland and EU-countries.

Objective
This course will provide knowledge and biological background on genetically modified organisms (GMO) and food produced with the help of GMO, especially on the molecular basis of GMO constructions with emphasis on genetically modified food in Switzerland and the EU. Criteria of rational food safety and health assessment in agriculture and food consumption will be elaborated.

Content
Overview on application in gene technology, the gene transfer potential of bacteria, plants and other organisms and the mostly used transgenes in food as well as on GMO used for food production and their detection technologies in food; food safety assessment of GMO food; information on the legislation in Switzerland and EU-countries

Lecture notes
Copies of slides from lectures will be provided

Literature
Actual publications from literature will be provided

Prerequisites / notice
Good knowledge in biology, especially in microbiology and molecular biology are prerequisites.

Some contents will be provided by registered students who will individually or as a group present an actual publication.

751-0021-00L World Food System Summer School W 4 credits 6P M. Grant, N. Buchmann

Number of participants limited to 25.

Abstract
Provide the opportunity for young scientists and practitioners to understand the challenges and opportunities of sustainable agriculture and organic production systems and to connect these to the broader context of the world food system. During the two week summer school at the Gut Rheinau, one of Switzerland's largest organic farms, participants will engage in lectures, workshops, group work, case studies.

Objective
Understand: the science, relationships, interactions and trade-offs in food systems; the role and potential of organic production systems; potential interventions; the cultural, socio-political, economic and environmental factors to be incorporated into solutions. Build skills in systems thinking, multi-cultural and multi-disciplinary collaboration, participatory processes. Connect to a network of expert faculty/scientists/practitioners

Content
The course framework includes the following modules: world food system overview; agricultural production; Global change drivers; smallholder livelihoods and rural development; Agroforest systems; labelling; International policy and trade; Processing, distribution, and retail; Nutrition and health; National policy and state interventions. The course will conclude with a group work on food system challenges.

Lecture notes
No pre-reading material before the course commences.

Prerequisites / notice
No prerequisites. Program is open to Masters, PhD and upper level Bachelor students.

Functioning of Soil Systems

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0533-00L</td>
<td>Soil Chemistry</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>R. Kretzschmar, D. I. Christl</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course discusses chemical and biogeochemical processes in soils and their influence on the behavior and cycling of nutrients and pollutants in terrestrial systems. Approaches for quantitative modeling of the processes are introduced.</td>
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<tr>
<td>Objective</td>
<td>Understanding of important chemical soil properties and processes and their influence on the behavior (e.g., speciation, bioavailability, mobility) of nutrients and pollutants.</td>
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<tr>
<td>Content</td>
<td>Important topics include the structure and properties of clays and oxides, the chemistry of the soil solution, gas equilibria, dissolution and precipitation of mineral phases, cation exchange, surface complexation, chemistry of soil organic matter, redox reactions in flooded soils, soil acidification and soil salinization.</td>
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<tr>
<td>Lecture notes</td>
<td>Handouts in lectures.</td>
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<tr>
<td>701-0535-00L</td>
<td>Environmental Soil Physics/Vadose Zone Hydrology W 3 credits 2G+2U D. Or</td>
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<tr>
<td>Abstract</td>
<td>The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.</td>
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<tr>
<td>Objective</td>
<td>Students are able to</td>
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<td></td>
<td>- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media,</td>
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<td>- quantify driving forces and resulting fluxes of water, solute, and heat in soils.</td>
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<td>- apply modern measurement methods and analytical tools for hydrological data collection</td>
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<td></td>
<td>- conduct and interpret a limited number of experimental studies</td>
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<td></td>
<td>- explain links between physical processes in the vadose-zone and major societal and environmental challenges</td>
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</tbody>
</table>
**Content**

Weeks 1 to 3: Physical Properties of Soils and Other Porous Media. Units and dimensions, definitions and basic mass-volume relationships between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay behavior.

Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity.

Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing.

Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:

1. Laminar flow in tubes (Poiseuille's Law); Darcy’s Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement.

   Lab #1: Measurement of saturated hydraulic conductivity in uniform and layered soil columns using the constant head method.

2. Unsaturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.

   Midterm exam

   Lab #2: Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip's approximations; infiltration rates and wetting front propagation.

3. Use of Hydrom model for simulation of unsaturated flow.

   Week 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface evaporation.

   Week 12 to 13: Solute Transport in Soils - Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion eq.; solutions for pulse and step solute application; parameter estimation; salt balance.

   Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

   Additional topics:

   Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; non-steady heat flow; estimation of thermal properties; engineering applications.

**Lecture notes**

Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller (available at the beginning of the semester)

http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology

**Literature**

Supplemental textbook (not mandatory) - Environmental Soil Physics, by: D. Hillel

**751-5101-00L Biogeochemistry and Sustainable Management**

2 credits 2G L. Merbold, N. Buchmann

This course focuses on the interactions between ecology, biogeochemistry and management of agro- and forest ecosystems, thus, coupled human-environmental systems. Students learn how human impacts on ecosystems via management or global change are mainly driven by effects on biogeochemical cycles and thus ecosystem functioning, but also about feedback mechanisms of terrestrial ecosystems.

Students will know and understand the complex and interacting processes of ecology, biogeochemistry and management of agro- and forest ecosystems, be able to analyze and evaluate the various impacts of different management practices under different environmental conditions, search literature, write and evaluate scientific reports, and be able to coordinate and work successfully in small (interdisciplinary) teams.

Agroecosystems and forest ecosystems play a major role in all landscapes, either for production purposes, ecological areas or for recreation. The human impact of any management on the environment is mainly driven by effects on biogeochemical cycles. Effects of global change impacts will also act via biogeochemistry at the soil-biosphere-atmosphere-interface. Thus, ecosystem functioning, i.e., the interactions between ecology, biogeochemistry and management of terrestrial systems, is the science topic for this course.

Students will gain profound knowledge about nutrient cycles and population dynamics in managed and unmanaged grassland, cropland and forest ecosystems in the field and in the lab. Responses of agro- and forest ecosystems to the environment, e.g., to climate, anthropogenic deposition, major disturbances, soil nutrients or competition of plants (including invasives) and microorganisms, but also feedback mechanisms of ecosystems on (micro)climate, soils or vegetation patterns will be studied. Different management practices will be investigated and assessed in terms of production and quality of yield (ecosystem goods and services), but also in regard to environmental regulations (including subsidies) and their effect on the environment, e.g., greenhouse gas budgets. Thus, students will learn about the complex interactions of a coupled human-environmental system.

Handouts will be available on the webpage of the course.

**751-5115-00L Current Aspects of Nutrient Cycle in Agro-Ecosystems**

2 credits 1S E. Frossard

The seminar concerns current aspects and research related to nutrient cycles in agro-ecosystems. It offers to deepen the knowledge on a specific theme related to nutrients. It is composed by presentations of national and international speakers and by an excursion. The students write a report where they compile the obtained information, relate it to their own knowledge and include literature.

Listen and understand expert's presentations. Ask questions and contribute to the discussion during the talk sessions and the excursion. Link the information obtained during the seminar with knowledge from previous lessons and with literature searched to complement the matter. Expand the knowledge on nutrient cycles and nutrient management in the agro-ecosystem.

**751-5123-00L Rhizosphere Ecology**

4 credits 4G H. A. Gamper,
Abstract
This course emphasizes interactions among physicochemical and biological processes and highlights implications for plant nutrition, growth, and health. Nutrient mobilization and acquisition by plants in response to fertilization, other plants, and microbes, are explored in model systems. Newly gained knowledge is applied to understand results of a pot experiment and thereby critically reflected.

Objective
To gain a holistic understanding of resource-driven and regulatory processes in natural and agronomic plant-microbe-soil systems.
To practice abilities to read scientific literature, understand it, present it, and discuss it with peers.
To combine available and newly acquired knowledge from soil physics, chemistry and (micro-)biology, plant physiology, pathology, and ecology and reflect on their relative importance for plant production, bioremediation, and nature conservation when considered together.
To practice manual skills in handling seedlings, soil, plant, and DNA samples, laboratory equipment, and working with different computer software.
To make observations, analyse, display, interpret and present own data.
To get familiar with (bio-)chemical, molecular genetic, and simple bioinformatics analyses.
To prepare as a group of course participants a poster on one selected aspect of a bigger pot experiment, present it, and discuss findings and posters of other course participants.
To combine findings with available knowledge, generate explanatory hypotheses, and identify potentially informative further analyses and experiments.

Content
This course comprised lectures, the set-up, harvest and data analysis of an experiment, soil (bio-)chemical, microbiological and molecular genetic analyses in the laboratory and practical computational data analyses. The focus is set on a better understanding of the role played by spatial and temporal physicochemical and microbiological gradients and various soil organisms in plant mineral nutrition. Mutualistic associations between plant roots and microbes, such as the root symbiosis with mycorrhizal fungi and root nodule-inducing bacteria are discussed. Rhizobias are isolated from field-collected root nodules and characterized, using molecular genetic tools. A short introduction into DNA-based bioinformatics and phylogenetic analyses is given to demonstrate how bacterial species are identified and potential host ranges of isolated rhizobia can be inferred, using so-called functional genes. A pot experiment in the glasshouse on cereal-legume mixed intercropping, including effects of pot size, intra- and interspecific plant competition, and root traits, allows to relate scientifically interesting research topics to practical application, while simultaneously stimulating critical reflections.

Lecture notes
Lecture slides and laboratory protocols are being made available in the directory ’751-5123-00L Rhizosphere Ecology’ of the electronic document exchange platform ILIAS, LDA-ELBA:
https://ilias-app2.let.ethz.ch/ilias.php?ref_id=85894&cmdClass=IRepositoryGUI&cmdNode=e1&baseClass=IRepositoryGUI
Content
The analyses of stable isotopes often provide insights into ecophysiological and ecological processes that otherwise would not be available with classical methods only. Stable isotopes proved useful to determine origin of pools and fluxes in ecosystems, to partition composite fluxes and to integrate processes spatially and temporally.

This course will provide an introduction to the applicability of stable isotopes to ecological research questions. Topics will focus on carbon (13C), nitrogen (15N), oxygen (18O) and hydrogen (2H) at natural isotope abundance and tracer levels. Lectures will be supplemented by intensive laboratory sessions, short presentations by students and computer exercises.

Lecture notes
Handouts will be available on the webpage of the course.

Literature
Will be discussed in class.

Prerequisites / notice
This course is based on fundamental knowledge about plant ecophysiology, soil science, and ecology in general. Course will be taught in English.

751-5001-00L
Agroecologists without Borders

W 2 credits 2S C. Decock, A. Hofmann, J. Six

Abstract
In this seminar students apply their knowledge on sustainable agriculture, tropical soils and land use to a case study related to a current research project from the Sustainable Agroecosystems group. The seminar offers interactions with researchers and extension specialists working in the context of agricultural development.

Objective
(1) Students analyze concrete examples of agricultural development projects in tropical agroecosystems.
(2) Students broaden their understanding of environmental and socio-economic challenges of smallholder farmers.
(3) Students articulate complexity and challenges in agricultural development interventions.
(4) Students develop their science communication skills by producing science communication materials in the context of the given case study.

Prerequisites / notice
Students signing up for this class should have a strong interest in tropical agriculture and science communication.

751-5201-00L
Tropical Soils and Land Use

W 2 credits 2G J. Six

Tropical Soils and Land Use

Does not take place this semester.

751-3405-00L
Radio-Isotopes in Plant Nutrition

W 3 credits 2G E. Frossard

Radio-Isotopes in Plant Nutrition

Abstract
The course will present the principles underlying the use of radioisotopes in soil/plant systems. It will present how the introduction of an isotope into a system can be done to get some information on the structure of the system. Case studies will be presented to determine element availability. Finally, published studies from other groups will be analyzed and presented by the students.

Objective
At the end of this course the students are familiar with the principles on which radioisotope works are based and they have learned from case studies how radioisotopes can be used to obtain meaningful data. They are aware of the advantages of using radioisotopes in element cycling studies, but also of the risks and open questions related to isotope work.

Content
Radio-isotopes are extensively used at the soil/plant or ecosystem level to quantify the fluxes of elements (phosphorus (P), heavy metals, radionuclides) within a given system and to assess the importance of processes controlling these fluxes (e.g. exchange reactions between the soil solution and the soil solid phase, element turnover through the microbial biomass, organic matter mineralization etc.).

The course will first present the principles, the basic assumptions and the theoretical framework that underlay the work with radioisotopes. It will present how the introduction of an isotope into a system can be done so as to get information on the structure of the system (e.g. number and size of compartments). Secondly, case studies on isotopic dilution and tracer work will be presented for instance on the isotopic exchange kinetics method to determine nutrients or pollutants availability. The case studies will be adapted to the ongoing research of the group of plant nutrition and will thus give an insight into our current research. In addition, published studies will be analyzed and presented by the students. Finally, the advantages and disadvantages of work with radioisotopes will be analyzed and discussed critically.

Lecture notes
Documents will be distributed during the lecture

Literature
Will be given during the lecture

Prerequisites / notice
The lecture will take place at the ETH experimental station in Eschikon Lindau. See the location of the station at: http://www.pe.ipw.agrl.ethz.ch/about/reach

Master Thesis

751-1030-00L
Master’s Thesis ■

Only students who fulfill the following criteria are allowed to begin with their master thesis:
- a. successful completion of the bachelor programme;
- b. fulfilling of any additional requirements necessary to gain admission to the master programme.

Abstract
The Master thesis is an independent scientific work. Normally the subject is selected among the topics of the core subject. It is written under the guidance of a agricultural science professor.

Objective
The independent writing of a scientific paper/thesis

Complementary Courses

760-0001-00L
Colloquium Master in Agricultural Science ■

Does not take place this semester.

751-0023-00L
ETH Week 2015: The Story of Food

W 1 credit 3S S. Brusoni, K. Fenner, A. Walter, C. Bratrich, N. Buchmann, A. Champetier de Ribes, M. Grant, W. Langhans

Abstract
The ETH Week is a new and innovative course designed to foster critical and independent thinking and creative learning. Students from all departments as well as professors and external experts will work together for one week in interdisciplinary teams. They will develop ideas and interventions that could play a role in solving some of our most pressing global challenges: the global food systems.

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 49 of 1434
Objective
- Domain-specific knowledge: Students have immersed knowledge about a certain complex, societal topic which will be selected every year. They understand the complex system context of the current topic, by comprehending its scientific, technical, political, social, ecological and economic perspectives. The focus in 2015 is the global food system.
- Analytical skills: The ETH Week participants are able to structure complex problems using selected methods. With the help of experts and team tutors, they are able to acquire further knowledge and critically analyse knowledge in interdisciplinary groups.
- Design skills: The students are able to use problem solving and decision making skills to develop concrete approaches for addressing a selected problem statement, critically reflect these approaches, assess their feasibility, transfer them into a concrete form (physical model, prototypes, strategy paper, etc.) and to present this work in a creative way (role-plays, videos, exhibitions, etc.).
- Self-competence: The students are able to plan their work effectively, efficiently and autonomously. By considering approaches from different disciplines they are able to make a judgment and form a personal opinion. They are able to communicate appropriately with non-academic partners from business, politics, administration, non-governmental organizations and media, present their results professionally and creatively and convince a critical audience.
- Social competence: The students are able to work in multidisciplinary teams, i.e. they can reflect critically their own discipline, debate with students from other disciplines and experts in a critical-constructive and respectful way and can relate their own positions to different intellectual approaches. They can assess how far they are able to actively make a contribution to society by using their personal and professional talents and skills and as 'Change Agents'.

Content
The week puts a focus on developing problem solving and design thinking skills within the context of understanding the world of food. During ETH Week students will have the opportunity to work in small interdisciplinary groups, allowing them to critically analyse both their own approaches and those of other disciplines, and to integrate these into their work.

While deepening their knowledge about how the food system works, students will be introduced to various methods and tools for generating creative ideas and understand how different people are affected by each part of the system. In addition to lectures and literature, students will acquire knowledge via excursions into the real world, empirical observations, and conversations with researchers and experts.

A key attribute of the ETH Week is that students are expected to find their own problem, rather than solve the problem that has been predefined. Therefore, teams will spend the first three days of the week identifying a problem to work on, and the last two days of the week generating solutions for the problem and communicating the team's ideas.

A panel of experts will judge your presentations at the end of the week. The winning teams will receive attractive prizes.

Prerequisites / notice
No prerequisites. Program is open to Bachelor and Masters from all ETH Departments. Students must register to attend the course by 17 May at www.ethz.ch/ETHWeek.

Agroecosystem Science Master - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
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<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
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<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
**Applied Geophysics Master**

Courses at ETH Zurich only take place in Spring Semester.

<table>
<thead>
<tr>
<th>Key for Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
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<td>Eligible for credits and recommended</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
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<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>Dr</td>
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<td>S</td>
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<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
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<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
Architecture Bachelor

First Year Basic Courses

First Year Examinations

Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tbody>
<tr>
<td>051-0111-00L</td>
<td>Architecture I</td>
<td>O</td>
<td>1</td>
<td>2V</td>
<td>C. Kerez</td>
</tr>
<tr>
<td>Abstract</td>
<td>In a series of lectures aspects of the architectonical space will be exemplified and put into a theoretical context.</td>
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<tr>
<td>Objective</td>
<td>Training of a conscious perception and a conceptual understanding of the architectural space as well as techniques for its representation.</td>
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<tr>
<td>051-0151-00L</td>
<td>Architectural Technology I</td>
<td>O</td>
<td>1</td>
<td>2V</td>
<td>A. Spiro, D. Fiederling</td>
</tr>
<tr>
<td>Objective</td>
<td>Knowledge of construction principles and its history. Cognition of correlation between concept, buildings structure, material and form.</td>
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<tr>
<td>Content</td>
<td>In the triad of typology, topology and tectonics, the latter is the primary focus of the theoretical discourse. The series of lectures identifies the most disparate tectonic principles which transcend time and geography, and elucidates the reciprocally generative parameters of construction, technology and form. The lectures theme convey fundamental concrete constructional and practical knowledge and concentrate on the guidance of the basic exercises (Architectural Technology I + II).</td>
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<tr>
<td>051-0211-01L</td>
<td>Architecture and Art I</td>
<td>O</td>
<td>1</td>
<td>2V</td>
<td>K. Sander</td>
</tr>
<tr>
<td>Abstract</td>
<td>Theory and practice in the visual arts: Artistic thinking and practice.</td>
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<tr>
<td>Objective</td>
<td>Independent artistic thinking. Acquisition of artistic criteria.</td>
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<tr>
<td>Content</td>
<td>Reflection of visual contents and phenomena. Examination of current positions in art.</td>
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Examination Block 2

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>051-0411-00L</td>
<td>Structural Design I</td>
<td>O</td>
<td>4</td>
<td>4G</td>
<td>P. Block, J. Schwartz</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course is an introduction to structural design using graphical methods and structural models, with a focus on a creative approach rather than repetitive calculations. Cable and membrane structures, arch and shell structures and combined arch and cable systems will be used to demonstrate these methods.</td>
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<tr>
<td>Content</td>
<td>After a general introduction of basic concepts, structural systems such as cable and arch structures will be analyzed with the help of graphic statics. The students will learn to understand the flow of forces in a structural system in relation to the system’s forms. They will be able to modify this force flow and give dimension to the structural components.</td>
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<tr>
<td>Lecture notes</td>
<td>All concepts, approaches and methods will be introduced in the weekly lectures and practiced in subsequent exercises.</td>
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<tr>
<td>Literature</td>
<td>on eQuilibrium <a href="http://www.block.arch.ethz.ch/equilibrium">http://www.block.arch.ethz.ch/equilibrium</a></td>
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<td>and <a href="http://www.schwartz.arch.ethz.ch/">http://www.schwartz.arch.ethz.ch/</a></td>
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<td>“Faustformel Tragwerksentwurf” (Philippe Block, Christoph Gengangel, Stefan Peters, DVA Deutsche Verlags-Anstalt 2013, ISBN: 978-3-421-03904-0)</td>
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<tr>
<td>051-0853-00L</td>
<td>Building Materials I</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>F. Winnefeld, M. Koebel, O. von Trzebiatowski, T. A. Zimmermann Schütz</td>
</tr>
<tr>
<td>Abstract</td>
<td>Building Materials - Structure, Quality, Usage</td>
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<td></td>
<td>concrete and other mineral materials</td>
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<td>metals, wood, glass and polymers</td>
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<td></td>
<td>ecological aspects</td>
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<tr>
<td>Objective</td>
<td>The lecture describes the fundamental properties of the most important construction materials: concrete and other mineral materials, metals, wood, glass and polymers. Furthermore, the content includes the relevant ecological aspects such as availability of raw materials, effort for production, emission of hazardous substances, disposal and recycling are treated as well.</td>
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<tr>
<td>051-0811-00L</td>
<td>Sociology I</td>
<td>O</td>
<td>1</td>
<td>2V</td>
<td>C. Schmid</td>
</tr>
<tr>
<td>Abstract</td>
<td>Sociology I investigates the relation between social developments and the production of the built environment from a macro-sociological point of view. It examines central aspects of social change, historical and present-day forms of urbanization, and typical examples of models of urbanization.</td>
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<tr>
<td>Objective</td>
<td>This series of lectures should enable students to comprehend architecture in its social context. It approaches the architectural profession from two different angles: macro-sociological and micro-sociological.</td>
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<tr>
<td>Content</td>
<td>Sociology I deals with the macro-sociological point of view, and investigates the relation between social developments and the production of the built environment. In the first part some central aspects of social change are examined in particular the transition from Fordism to Postfordism and from Modernism to Postmodernism, and the interlinked processes of globalization and regionalization. The second part deals with historical and present-day forms of urbanization. Among other aspects treated here are the changed significance of urban-rural contrasts, the processes of suburbanization and periurbanization, the formation of global cities and metropolitan regions, the growth of new urban configurations in centres (gentrification) and on urban peripheries (edge city, exopolis). In the third part these general processes are illustrated by typical models of urbanization.</td>
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Examination Block 3
During the first semester certain aspects of the architectonic space and its possibilities for transposition into other media will be examined.

The lecture conveys historical knowledge about architecture and art as well as methodical knowledge as a preparation for the independent handling of historical sources and scientific literature. The main focus will be laid on the architecture of the Greco-Roman antiquity, the Middle Ages, the Renaissance and the era between Baroque, Enlightenment, and Modernity.

Objective
Acquisition of basic knowledge of the history of art and architecture, resp. of methodical basic knowledge of historical working.

Content
The history of art and architecture is part of our reality: it confronts us in the historically shaped environment of the city and plays an essential role in the creation of architecture. The historical lectures are therefore part of the fundamental courses of the undergraduate programme in architecture. On the basis of cultural and art-historical research this course imparts knowledge about architecture and art from ancient times to the present. At the same time they sharpen the perception for the conditions and capabilities of building activity in history. Moreover, they convey methodical knowledge and technical language skills and are meant as a preparation for the independent handling of historical sources and scientific literature.

The first one-year course aims at these goals in the form of exemplary epoch representations which through light upon the historical continuities. The main focus will be laid on the architecture of the Greco-Roman antiquity, the Middle Ages, the Renaissance and the era between Baroque, Enlightenment, and Modernity.

Lecture notes
3 Skripte sind auf der Professur, HIL C 70.5-8, erhältlich:
- Architektur der Klassischen Antike, Fr. 15.-
- Renaissance und Barock, Fr. 15.-
- Aufklärung bis Moderne, Fr. 15.-

Prerequisites / notice
Zu beziehen am Dienstag und Donnerstag

The course can not be taken by Master students of the D-ARCH, who have already completed it within the Bachelor programme.

Economics I
Introduction to economics and to the analysis of markets.

Objective
Understanding of the basic economic concepts and models and of their application to real world situations, notably on property markets.

Content
The course in economics extends over two semesters. The focus during the Fall term is on an introduction to economic thought. These considerations provide the fundamental requirements for the economic analysis of land, housing and urban markets in the following Spring term.

The Fall semester focuses on the economic way of thinking. We shall discover why A. Marshall defined economics as "a study of mankind in the ordinary business of life". The course introduces the student to the "big questions" in economics, such as the concept of rationality and its limits, factors driving supply and demand, the working of markets, the importance of the price system and the reasons why markets may fail.

There are many interactions between economic and social phenomena on the one hand, and the built environment on the other. Our knowledge of the fundamental economic principles will allow us to understand the workings of the housing, land, credit and real estate markets - markets of fundamental importance for the future architect. We consider questions such as: which are the major problems of the land market? Which factors determine the price of land? What are the economic drivers that shape the form of our cities? Which are the primary difficulties in designing a reasonable housing policy? Finally, the course discusses the main determinants of real estate investment, both its risk and its opportunities.

Lecture notes
Course material in e-learning environment www.vwl.ethz.ch/architektur


Prerequisites / notice
The course "Economics II (real estate and urban economics)" follows in the Spring term.

Mathematics I
Description and discussion of curves and surfaces focusing on their generation by movement: Parameterization, tangent vector, tangent plane, ruled surfaces, developable surfaces. (Methods of vector geometry and differential calculus are used.)

Objective
Vertiefen und Ergänzen der mathematischen Kenntnisse und Fertigkeiten

Content
Behalten einiger für das Studium der Architektur fundamentalen Begriffe und Strukturen im Rahmen der Mathematik

Erkennen, dass mathematische Beschreibung und Abstraktion zu neuen Einsichten führen und verborgene Zusammenhänge erschliessen können

Lecture notes
Script available (in german)

Prerequisites / notice

Subjects with Semester Grade

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>051-0331-00L</td>
<td>History of Art and Architecture I</td>
<td>O</td>
<td>4</td>
<td>4G</td>
<td>L. Schmitt, U. Schulte-Umbrecht</td>
</tr>
<tr>
<td>051-0823-00L</td>
<td>Economics I</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>M. Salvi</td>
</tr>
<tr>
<td>401-0001-00L</td>
<td>Mathematics I</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>M. Leupp</td>
</tr>
<tr>
<td>051-0211-02L</td>
<td>Architecture and Art I (2-Semester Course, Exercise)</td>
<td>O</td>
<td>0</td>
<td>6U</td>
<td>K. Sander</td>
</tr>
<tr>
<td>051-0129-00L</td>
<td>Architectural Design I (2-Semester Course, Exercise)</td>
<td>O</td>
<td>0</td>
<td>6U</td>
<td>C. Kerez</td>
</tr>
<tr>
<td>051-0131-00L</td>
<td>Architectural Technology I (2-Semester Course, Exercise)</td>
<td>O</td>
<td>0</td>
<td>6U</td>
<td>A. Spiro</td>
</tr>
</tbody>
</table>

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 53 of 1434
Abstract
Finding, analysing, testing and refining basic construction principles. In the focus are the interaction of architecture, technology and structure and the creative dialogue with other works of art and architecture.

Objective
Empirical and analytical acquisition of basic construction principles. Cognition of correlation between structure and form, between architecture, technology and buildings structure.

Content
In a series of creatively designed exercises, various terms related to the subject area of Material - Structure - Space are made sensually tangible and are dealt with conceptually. Their interdependence will become apparent in the process and the relationship between tectonics and visual expression will be studied. In addition, the influence of materials and their properties, of construction principles and their specific application as well as of planning and production processes on the form as the end result will be elaborated theoretically in a series of lectures.

Second and Third Year Basic Courses

Examination Blocks

Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>051-0113-00L</td>
<td>Architecture III</td>
<td>O</td>
<td>1 credit</td>
<td>2V</td>
<td>D. Eberle</td>
</tr>
</tbody>
</table>

Abstract
The lectures discuss determining factors in architectural design based on the basic terms place, structure, shell, program and materiality.

Objective
The lectures aim at conveying an integral understanding of architecture: its development, its determining factors, and the influence of its societal context.

Content
The lectures discuss significant determining factors in architectural design based on five basic terms: place, structure, shell, program and materiality. Several architectural examples are being examined within their specific societal context with an emphasis on the interrelation of architecture, science, culture and art.

Examination Block 2

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>051-0413-00L</td>
<td>Structural Design III</td>
<td>O</td>
<td>3 credits</td>
<td>3G</td>
<td>J. Schwartz</td>
</tr>
</tbody>
</table>

Abstract
Addresses construction as integrating component of design processes, including considerations based on contemporary case studies.

Objective
Elaboration of construction principles on the basis of solid and filigree structure theories.

Content
Elaboration of construction principles on the basis of solid and filigree structure theories.

Prerequisites / notice
After each lecture, students are asked to produce an exercise based on the presented tools. The format of the exercise is an A3 or an A4, according to the given template. Each student has one week to prepare each exercise, and it should be delivered, in form of a physical copy, in the next lecture. (Language: preferably English, German).

EXERCISE
The Exercise tasks are a valuable preparation for the Exam (Exam only relevant for the "Jahreskurs" students) therefore it is highly recommendable to finalize all weekly Exercise tasks, as an individually conducted piece of work.

"Semesterkurs" (semester course) students from other departments or students taking this lecture as GESS / Studium Generale course as well as exchange students must submit a research paper, which will be subject to the performance assessment: "Bestanden" (pass) or "Nicht bestanden" (failed) as the performance assessment type, for "Urban Design I: Urban Stories" taken as a semester course, as well as exchange students must submit a research paper, which will be subject to the performance assessment: "Bestanden" (pass) or "Nicht bestanden" (failed) as the performance assessment type, for "Urban Design I: Urban Stories" taken as a semester course, is categorized as "unbenotete Semesterleistung" (ungraded semester performance).

Examination Block 3

Students are free to take the exam either in German or in French. They may choose between 851-0710-00L Introduction to Law for Civil Engineering and Architecture or 851-0709-00L Introduction to Civil Law (French).

Prerequisites / notice
After each lecture, students are asked to produce an exercise based on the presented tools. The format of the exercise is an A3 or an A4, according to the given template. Each student has one week to prepare each exercise, and it should be delivered, in form of a physical copy, in the next lecture. (Language: preferably English, German).

EXERCISE
The Exercise tasks are a valuable preparation for the Exam (Exam only relevant for the "Jahreskurs" students) therefore it is highly recommendable to finalize all weekly Exercise tasks, as an individually conducted piece of work.

"Semesterkurs" (semester course) students from other departments or students taking this lecture as GESS / Studium Generale course as well as exchange students must submit a research paper, which will be subject to the performance assessment: "Bestanden" (pass) or "Nicht bestanden" (failed) as the performance assessment type, for "Urban Design I: Urban Stories" taken as a semester course, is categorized as "unbenotete Semesterleistung" (ungraded semester performance).
**Abstract**

After a review of essential facts from the first year the course will be examine the interplay of architectural concept and structural system by analyzing buildings of exemplary quality. The focus will be on the integration of specifics of structural systems made out reinforced concrete or steel into architectural design.

**Objective**

Students are enabled to integrate essential characteristics of structural systems made out reinforced concrete or steel into their architectural design.

**051-0519-00L Building Physics II: Moisture**

**Abstract**

70% of all construction problems are related to moisture. This course aims at providing the necessary theoretical background in order to foresee and avoid these problems.

**Objective**

- to develop a basic understanding of mass transport and buffering
- to become aware of potential moisture-related damage and health risks
- to learn how to (i) design building components and (ii) assess their hygrothermal performance

**Content**

- hygrothermal loads
- conservation of mass
- dry air: constitutive behaviour, transport, potential problems and solutions
- moist air: constitutive behaviour, transport, potential problems and solutions
- liquid water: constitutive behaviour, transport, potential problems and solutions
- moisture-induced degradation processes
- case studies
- exercises

**Lecture notes**

Handouts, supporting material and exercises are provided online (http://www.carmeliet.arch.ethz.ch/Education/ with Building Physics II: Moisture in the Documents section). The course syllabus can be bought at the Chair of Building Physics.

**Literature**

All material is provided online (http://www.carmeliet.arch.ethz.ch/Education/ with Building Physics II: Moisture in the Documents section)

Prior knowledge of "BP I: heat" is required.

**051-0551-00L Energy- and Climate Systems I**

**Abstract**

The lecture contains concepts, physics and components of building technologies for the efficient and sustainable energy supply and climatisation of buildings and their interaction with architecture and urban design. Using calculations, students learn to aquire relevant numbers and assess the performance of solutions.

**Objective**

The lecture's target is the knowledge of the physical basics and technical components of relevant systems for a efficient and sustainable climatisation and maintenance of buildings and their interdependency with the architectonic design and construction. By learning rough calculation methods, determination of relevant dimensions and identification of important parameters become possible. Hence, adequate approaches for the own design can be chosen, reviewed quantitatively and qualitatively and set in with a synergistic effect.

**Content**

1. Introduction
2. Thermal systems
3. Ventilation
4. Daylight and artificial lighting

EK I lectures focus on technical components in use as well as their rough calculation methods and their integration into design and construction.

Based on EK I, the EK II lectures focus on all possible systems and concepts available to the architect for a sustainable design.

**Lecture notes**

The Slides from the lecture serve as lecture notes and are available as download.

**Literature**

A bibliography will be distributed at the beginning of the lecture.

**851-0703-01L Introduction to Law for Architecture**

**W**

Only for Architecture BSc.

**Abstract**

Students who have attended or will attend the lecture "Introduction to Law for Civil Engineering" (851-0703-03L) cannot register for this course unit.

**Objective**

This class introduces students to basic features of the legal system. Questions of constitutional and administrative law, contract law, tort law, corporate law, as well as litigation are covered.

**Content**

1. Public Law
2. Private law

Constitutional law: sources of law, organization of the state, fundamental rights. Administrative law: administrative decisions, organization of the administration, enforcement of administrative decisions, procedural law, basics of police, environmental and zoning law.

2. Private law


**Lecture notes**

There will be 'Lecture Notes' (in German) for this course, beginning in Fall 2015

**Literature**

Further information is available at http://www.hertig.ethz.ch/courses.htm

**851-0709-00L Introduction to Civil Law**

**W**

**Abstract**

The course Private Law focuses on the Swiss Code of Obligations (contracts, torts) and on Property Law (ownership, mortgage and easements). In addition, the course will provide a short overview of Civil Procedure and Enforcement.

**Objective**


**Content**

Le cours de droit civil porte notamment sur le droit des obligations (droit des contrats et responsabilité civile) et sur les droits réels (propriété, gages et servitudes). De plus, il est donné un bref aperçu du droit de la procédure et de l'exécution forcée.

**Literature**

Editions officielles récentes des lois fédérales, en langue française (Code civil et Code des obligations) ou italienne (Codice civile e Codice delle obbligazioni), disponibles auprès de la plupart des bibliothèques.

**Prerequisites / notice**

- Sont indispensables:
  - le Code civil et le Code des obligations;
  - sont conseillés:
  - Nef, Urs Ch.: Le droit des obligations à l'usage des ingénieurs et des architectes, trad. Bovay, J., éd. Payot, Lausanne

**Remarques**

- Le cours de droit civil et le cours de droit public (2e sem.) sont l'équivalent des cours "Recht I" et "Recht II" en langue allemande et des exercices y relatifs.
- Les examens peuvent se faire en français ou en italien.
- Examen au 1er propédeutique; convient pour travail de semestre.
**History of Art and Architecture III**

ECTS: 2

**Abstract**
The two-semester course offers an introduction to the history and theory of architecture from the industrial revolution up to now. Based on current questions a variety of case studies will be discussed.

**Objective**
The aim is to give an overview on crucial events, works of art, buildings and theories since the beginning of the 19th century up to today. The course should enhance the comprehension of historical and theoretical issues, and allow the students to localize their own practice within a broader historical context.

**Content**
The subject of this lecture course is the history and theory of architecture since the beginning of the 19th century up to now. It examines the architectural answers to the changing technical inventions and social practices. Consequently, the focus will be less on individual architects or buildings than on various themes that determined the architecture of the period.

**Lecture notes**
http://www.stalder.arch.ethz.ch/courses

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**Architecture V**

ECTS: 2

**Abstract**
The course target is to let the students gain an overview of a line of formative occurrences, works of art, buildings and theories from the early nineteen-seventies. The students should become sensitive for questions and problems in the field of history and theory and they should increasingly be able to relate their own praxis with historical relations.

**Objective**
Further recommended literature to consult is listed within the script.

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**Building Research and Preservation of Cultural Heritage I**

ECTS: 2

**Abstract**
The polytechnic tradition of preservation of cultural heritage lies in connecting theory with building research and history. Building Research and Preservation of Cultural Heritage are research areas on the IDB. The lecture will give an overview of the entire subject, ranging from knowledge of historical architecture, constructions, and techniques to methods of analysis and research problems.

**Objective**
The aim of the two-semester lecture is to bring architecture students into a first contact with the complexity of methods of the subject (comprising aspects of humanities, engineering and natural sciences). This entails demonstrating the opportunities and limitations of interdisciplinary work, conveying an understanding of dynamics and long-term problems of existing buildings, and sensitizing students to problems related to maintaining the value of cultural heritage.

**Content**
- Aims and methods of analysis and documentation of artifacts
- Grammar of historic architecture, the history of historic building research
- Losses of knowledge and techniques
- Theory formation in preservation of historical monuments
- Life cycles of structures and buildings; opportunities for a - long-term maintenance of value
- Building within the Existing as a topic in the training of architects
- Exemplary research problems and interdisciplinary projects

**Examination Block 3**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>051-0311-00L</td>
<td>History of Art and Architecture III</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>L. Stalder</td>
</tr>
<tr>
<td>051-0363-00L</td>
<td>History of Urban Design I</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>V. Magnago Lampugnani</td>
</tr>
<tr>
<td>051-0351-00L</td>
<td>Building Research and Preservation of Cultural Heritage I</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>U. Hassler, M. Schuller</td>
</tr>
</tbody>
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**Examination Block 4**

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<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>051-0125-00L</td>
<td>Architecture V</td>
<td>O</td>
<td>1</td>
<td>3V</td>
<td>N. Zschocke</td>
</tr>
</tbody>
</table>

**Number**

| 051-0311-00L | History of Art and Architecture III | O    | 3    | 2V    | L. Stalder            |
| 051-0363-00L | History of Urban Design I         | O    | 2    | 2G    | V. Magnago Lampugnani |
| 051-0351-00L | Building Research and Preservation of Cultural Heritage I | O    | 2    | 2V    | U. Hassler, M. Schuller |

**Examination**

| 051-0125-00L | Architecture V                     | O    | 1    | 3V    | N. Zschocke            |
The two-semester course offers an introduction to the history of modern and contemporary art and architecture since ca. 1970. Motivated by questions of the current discourse, central topics and exemplary works of art and architecture are discussed. Concepts such as "labor", "economy", "experience", "research", "nature", "diversity" or "surface" are used to focus on specific historical developments and connections. Art and architecture is considered as a field of cultural change as well as an indicator of social, economic, and political conflicts which in turn helps to understand historical dynamics. The course "Lehrkanape" (one hour) is part of the course and treats alternative methods of teaching and learning.

051-0155-00L Architectural Technology V

Abstract
The lecture series explores the correlation among intentions of design, architectonic expression and construction premises. These critical areas or aspects of study, which are presented with selected projects, their respective theoretical backgrounds and historical development, are pluralistically associated and brought into relation with varying contemporary opinion.

Objective
The lecture series Konstruktion V/VI aims to analyse (structural) construction techniques and their formal appearance and expression in their interrelation. The different themed parts of structural design, building shell and knowledge of material get connected with architectural design in practice and reflected in the wider context of architectural theory. The intention is to consolidate the understanding of the connection between structure, process and formal appearance and expression in the architecture of the 20th century.

Content
The lecture series in the course entitled Architecture and Construction explores the correlation among intentions of design, architectonic expression and construction premises. Each lecture is focused on individual themes, as for example, the application of certain materials (glass, or natural stone), of particular construction systems (tectonic, hybrid) or design generators (grids, series) and alternatively the search for a definable, tangible architectural expression (vernacular architecture, readymades). These critical areas or aspects of study, which are presented with their respective theoretical backgrounds and historical development, are pluralistically associated and brought into relation with varying contemporary opinion. The yearlong lecture cycle is comprised of twenty individual lectures, in which the majority of projects being analyzed date from the last few decades.

Lecture notes
no script

Literature
list of literature per lecture

Prerequisites / notice
General remarks (on exam as well as exam preparation)

The comprehensive topics of the lectures are the subject matter of the exam. The lectures are scheduled for a full year (Konstruktion V/VI) and therefore the knowledge of the subject matter of the running as well as the of the preceding semester's lectures is required. To improve your chances to pass the examination at first try, we strongly recommend you to take the exam after having visited the lecture during two semesters. If you are an exchange student, or a student from a different department and wish to take a partial examination covering only the subject matter of the last semester (Konstruktion V or VI), you need to contact the chair in advance.

The brochures published by the chair offer additional help. Knowledge of these brochures and their key subjects is recommended for the exam. The brochures can be ordered at the chair after the last lecture before the examination. However, the subject matters of the brochures and the lectures are not identical, the brochures provide information for a deeper understanding of the lectures. Apart from additional articles written by the chair, the brochures are composed of three modules: Project documentation, crucial texts on the work reception as well as theoretical articles about the particular thematic priorities by various authors. Concerning their content these anthologies allow insights into a wide range of theories, lines of reasoning and fields of research up to diverging point of views of specific problems.

051-0615-00L Design and Strategies in Urban Space I

Abstract
Means and potentials of course entitled Architecture and Construction is explored the correlation among intentions of design, architectonic expression and construction premises. Each lecture is focused on individual themes, as for example, the application of certain materials (glass, or natural stone), of particular construction systems (tectonic, hybrid) or design generators (grids, series) and alternatively the search for a definable, tangible architectural expression (vernacular architecture, readymades). These critical areas or aspects of study, which are presented with selected projects, their respective theoretical backgrounds and historical development, are pluralistically associated and brought into relation with varying contemporary opinion.

Objective
This lecture series imparts advanced expertise in urban planning. The main focus is to illustrate the complex manner in which various boundaries and limitations. Nature and technology as imaginary utopias or the myth of timeless way of building versus the edifice as during or after the design process? Departing from these, and similar, questions, the course seeks insights into the dialectics between built mobility needs as well as various spatially relevant stakeholders offer the basic means to steer the development. The second part of the lecture series is dedicated to these themes in the everyday practice of planning and design by addressing pressing questions of contemporary urban design practice and theory. The goal is to communicate a broad-based systemic knowledge base, which helps enable students to synthesize and evaluate complex urban design and planning problems.

Content
The fall semester introduces the notion of strategic design and imparts further knowledge about the structure and models of the contemporary city. It is structured in two parts:

Part 1: Strategic Design
The first part of the lecture series imparts general basics to understand the city and the field of urban design. Different approaches and methods of analysis are presented, the dealing with uncertainty in planning is addressed and practical methods of urban design are identified.

Part 2: Structures and Models
Urban space is shaped on different levels. The city ground plan, the relationship between public space and private infrastructure, the city and mobility needs as well as various spatially relevant stakeholders offer the basic means to steer the development. The second part of the lecture series is dedicated to these themes in the everyday practice of planning and design by addressing pressing questions of contemporary urban design practice and theory. The goal is to communicate a broad-based systemic knowledge base, which helps enable students to synthesize and evaluate complex urban design and planning problems.

Lecture notes
There is no script accompanying the lecture series. At the end of the semester the lecture slides and at the end of the 3rd year course a reader with secondary literature will be available for download on the homepage of the chair of architecture and urban design: http://www.christiaanse.arch.ethz.ch

Literature
At the end of the 3rd year course a reader with secondary literature will be available for download on the homepage of the chair of architecture and urban design: http://www.christiaanse.arch.ethz.ch

Examination Block 5

051-0115-00L Theory of Architecture I

Abstract
The first series of lectures studies existing models of the construction of theory in the works of specific architects. How does a coherent architectural language of form arise? How is it conceptualized by the architects themselves? How is it verbalized, how does it find expression in a theory, and how is it interpreted by critics? What is the role of conventions in this process? Does theory evolve before, during or after the design process? Departing from these, and similar, questions, the course seeks insights into the dialectics between built work and theory, and, rather, between built work and interpretation.

Objective
The lecture series of architectural theory is continued with a comparison of different approaches to define architecture and to discuss its boundaries and limitations. Nature and technology as imaginary utopias or the myth of timeless way of building versus the edifice as an autonomous work of art will be opposed with each other. The complexity of terms like meaning in an architectural context will be demonstrated with case studies of contemporary architecture. In addition to the aesthetics of the building there are the ecological aesthetics of everyday and nature. Theory aims at the goal to make these realms transparent and describable. Finally we will discuss the question, in as much architectural design as a process of reflection and projection incorporates already an utopian dimension.

Number
051-0115-00L Theory of Architecture I
Title
The Building and the Construction of Theory
Type
O
ECTS
1
Hours
2V
Lecturers
A. Moravanszky

051-0757-00L Building Process I

Abstract

Objective

Content

Literature

Number
051-0757-00L Building Process I
Title
O
ECTS
2 credits
Hours
2G
Lecturers
S. Menz

http://www.ursprung.arch.ethz.ch/courses
The design course is built on various exercises. During Fall Term, the students are concerned with the conversion and densification of
building structures at three different sites in Zurich.
Conveying a way of thinking that is also able to understand complex contexts and act on various levels is one of the focuses of the chair. This networked thinking relates to practice and educates the students to be competent architects. Achieving this goal requires a method that teaches a clearly structured, precisely formulated approach and communicates the simultaneity of complex tasks and processes.

The design course is built on four exercises. Based on the existing buildings, the themes Place, Structure and Shell are being examined - first separately and then combined in a final project. The extension and densification of existing building structures are being carried out at three different sites in Zurich; the new use is planned for work and living. The exercises are divided into a City Level and a House Level. At the City Level a group of students examines the three building sites according to each theme. At the House Level the students develop designs addressing the themes in groups of two.

The aim of the course is to reinforce the sensibility for such a broad attitude and at the same time to develop the skills for its application. To deal with the reality of construction and material is thereby an important concern.

To promote interdisciplinarity through integrated teaching.

Achieving the goal of competent architects requires a method that teaches a clearly structured, precisely formulated approach and communicates the simultaneity of complex tasks and processes.

Systematic and methodical design and construction development. Full range from concept to detail. Fall semester highlights fundamentals on "collective housing", under the specific aspect of building depth. Discusses relations with current interdisciplinary sets of problems.

The target of the design work is to improve and widen the basic knowledge of domestic architecture and housing and also to get to the bottom of former ideas.

At the beginning of our investigation, based on different depths of buildings (6 to 21m), we formulate first basic rules of supporting-, room- and local public infrastructure for apartments. Based hereon and still without context we design an idealtypic apartment building with apartments of different size. Only after catching the rules of the building systematically, the urbanistic context and the front of the building will be introduced into the design process. This approach to the design task allows a self-supporting research of structural and living specific questions, this without being distracted rashly from outer inherent necessities.

Architectural Design (from 5. Semester on)

<table>
<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td></td>
<td>Please register (<a href="http://www.mystudies.ethz.ch">www.mystudies.ethz.ch</a>) only after the internal enrolment for the design classes (see <a href="http://www.einschreibung.arch.ethz.ch/design.php">http://www.einschreibung.arch.ethz.ch/design.php</a>). Students who do not wish to change the design class must not enrol.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>These days architecture is affected by increasingly similar images. We want to turn to another reality - the place. The strengthening of the singularity of each place is the promise for an overall more differentiated living space.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>In the focus are the development of a stable attitude towards the existing structure and the design of a house for the community.</td>
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<td>Architecture requires a fine perception of the existing and a brave vision for the future. The condition for both is a firm attitude coming out of a living collective.</td>
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<td>The aim of the course is to reinforce the sensibility for such a broad attitude and at the same time to develop the skills for its application. To deal with the reality of construction and material is thereby an important concern.</td>
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<td>Wir werden uns im Semester mit der Idee «Origen» beschäftigen und zusammen mit Giovanni Netzer versuchen einen Beitrag zu einer</td>
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<td>Verdeutlichung zu erreichen. Wie kann das Zusammenleben von Dorfbewohnern und Origens Künstlern, Gästen und Mitarbeitern weitergedacht werden? Welche Wohnformen vermitteln den Bewohnern Geborgenheit?</td>
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<td>With integrated Diszplin Konstruktion Dozentur D.Mettler/D.Studer (LV 051-1201-15, 3 KP).</td>
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<td>Ausführliches Semesterprogramm: <a href="http://www.caminada.arch.ethz.ch">www.caminada.arch.ethz.ch</a></td>
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<td>Assistenten: Thomas Stettler, Silvan Blumenthal, Franziska Wittmann</td>
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<tr>
<td>051-1103-15L</td>
<td>Architectural Design V-IX: Spatial Transformation in the Age of Obsolescence (Guest Prof. D. Liu)</td>
<td>W</td>
<td>13 credits</td>
<td>16U</td>
<td>D. Liu, further lecturers</td>
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<td>Please register (<a href="http://www.mystudies.ethz.ch">www.mystudies.ethz.ch</a>) only after the internal enrolment for the design classes (see <a href="http://www.einschreibung.arch.ethz.ch/design.php">http://www.einschreibung.arch.ethz.ch/design.php</a>).</td>
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<td>The Studio takes the opportunity to explore the same issue of obsolescence in two different cities, cultures and time through the means of design and research. We aim to exchange the thoughts of the difference and sameness; and to ultimately develop a new prototype in form and urbanism to implement in both contexts.</td>
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<td>Zurich - Guangzhou</td>
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<td>The Studio takes the opportunity to explore the same issue of obsolescence in two different cities, cultures and time through the means of design &amp; research. We aim to exchange the thoughts of the difference and sameness and to ultimately develop a new prototype in form and urbanism for the places in similar.</td>
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Never before the world has seen such levels of connectivity and interaction between people as it is happening in the beginning of the XXI century. Urbanization, democratisation of air travelling and widespread access to telecommunications make us global citizens. Cultural exchange happens everywhere at any time. Post-colonial, post-industrial times require parallel, alternative ways of thinking to deal with the legacy of all kinds of built structures. Reuse, refurbishment, transformation, demolition, substitution. What is our attitude as architects? What is the role of architecture in such a fast-changing world?

Welcome to the age of obsolescence!

Case 1 (Fall Semester 2015): Zürich, Switzerland - Papierwerd-Areal

Case 2 (Spring Semester 2016): Guangzhou, China - abandoned cement factory

What are the stage of development and the meaning of obsolescence in both places today? How can one analyse these two very different background conditions and explore new, creative common ways for the future?

“Obsolescence never meant the end of anything, it’s just the beginning.” – Marshall McLuhan

**051-1107-15L**

Architectural Design V-IX: Manifesta HS15 (Emerson)

**W** 13 credits 16U

T. Emerson

Does not take place this semester.

Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php).

**Abstract**

In the studio we will move between a landscape of ideas and the actual built landscape in East Germany, between visions and shrinking cities, between different social systems and layers of time with the goal of recovering interesting concepts from failed plans.

**Objective**

In the studio we will pursue the assumption that many of the hopeful utopian approaches and social attitudes upon which the socialist types were based could still be of interest today. In this sense, we will move between a landscape of ideas and the actual built landscape, between visions and shrinking cities, between different social systems and layers of time with the goal of recovering interesting concepts from failed plans.

The first step will be an archaeological investigation of the utopian fragments within the ruins of former visions, assembling an inventory of projects and socialist types with visionary potential. In a critical reflection from a contemporary perspective, the content of the architectural imprint of socialism is to be explored in order to find tools for dealing with today’s territories of emigration and economic collapse.

In this way, could it be possible to develop a future for East Germany and elsewhere that doesn't put a false 'heaven' of growth and repopulation back on the drawing board, but rather, considerately and critically continues the past trajectory in a new light? Could we develop both visionary and pragmatic architectural interventions that enliven the landscape without actually imagining that it flourishes? (2)


A semester reader with all important text sources and additional material will be provided.

Integrated Discipline Planning (P) included LV No. 063-1401-14

- Course numbers for inscription:
  - LV No. 051-1113-14 U (Design)
  - LV No. 063-1401-14 (Integrated Discipline Planning)

- Work format: individual and group work

- Assistants for the design course:
  - Michael Hirschbichler, 044 633 38 21, hirschbichler@arch.ethz.ch
  - Marcin Ganczarski
  - Ciro Miguel


- Course introduction/Special event: 16.09.2013, 10:30h, ONA studio;
Abstract This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in previous years. It involves the active participation of specialists from related disciplines (e.g. building structures, landscape architecture, history of art and architecture, monuments conservation etc.).

Objective Qualification to control the design process increasingly independent and with sole responsibility and to find an individual design methodology and attitude.


Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php).

Abstract Designing Architecture, which sounds the potential of its usage, its location, the city, the society and its culture and transforms these into a coherent spatiality and materiality by a distinct concept.

Objective Capability to develop a design from an idea, a concept to an advanced project, to question the intermediate stages in a self-critical way, thereby finding an individual design method and attitude.

Content Design work in different fields of architecture and urbanism with integration of the knowledge acquired in the first years of studies, supported by experts in related sciences (e.g. structural engineering, landscape architecture, history of art and architecture, historic preservation etc.)


Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php).

Abstract The studio will plan a school complex for approx. 600 students near Phnom Penh, Cambodia. Here, class rooms, general assembly rooms and necessary infrastructures need to be integrated in an already existing rural neighborhood. Attention has to be given to the climatic condition, available resources and the development of easily applicable construction principles.

Objective It is the educational objective to teach students a socially responsible intercourse between the discipline of architecture and clients belonging to a low- or no-income group in one of the poorest societies of the world. Future urbanization will happen mostly in these developing territories. It is the aim of the course to equip students with the ability to understand and act in such territories and to develop the necessary skills to propose meaningful and engaged design strategies which are developed and operate from within a field of first hand knowledge. Design decisions should be based on questions of climatic conditions, availability, responsibility, functionality and the respect for social and cultural settings. Students will start their design work by studying those local conditions through field research with local architects and decision makers. Designs will react to those findings by proposing design solutions. On the object level, it is the aim to develop construction methods and details, which will react and respect local available skills as well as materials and deepen this thinking by an integrated structural design component together with the Professorship of Building Structure as well as the Professorship of Building Systems. In addition, financial impacts have to be kept in mind. It is also important to interact with local architects and planners.

A seminar week visiting Cambodia will be offered to those students who would like to attend. Participation is highly recommended but not mandatory.

Content Materials produced will include the representation of small neighbourhood schemes as well as drawings and models representing the construction scale. The aim is to realize the most convincing design with the Swiss NGO Smiling Gecko.

We are planning a school in rural Cambodia within an existing village structure about two hours north of the capital Phnom Penh. The school consists of several classrooms, a cafeteria, an auditorium as well as medical and infrastructural buildings. We plan within the specific context of a society which is dominated on one hand by the fascinating history of the Khmer culture and on the other hand a dramatic demographic development due to the brutal civil war in the recent past. 52.1% of the population of Cambodia are under the age of 24 years, the average of the total population is 23.5 years. The question of education and care is thus socially relevant and urgent.

In addition to these specific social conditions, the availability of material resources, talent and technical skills as well as the climatic, ecological and economic conditions have to be considered in the design. The question of contemporary didactical concepts and their spatial implementation is an important issue in the semester. Together with local professionals we will develop a reasonable and customized strategy how the school system and the necessary infrastructure can be implemented in several phases. It is the declared aim of the course to develop designs that are feasible in terms of architecture and construction, from urban and neighborhood issues to the constructive detailing of individual buildings. The results of the studio should be a relevant contribution to the contemporary architectural culture of Cambodia, respecting the specific social and climatic conditions. The client considers the realization of the project.

The Professorship offers this course together with the integrated discipline Construction. The Professorship of Architecture and Structure, Prof. Philippe Block offers the integrated discipline Structural Design and the Professorship of Architecture and Building Systems, Prof. Arno Schlüter offers the integrated discipline Building Systems (climatic questions).

Prerequisites / notice A seminar week is offered on this subject to interested students. Participation is strongly recommended but not mandatory. The designs created include material-specific, architectural as well as constructive investigations, drawings and models.


Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php).

Abstract This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in previous years. It involves the active participation of specialists from related disciplines (e.g. building structures, landscape architecture, history of art and architecture, monuments conservation etc.).

Objective The goal is to communicate a broad-based systemic knowledge base, methodologies and strategies, which helps to enable students to evaluate complex urban design and planning problems and to synthesize their knowledge in an urban design project.

Prerequisites / notice Detailed information on design studios will be announced in advance to the registration process on the homepage of the chair of architecture and urban design: http://www.christiaanse.arch.ethz.ch

The number of participants is limited to max. 36 students.

051-1123-15L Architectural Design V-IX: A Proposal (Guest Lecturer P. Flammer) W 13 credits 16U P. Flammer

Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php).

Abstract Starting position are your thoughts, wishes and imagination from what you formulate your architectonic idea. This idea, in general, should be explicable and conceptional. Thereof you generate a form. So, the construction is relevant and not the evolutionary history anymore.

Hence, this construct can't be the solution, but a proposition.
<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<th>Instructor(s)</th>
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<tbody>
<tr>
<td></td>
<td>Objective</td>
<td>Competence to generate a architectonic project out of a own idea.</td>
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<tr>
<td></td>
<td>Abstract</td>
<td>Architectural design based on place, category, modification and built form.</td>
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<td>Objectives</td>
<td>This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in previous years. It involves the active participation of specialists from related disciplines (e.g. building structures, landscape architecture, history of art and architecture, monuments conservation etc.).</td>
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<td>Content</td>
<td>WINERY &quot;CHILLESTEIG&quot;, ZÜRICH-HÖNGGG: The &quot;Chillesteig&quot; winery is located just below the Höngg cemetery, facing south toward the &quot;Europa&quot; bridge and the Limmat. Architecture and Wine go together well. An exceptional design of landscape, building and space in combination with upsacle interior and exhibition architecture contribute to the unique atmosphere of the winery - which includes a wine press, a wine tasting bar, a venue for shows and an exhibition space.</td>
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<td>Prerequisites / notice</td>
<td>- Accompaniment by Professor für Landschaftsarchitektur Günther Vogt - Integrated Discipline Construction, D.Mettler/D.Studer, Bautechnologie und Konstruktion 051-1201-15 L - Integrated Discipline Focal Work Construction, D.Mettler/D.Studer, Bautechnologie und Konstruktion 063-1337-15 L - Critics every 2 weeks - Professor Miroslav Sik, HIL G75.2, Tel 044 633 28 13, Fax 044 633 10 81, <a href="mailto:sik@arch.ethz.ch">sik@arch.ethz.ch</a> - Introduction 15.09.15, 10.00 Uhr, HIL G61</td>
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| 051-1129-15L | Architectural Design: Villa Housing City (M.Peter) | 13 credits | Autumn 2015 | M. Peter, C. Dumont d'Ayot |
|             | Objective | Qualification to control the design process increasingly independent and with sole responsibility and to find to an individual design methodology and attitude. |
|             | Abstract | This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in previous years. It involves the active participation of specialists from related disciplines (e.g. building structures, landscape architecture, history of art and architecture, monuments conservation etc.). |
|             | Objectives | - Accompaniment by Professor für Landschaftsarchitektur Günther Vogt - Integrated Discipline Construction, D.Mettler/D.Studer, Bautechnologie und Konstruktion 051-1201-15 L - Integrated Discipline Focal Work Construction, D.Mettler/D.Studer, Bautechnologie und Konstruktion 063-1337-15 L - Critics every 2 weeks - Professor Miroslav Sik, HIL G75.2, Tel 044 633 28 13, Fax 044 633 10 81, sik@arch.ethz.ch - Introduction 15.09.15, 10.00 Uhr, HIL G61 |

| 051-1131-15L | Architectural Design V-IX: Modern Cities - Réinventer | 13 credits | Autumn 2015 | J. Herzog, P. de Meuron |
|             | Objective | The semester will start with the development of an urban vision in groups of six, which will then evolve into a proposition for a master-plan. The latter will be the base for individual projects, developed in groups of two. Working with references will be an important aspect of the studio: the typological collection of buildings gathered by the chair will provide the raw material for the own projects. Model photography will be the primary design tool, which will be professionally assisted be the photograph Roman Keller. A workshop will take place in Brussels during the second studio week, from the 22nd to the 24th of September. The trip and accommodation costs will be taken in charge by the chair. |
|             | Content | - Accompaniment by Professor für Landschaftsarchitektur Günther Vogt - Integrated Discipline Construction, D.Mettler/D.Studer, Bautechnologie und Konstruktion 051-1201-15 L - Integrated Discipline Focal Work Construction, D.Mettler/D.Studer, Bautechnologie und Konstruktion 063-1337-15 L - Critics every 2 weeks - Professor Miroslav Sik, HIL G75.2, Tel 044 633 28 13, Fax 044 633 10 81, sik@arch.ethz.ch - Introduction 15.09.15, 10.00 Uhr, HIL G61 |

|             | Objective | Architectural Design V-IX: Lyon: tres montañas, tres ríos, tres parques, tres escaleras (Vogt) |
|             | Content | The Alps as Common Ground |
|             | Abstract | With each design semester the Chair of Professor Vogt is working its way around the Alpine arc with the thesis that it can be read as an urban Common Ground. The task of each design semester is to verify this thesis by focusing on a metropolitan region and enquiring as to its specific relationship with the Alps. |

For more information about this semester can be found at: www.christgantenbein.arch.ethz.ch.
With each design semester the Chair of Professor Vogt is working its way around the Alpine arc with the thesis that it can be read as an urban Common Ground. The task of each design semester is to verify this thesis by focusing on a metropolitan region and enquiring as to its specific relationship with the Alps.

In the coming semester we shall be working with the urban territory of Lyon, which snakes between the Massif Central, Jura mountains and the Alps and reaches from the Mediterranean via the plateaus of the Bas-Dauphiné, Bresse and Dombes right up to the roof of Europe, Mont Blanc, 4,810 metres above sea level.

We understand design not as an end product but as a process. Our first step is to investigate Lyon’s large scale relationships. A four day long field trip complements this analytical gaze with a personal take on the area. Students then develop an individual programme as the foundation for their design. The proposed interventions can vary between urban planning and landscape scenarios and concrete architectural proposals.

Lecture notes
The Workbook is released in the first week.

Library
The relevant literature is included in the workbook.

Prequisites / notice
Process Cartography
Chair of Günther Vogt
www.vogt.arch.ethz.ch
Contact: kissling@arch.ethz.ch
Assistants: Sebastiano Brandolini, Thomas Kissling, Roland Shaw, Ilkay Tanrisever
Design (051-1135-15 U - 13 KP) and integrated discipline planning / landscape architecture (051-1235-15 U - 3KP)
The trip to Lyon takes place between 02.10.15 - 05.10.15. The contribution towards expenses will be 220 CHF.


Architectural Design V-IX: Just Build
HeadHandIntuition (GD Heringer/M.Rauch)
Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php).

Abstract
The focus of this semester is engaging with earthen building, emphasizing in particular the topics of decay and life cycles. These aspects, inherent to architectural design, are inadequately addressed by current dialogues. The project will be a structure of medium-scale planned to the level of construction detailing.

Objective
Just build.

Content
Methodological Focus:
- architectural design
- construction detailing
- working models / mockups

Architectural Design V-IX: Super Mercato
(A.Brillembourg/H.Klumpner)
Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php).

Abstract
This semester we will ask students to imagine flexible commercial spaces where producers and consumers engage with each other to form a revitalized kind of market place: a SUPER MERCATO. The studio will attempt to translate the analogy of a market hall with mixed uses for the village of San Patrignano into newly conceived spaces for the production, presentation and purchase of goods.

Objective
The entire area within the village perimeter is regarded as one or a collection of many potential sites. Analyses on site and of exemplary communities will allow students to develop first arguments for the scale and type of their potential project. Each student is expected to develop an initial concept for a community-oriented building intervention. Once the specific site and approach is determined, students will further develop their individual projects to an appropriate level of detail. The rural context of the Emilia-Romagna province and the village culture of San Patrignano will act as immediate sources of inspiration and points of reference.

The studio will help frame an understanding of the forces enabling the production of goods within communities and the potential behaviors, requirements and practices of its residents. It will also encourage the development of a critical position on the potential role of the architect to mediate a design process within a broader social, political and economic discourse.
Throughout the semester, students will focus on developing transferable and practical skills—such as:

A. Caruso

This semester is about the production of atmosphere, about making spaces that have a precise and relevant spatial character. It was once

For decades, our society has been increasingly facing an alienation from the production of food and consumer goods in general.

Reading material will be provided throughout the semester, as well as references to similar case studies.

Qualification to control the design process increasingly independent and with sole responsibility and to find to an individual design

methodology and attitude.

Content

This semester is about the production of atmosphere, about making spaces that have a precise and relevant spatial character. It was once

self-evident that this was the main task of the architect, to make buildings and spaces that supported the rituals of daily life whether that

involved in producing goods and commercial spaces in general. Students will then begin developing individual design proposals for their

customers. Although a community producing food and other goods is not a particularly new phenomenon, such small-scale environments

seem to offer refreshing conditions for people to re-engage with the origins of their consumer. This semester we intend to re-

investigate this relationship between producer and consumer from a newly conceived spatial perspective.

The Italian village of San Patrignano in the Emilia-Romagna province is a unique community that is in a constant state of internal

transformation and adaptation. The high degree of self-sufficiency is at the same time part of its existence and nationwide success.

Originally founded in 1978 to provide secluded spaces for drug-rehabilitation, San Patrignano today consists of around 1600 residents.

While overcoming their former drug-addiction the residents live and work together in a small hillside enclave, isolated from inner-city

temptations. Part of their rehabilitation therapy is to spend time learning to produce and further advance the production of food, furniture

and other goods. These unique products are then consumed and sold locally or beyond its borders.

San Patrignano's growth pattern has always followed a path of improvisation and step-by-step planning. The success of its rehabilitation

method has evolved into an increasing demand for additional living spaces. Simultaneously, there appears to be a great potential to also

extend and rethink the spaces where goods are produced, presented and purchased.

Students begin the semester with a series of precedent analyses in small groups. Lectures will be held on topics such as communities

involved in producing goods and commercial spaces in general. Students will then begin developing individual design proposals for their

notion of a SUPER MERCATO. Weekly discussions on thematic topics will take place, building to a comprehensive understanding of

relationship between local producers and customers. Three main reviews will take place throughout the semester, including the final

review.

The class material can be downloaded from the student-server.

For more information on this studio, please refer to our Chair's website: http://u-tt.arch.ethz.ch/classes/

The design studio is also planned in conjunction with the Seminar Week trip to San Patrignano, Italy through the Brillembourg & Klumpner

Chair of Architecture and Urban Design. Enrollment in the San Patrignano Seminar Week is NOT required but is highly recommended as it

forms an essential part of the studio and maximizes design output.

Integrated Discipline: Urban Design

Language: English

Work: Groups (analysis) - Individual (design project)

Location: GNA

Chair: Prof. Brillembourg & Prof. Klumpner

Assistants: Hannes Gutberlet, Katerina Kourkoula, Gianmaria Socci, Danny Wills

All inquiries can be directed to: Hannes Gutberlet - gutberlet@arch.ethz.ch


Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php).

Abstract looking at the history of art in European society, specifically charting how the development of art has come out of, and reflects the different contexts for which it is made and displayed. the project will be to design a small suite of galleries for specific collections of art, a small museum for a site in Zurich.

Objective Qualification to control the design process increasingly independent and with sole responsibility and to find to an individual design methodology and attitude.

Content This semester is about the production of atmosphere, about making spaces that have a precise and relevant spatial character. It was once self-evident that this was the main task of the architect, to make buildings and spaces that supported the rituals of daily life whether that was praying in a chapel, debating matters of state in parliament, or enjoying cakes and tea at home. In order to narrow down the theme of atmosphere and avoid becoming overly philosophical, we will look specifically at the installation and experience of art. We will begin by looking at the history of art in European society, specifically charting how the development of art has come out of, and reflects the different contexts for which it is made and displayed. We will look in considerable detail at specific installations from the chapel to the art fair. The major project of the semester will be to design a small suite of galleries for specific collections of art, a very small museum for a site in Zurich. The semester will be run in collaboration with Fredi Fischli and Niels Olsen of gta exhibitions.

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 64 of 1434
### 051-1143-15L Architectural Design V-IX: (Meili / N.N.)
**W** 13 credits 16U  M. Meili, to be announced

**Abstract**
Does not take place this semester.

**Content**
This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in previous years. It involves the active participation of specialists from related disciplines (e.g. building structures, landscape architecture, history of art and architecture, monuments conservation etc.).

### 051-1145-15L Architectural Design V-IX: A Room for the Biennale ■
**W** 13 credits 16U  C. Kerez

**Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php).**

**Tuesday and Wednesday all day:**
Please note: This course takes place in 8952 Schlieren, Engstingerstrasse 5 !

**Abstract**
The students will develop and design a room which will be built in the Swiss Pavilion of the Architecture Biennale 2016 in Venezia.

**Objective**
Experimental discussion to "built roof" in the form of phisical and virtual models. theoretical discussions to "show architecture"; critical evaluation of the realized intermediate results; interdisciplinary collaboration with the chairs of Prof. Karin Sander, Ludger Hovestadt and Joseph Schwartz.

**Content**
The Biennale project will be integrated into the Giardini, as an interdisciplinary research of statics, geometry and construction of a room with maximal complex room mantling. Moreover, a theoretical and historical examination of the room development shall serve as a basis for its programming with curatonic work and enable localization within the contemporary architectural discourse.

Room as a physical phenomenon:
A interdisciplinary, ETH internal collaboration within the chairs of the professors Christian Kerez (architectural design), Joseph Schwartz (chair of structural design), Ludger Hovestadt (Computer Aided Architectural Design CAAD) and Olga Sorkine-Hornung (Interactive Geometry Lab, D-INFK) will supervise a free design semester. Hence, the students' models are currently tested regarding their static powerness, producibility and room-geometric qualities, are possibly modified or produced with gained knowledge under other conditions. Target of the semester is to investigate and produce digital data, physical models and 1:1 Mock-Ups of room parts which will serve as a pre-stage for the physical production.

Room as a cultural phenomenon:
The Architectural Biennale and at the same time the possibility to present the results of this spatial, static and constructive research to the large public in a built form should be taken as occasion to stimulate a critical reflexion in form of a theoretical and historical research. At the exposition in Venice, the built room in the Swiss pavillon will be shown also as a cultural phenomenon. Therefore, on the one hand, relations to historic relevant projects and steps shall be made, on the other hand, the room should also be arranged kuratorically - this should express the attitude that architecture can be catched sterically, independently of conventions and historic references.

**Lecture notes**
The Reader will be handed out at the first meeting and is in English only.

**Prerequisites / notice**
Please enroll also for: Integrated seminar week (19.-23.10.15) in Zurich ; Cost range: A.

051-1247-15L Integrated Discipline Architecture and Art (K. Sander)
051-1223-15L Integrated Discipline Structural Design (J. Schwartz)
051-1217-15L Integrated Discipline CAAD (L. Hovestadt).

### 051-1147-15L Architectural Design V-IX: (M.Topalovic)
**W** 13 credits 16U  M. Topalovic

**Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php).**

**Number of participants limited to 10 (5 teams of 2 students).**

### 051-1181-15L Architectural Design V-IX: (K.Christiaanse)
**W** 13 credits 16G  K. Christiaanse

**Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php).**

**Abstract**
This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in previous years. It involves the active participation of specialists from related disciplines (e.g. building structures, landscape architecture, history of art and architecture, monuments conservation etc.).

**Objective**
The goal is to communicate a broad-based systemic knowledge base, methodologies and strategies, which helps to enable students to evaluate complex urban design and planning problems and to synthesize their knowledge in an urban design project. Qualification to control the design process increasingly independent and with sole responsibility and to find to an individual design methodology and attitude.

### 051-1183-15L Architectural Design V-IX: Architecture & Building Structure: Track 4 - A Station with Market Hall
**W** 13 credits 16U  J. Schwartz, M. Beckh, A. Deplazes, D. Eberle, M. Schrems

**Abstract**
Constructive and technical bearing structure problems of transformation are mainly taught. The focus is set on a creative argumentation with questions of inner power flow, of constructive execution as well as of the quality of the architectural room. The competences of all the elective and major courses are brought together in one course.

**Objective**
As a didactic target a profound debate on supporting structure, on construction and on room creation is declared.

**Content**
Due to the

### 051-1151-15L Architectural Design V-IX: At Work. Idyll and Ideology ■
**W** 13 credits 16U  A. Lehnerer

**Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php).**

**Abstract**
The HS15 design studio "at work" is following a invitation for a cooperation with the chair for the "Manifesta 11" taking place in summer 2016. It is about work places and work rooms in the city - and on how they avert from urban publicity or integrate themselves as a matter of course.
Objective
To develop concepts of architectural and urban design and its specific formulation. Understanding architecture as cultural practice with a strong but unstable connection to society, i.e. to the city and the history of our built environment. Through design and means of architecture, being able to deliver a critical contribution to a specific discourse within the disciplin. Working with the speculative reality of architecture.

Content
‘idyll and ideology’ is a series of critical studies that speculates about, while also reinterpreting, the structural inventory found within our towns and countryside. The design project is rooted within the context of the discipline between the theory of architecture and the stories of the built environment - an architecture that claims to be both cultural and contextual while simultaneously pursuing the desire for the autonomy of form. The city as a cultural expression has always been the critical project of architecture. By focusing on individual elements that make up the whole, a precise architectural discussion can be developed about collective form. The design process describes the ideological reshaping of a constructed idyll and the related negotiation of its resulting contradictions. The outcome is a third typology between house and city.

Integrated Discipline Construction

The integrated Discipline Construction can also be completed as "additional integrated Discipline", but the integrated Discipline Construction must be chosen at least once.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

Abstract
Presence on the first day (initial course event) to the integrated discipline construction is compulsory for participating in this course.

Objective
In the context of the semester-long design projects, the reciprocity between design, construction and materiality is reinforced.

Abstract
One focus is the coherence of design and construction.

Objective
The integration of knowledge gained in the basic courses lends the work an additional dimension and demands of the students an increasingly integrative ability to think and design.

Content
This part of the curriculum addresses design work in different areas of architecture and integrates the knowledge acquired in previous years. It involves the active participation of specialists from related disciplines (e.g. building structures, landscape architecture, history of art and architecture, monuments conservation etc.).

Prerequisites / notice
It is a must to take part in the introduction course to "Integrated Discipline Construction".

Time and place see on http://www.buk.arch.ethz.ch/Lehre/Einfuehrungsveranstaltung .

051-1237-15L Integrated Discipline Landscape Architecture (C.Girot) W 3 credits 2U C. Girot

Abstract
Design concepts ranging from architectural objects to urban planning are developed together with the discipline of landscape architecture.

Objective
Students gain an insight into the integrated disciplines of design in architecture together with landscape architecture.

Prerequisites / notice
In order to complete the subject Integrated Discipline it is necessary that students apply at the Chair of C. Girot within the first three weeks of the semester. Thereafter no applications will be processed.

Learning aids: Pamphlets Design of the Chair of Prof. Girot. www.girot.arch.ethz.ch

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>051-1241-15L</td>
<td>Integrated Discipline Construction - Autumn Semester 2015</td>
<td>W</td>
<td>3 credits</td>
<td>2U</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Abstract
The integrated focal work has to accompany the design, though the focal work has to be an autonomous work. The formal framework needs to be discussed with the assistants.

Objective
Work on a current design project with focus on construction.

Prerequisites / notice
For students who attend the architectural design only.


Abstract
The formal framework needs to be discussed with the staff members.

Objective
A study in building research and preservation of building heritage with a clear topic.

Integrated Discipline History of Urban Design (V.M.Lampugnani)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>051-1205-15L</td>
<td>Integrated Discipline History of Urban Design</td>
<td>W</td>
<td>3 credits</td>
<td>2U</td>
<td>V. Magnago Lampugnani</td>
</tr>
</tbody>
</table>

Abstract
The integrated focal work has to accompany the design, though the focal work has to be an autonomous work. The written essay should be at least 10 pages. The formal framework needs to be discussed with the assistants.

Objective
An urban history case study with a clear topic and a clear formulation of a question. The findings and the discoveries shall be part of the base of the design.

Prerequisites / notice
For students who attend the architectural design only.

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 66 of 1434
Today architectural sketching without the employment of information technologies is only meaningful in exceptional cases. CAD plans,  
Integrated Discipline Structural Design (J. Schwartz)  
3 credits  
2U  
This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in  
A short written essay and/or design work will be integrated in the design project.  
The aim is a profound examination of a topic of history of art and architecture. The gained insights will be converted into the design process.  
Content  
Die integrierte Studienleistung ist dem Entwurf beigeordnet, doch muss eine klar erkennbare eigenständige Leistung in Form einer kurzen  
frülichen und/oder gestalterischen Arbeit erbracht werden. Die Themenwahl erfolgt in enger Absprache mit dem Lehrstuhl, Form und  
Umfang der Arbeit werden im vorhinein abgesprochen.  
Prerequisites /  
Voraussetzung ist die Anmeldung unter mystudies.ethz.ch und per Email an die Professur bis zum Ende der ersten Semesterwoche unter  
Angabe des Entwurfenthemas und der betreuenden Professur.  
Die Arbeit muss zwei Wochen vor der Schlusskritik des Entwurfes abgegeben werden.

051-1209-15L  
Integrated Discipline History of Art and Architecture  
W  
3 credits  
2U  
I. Heinze-Greenberg  
Abstract  
A short written essay and/or design work will be integrated in the design project.  
Objective  
The aim is a profound examination of a topic of history of art and architecture. The gained insights will be converted into the design process.  
Content  
Die integrierte Studienleistung ist dem Entwurf beigeordnet, doch muss eine klar erkennbare eigenständige Leistung in Form einer kurzen  
frülichen und/oder gestalterischen Arbeit erbracht werden. Die Themenwahl erfolgt in enger Absprache mit dem Lehrstuhl, Form und  
Umfang der Arbeit werden im vorhinein abgesprochen.  
Prerequisites /  
Voraussetzung ist die Anmeldung unter mystudies.ethz.ch und per Email an die Professur bis zum Ende der ersten Semesterwoche unter  
Angabe des Entwurfenthemas und der betreuenden Professur.  
Die Arbeit muss zwei Wochen vor der Schlusskritik des Entwurfes abgegeben werden.

051-1211-15L  
Integrated Discipline Theory of Architecture (A. Moravanszky)  
W  
3 credits  
2U  
A. Moravanszky  
Abstract  
Analysis of the design project with methods of architectural theory.  
Objective  
Theoretical reflection on the principles which guide the design process.  
Content  
The goal is a critical debate on the conventions of architectural practice, the insights of which shall inform the design process.  
Objective  
The goal is a critical debate on the conventions of architectural practice, the insights of which shall inform the design process.  
Content  
The integrated design is organized and operated by both chairs engaged in close cooperation.

051-1213-15L  
Integrated Discipline Theory of Architecture (L. Stalder)  
W  
3 credits  
2U  
L. Stalder  
Abstract  
In the bachelor program, the integration of architectural theory into the design process is only offered in cooperation with the chair of  
at architectural design for the whole design studio. On the basis of a reading of theoretical texts the conventions of architectural practice are  
critically debated. The theoretical perspective will be discussed in the midterm and/or final design studio criticism.  
Objective  
The goal is a critical debate on the conventions of architectural practice, the insights of which shall inform the design process.  
Content  
The goal is a critical debate on the conventions of architectural practice, the insights of which shall inform the design process.  
Objective  
The integrated design is organized and operated by both chairs engaged in close cooperation.

051-1215-15L  
Integrated Discipline Building Physics (J. Carmeliet)  
W  
Does not take place this semester.  
Limited number of participants.  
Enrolment under mystudies and per email to the chair is compulsory by the end of the 1st semester week at the latest!  
Please specify your design theme as well as the name of the supervising chair.  
Abstract  
Hygrothermal analysis of a building wall component  
Objective  
The goal is that the students learn to evaluate hygrothermal performance of the building in the different stages of the design process. The  
students learn to evaluate and optimize their design, to choose adequate wall solutions and materials, to design details from a perspective  
of hygrothermal performance.  
Content  
Students interested in this course are required to enroll via mystudies.ethz.ch and apply via e-mail at the chair until end of the first week of  
the semester. Students are asked to indicate the theme of the design and the chair they are working with. The work is handed in at the  
same time as the design.

051-1217-15L  
Integrated Discipline CAAD (L.Hovestadt)  
W  
3 credits  
2U  
L. Hovestadt  
Abstract  
This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in  
previous years. It involves the active participation of specialists from related disciplines (e.g. building structures, landscape architecture,  
history of art and architecture, monuments conservation etc.).  
Objective  
Today architectural sketching without the employment of information technologies is only meaningful in exceptional cases. CAD plans,  
three-dimensional rendering, CNC model construction etc. are pervasive media for the development and presentation of architectural  
drafts. This elective course tries to follow questions on a new plateau: Which are the common traits of current design methods and modern  
information technologies and how can they symbolically lead to a new architectural expressions in formal and constructional regard. Draft-
accompanying, these questions are pursued on a theoretical level, in order to be able to find its expression in the concrete draft. Ascertainment  
technical applications are not ment to be of priority.  
Content  
http://www.caad.arch.ethz.ch  
Lecture notes  
http://www.caad.arch.ethz.ch  
Literature  
http://www.caad.arch.ethz.ch

051-1219-15L  
Integrated Discipline Building Systems (A. Schlüter)  
W  
3 credits  
2U  
A. Schlüter  
Abstract  
The integrated discipline Building Systems addresses specific questions about building systems and system concepts. Energetic analysis  
and system designs are carried out on the students individual design projects.  
Objective  
The course aims for an ability to understand concepts of sustainable building technology coherently integrated into an architectural design.  
The focus lies on LowEx-systems.

051-1221-15L  
Integrated Discipline Architecture and Building Process (S.Menz)  
W  
3 credits  
2U  
S. Menz  
Abstract  
This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in  
previous years. It involves the active participation of specialists from related disciplines.  
Objective  
Alongside a discussion of the basic principles, trends and terminologies, a closer look will be taken at each topic.  
Content  
This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in  
previous years. It involves the active participation of specialists from related disciplines.  
Literature  
Sacha Menz (Hrsg.), Drei Bücher über den Bauprozess, vdf Hochschulverlag an der ETH Zürich, 2009  
Literaturempfehlungen unter www.bauprozess.arch.ethz.ch

051-1223-15L  
Integrated Discipline Structural Design (J. Schwartz)  
W  
3 credits  
2U  
J. Schwartz  
Abstract  
This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in  
previous years. It involves the active participation of specialists from building structur.  
Objective  
Understanding of the importance of the structural system for architectural design and integration of structural thinking into the design  
process.
**Content**
This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in previous years. It involves the active participation of specialists from related disciplines (e.g. building structures, landscape architecture, history of art and architecture, monuments conservation etc.).

**Prerequisites / notice**
Grant by lecturer is required.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>051-1225-15L</td>
<td>Integrated Discipline Architecture and Digital Fabrication (F.Gramazio/M.Kohler)</td>
<td>W</td>
<td>3</td>
<td>2U</td>
<td>F. Gramazio, M. Kohler</td>
</tr>
<tr>
<td>051-1227-15L</td>
<td>Integrated Discipline Information Architecture (G.Schmitt)</td>
<td>W</td>
<td>3</td>
<td>2U</td>
<td>G. Schmitt</td>
</tr>
<tr>
<td>051-1231-15L</td>
<td>Integrated Discipline Sociology (C.Schmida)</td>
<td>W</td>
<td>3</td>
<td>2U</td>
<td>C. Schmid, P. Klaus</td>
</tr>
<tr>
<td>051-1235-15L</td>
<td>Integrated Discipline Landscape Architecture (G. Vogt)</td>
<td>W</td>
<td>3</td>
<td>2U</td>
<td>G. Vogt</td>
</tr>
<tr>
<td>051-1245-15L</td>
<td>Integrated Discipline Structural Construction (P.Block)</td>
<td>W</td>
<td>3</td>
<td>2U</td>
<td>G. Birindelli</td>
</tr>
</tbody>
</table>

**Abstract**

**051-1225-15L**
The Integrated Discipline deals with the interrelation between material and algorithmic design. The direct control of production data opens up new possibilities for design strategies that are exempt from the limitations of standard CAD software. The Integration of process, function and design allows for a new approach to the production of architecture.

**Content**
We use the term digital materiality to describe an emergent transformation in the expression of architecture. Materiality is increasingly being enriched with digital characteristics, which substantially affect architectures physis. Digital materiality evolves through the interplay between digital and material processes in design and construction. The synthesis of two seemingly distinct worlds - the digital and the material generates new, self-evident realities. Data and material, programming and construction are interwoven. This synthesis is enabled by the techniques of digital fabrication, which allows the architect to control the manufacturing process through design data. Material is thus enriched by information, material becomes informed. In the future, architects will permeate the fabrication process in its entirety. This new situation transforms the possibilities and thus the professional scope of the architect.

**051-1227-15L**
This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in previous years. It involves the active participation of specialists from related disciplines (e.g. building structures, landscape architecture, history of art and architecture, monuments conservation etc.).

**Objective**
Apart from learning about and experiencing Information Architecture, the course also introduces research and management skills that will distinguish the future trained ETH architect.

**Content**
This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates the knowledge acquired in previous years. It involves the active participation of specialists from related disciplines (e.g. building structures, landscape architecture, history of art and architecture, monuments conservation etc.).

**051-1231-15L**
This part of the curriculum addresses design work in different areas of architecture and urbanism and integrates sociological questions and research methods.

**Objective**
To consider the social context in the design process!

**Content**
The content is related to the design process and is defined accordingly to the individual project.

**051-1233-15L**
The integrated focal work has to accompany the design, though the focal work has to be an autonomous work. The formal framework needs to be discussed with the assistants.

**Objective**
An urban design case study with a clear topic and a clear formulation of a question. The findings and the discoveries shall be part of the base of the design.

**051-1235-15L**
The integrated focal work is to accompany the design, though the focal work has to be an autonomous work. The formal framework needs to be discussed with the assistants.

**Objective**
An urban design case study with a clear topic and a clear formulation of a question. The findings and the discoveries shall be part of the base of the design.

**051-1245-15L**
Implementation into architectural design of the gained structural construction knowledge, in order to find best possible and holistic solutions for a construction task.

**Objective**
The integrated course achievement is allocated to the design course and is fulfilled under the supervision of professionals out of the field of structural teaching. The main focus, the form and the scope of the thesis are specified in agreement with the chair.

**Content**

**051-1247-15L**
In the integrated discipline the architectural design will be juxtaposed by artistic thinking and working. The conceptual approach will in particular be rendered more precise in the dialogue between architectural and artistic methods. There is also a focus on the technique of describing the context precisely.

**Objective**
Art is the discipline that is constantly creating new realities of terminology and perception. The purpose of the integrated discipline is to use this knowledge, that is produced by art, and to concern it by making design decisions.

**Content**
A systematic procedure for every step in the design will be supported in the integrated discipline, from the generation of new ideas through to detailing and up to presentation. Reflections on method flow into the design in an integrated manner. There will also be an emphasis on giving expression to the results of the design process through artistic means. In addition a publication should be compiled, presenting the conceptual steps developing the design.

**051-1247-15L**
Application for the coursework with the lecturer: Nikolai von Rosen, vonrosen@arch.ethz.ch

**Seminar Weeks**

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
---|---|---|---|---|---
051-0911-15L | Seminar Week Autumn Semester 2015 | W | 2 | 3A | Lecturers
Abstract
The seminar week is obligatory for students of all semesters. There are many and varied study contents.

Objective
The students will be enabled to discuss narrowly formulated factual questions in small groups and in direct contact with the professors.

► Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-ARCH:

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses

ETH/ÜZH

<table>
<thead>
<tr>
<th>Architecture Bachelor - Key for Type</th>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
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</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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</tbody>
</table>

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Integrated Discipline Planning

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>063-1401-15L</td>
<td>Integrated Discipline Planning - Autumn Semester 2015</td>
<td>W</td>
<td>3 credits</td>
<td>2U</td>
<td>Lecturers</td>
</tr>
<tr>
<td></td>
<td>Please register (<a href="http://www.mystudies.ethz.ch">www.mystudies.ethz.ch</a>) only after the internal enrolment for the design classes (see <a href="http://www.einschreibung.arch.ethz.ch/design.php">http://www.einschreibung.arch.ethz.ch/design.php</a>)</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Abstract</td>
<td>The integrated focal work has to accompany the design, though the focal work has to be an autonomous work. The formal framework needs to be discussed with the assistants.</td>
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<tr>
<td>Objective</td>
<td>Work on a current or a passed design project in a large scale.</td>
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</table>

### Integrated Discipline Focal Work (only for Programme Regulations 2007)

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td></td>
<td>The integrated focal work has to accompany the design, though the focal work has to be an autonomous work. The formal framework needs to be discussed with the assistants.</td>
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<tr>
<td>Objective</td>
<td>A case study with a clear topic and a clear formulation of a question. The findings and the discoveries shall be part of the base of the design.</td>
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</table>

### Integrated Discipline Focal Work Construction

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>The focal work serves the scientific foundation of an exemplary subject of architecture.</td>
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<tr>
<td>Objective</td>
<td>The focal of knowledge gained in the basic courses lends the work an additional dimension and demands of the students an increasingly integrative ability to think and design.</td>
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</table>

### Major Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>063-0366-00L</td>
<td>The Architecture of the City from Modernity to Today</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>V. Magnago Lampugnani</td>
</tr>
<tr>
<td>Abstract</td>
<td>The lecture covers the time of the 20th century and describes with theories, projects and implemented plannings the history of the modern city. The lectures emphasizes on the historical plannings and methods and presents each specific urban development within a broader context.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>This course analyzes the history of urban architecture primarily in its existing three dimensional form as a complex human artefact. It also explores the inspirations that prompted the creation of this artefact: philosophical and religious concepts, social conditions, property relationships and the mechanisms that exploit the economics of real estate and the influence of building technology. Intellectual, literary or artistic modes of thought will also be assessed with regard to their impact on urban development. Urbanism has its own distinctive approach as a discipline, but it is also clearly responsive to the influence of related disciplines. Study is made of actual cities and urban expansion plans which are in the process of implementation, as well as unrealized projects and visions of the future. These projects sometimes illustrate ways of thinking that are equal to, or clearer than, actual urban situations.</td>
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</tbody>
</table>
Content

The lecture which will be hold only in one semester includes the developments of the 20th century

1. Le Corbusier: theories, visions and clearcuts in the name oft he autorité
2. The United States in the Jazz Age: Between Metropolis of Tomorrow and Broadacre City
3. Italy in the Fascist Era: Monumental ensembles and new town between assiduousness of modernization and obsession of representation
4. Urban design under totalitarian regimes: The architects of the "Tausendjährige Reich" and the "engineers of luck" of the Soviet Union of Stalin
5. Coming to terms with the past and the Cold War: Reconstruction in the two German states
6. The myth of the human scale: the 1950s in Spain, Great Britain, Scandinavia and Italy
7. Postwar Experiments: Rationalistic classicism in France
8. Two new towns in the 20th century: Chandigarh and Brasilia
9. Fictions and visions: The international utopia of the city
10. The second conquest of the North American territorium: The automobile and the city in the USA
11. Analysis, analogy and renewal: The adventure of the typological city

Lecture notes

To each lecture an overview is listet within a script, that can be purchased at the chair for the history of urban design (HIL D 75.2) at the price of CHF 25. - The script serves as an auxiliary means to the attended lecture compiling the most important illustrations showed and the names and dates of the buildings and its builders along with a short introductory note. Aside this script the chair offers the Quellentextbände' (source texts) which help to extend the knowledge of theoretical discourses in the field of urban design. For the master program the institute offers one volume of texts at the price of CHF 5. - The script is in German, the Quellentextbände are reprinted in their original languages.

Literature

Further recommended literature to consult is listet within the script.

051-0765-15L Building Process: Economy W 2 credits 2G S. Menz, H. Reichel

Abstract

The demonstration of economic considerations within the design and construction process of buildings is the main focus of the diploma subject.

Objective

To grasp the coherences of costs, income and income return.

Content

The demonstration of economic considerations within the design and construction process of buildings is the main focus of the diploma subject. Alongside determining basic principles, case studies play an important role in teaching. The economic factors of building construction are examined and the specific decision process is simulated. The case studies in the lectures as well as the processing of individual topics within the framework of elective work permit and require students active participation.

Lecture notes

Bauökonomie ("construction economics"), Ausgabe 1.5

Lecture script for students of architecture, ETH Zurich, spring 2010

Chair of Architecture and Building Process (ed.), Manfred Nussbaum

Literature

http://www.bauoek-modell.ethz.ch

Enrolments of students not showing up on 17.9.15 are deleted without delay.


Abstract

Basics of the Theory of Architecture

Objective

The building blocks of the theory of architecture - those concepts which are thought to determine form in the design process - are tested for their appropriateness and applicability. Departing from contemporary revisions of the idea of truth of materials, the course examines historical constructions of the meaning of building materials. Further topics include the debates on regionalism, based on the concept of place (genius loci), on tradition, function and style.

Literature


Master copies available at the chair.

063-0313-15L History of Art and Architecture V: Buildings for Books W 1 credit 1V G. Grämiger

Abstract

The architectural history of libraries from the Renaissance until now

Objective

Deepen the basic knowledge

Content

Libraries are showplaces for knowledge. The architecture of such institutions are not merely an envelope, but rather a spatial design for collections of knowledge. Rooms designed for book-collections have always had to meet practical requirements. The codices were to be displayed, but also had to be protected from weather, fire, and theft. Additionally, the stored books had to be arranged. The order and structure of a library serves not only to preserve the objects in an efficient way and to enable them to be located quickly, but such requirements are always accompanied by theoretical considerations about ways in which current views of knowledge should be applied to the spatial arrangement of a library. This has made the architecture of libraries a readable symbol. It is not surprising that limited space and rigid furnishings in the buildings led to constant conflict with the ideal arrangements that had been conceived. The lecture wants to discuss the history of libraries from the Renaissance until now and focuses on such and other questions.

063-0315-15L History of Art and Architecture V: English Architecture in the Postwar Period (P. Ursprung) W 1 credit 1V L. Stalder

Abstract

The lecture investigates some of the key concepts of post-war architecture taking the English Avantgarde as an example.

Objective

The lecture aims to focus on some of the concepts of the recent architectural history that have an ongoing influence on contemporary architecture.

Content

Theory and History of Architecture in Postwar Britain.

Prerequisites / notice

The lecture is held in English.


Does not take place this semester.

Alternating with the course "Building in Constancy" held.
Abstract
While contemporary education in the field of building construction clearly emphasizes new building, architects future tasks will shift increasingly towards the existing stock. Knowledge about methods of historic construction is indispensable for any measures in the building stock. Therefore we launch an introduction into vital areas of historic construction and building techniques.

Objective
Facing analytical tasks in the context of historical constructions, the students shall gain a general overview of the themes of historic building construction (construction processes, quality assurance intervening in historical buildings, typical problems and solution possibilities, standardization and scaling, methods of analysis and evaluation of the building stock).

Content
Focus topics will be:
- Pre-industrial building construction and 19th century (IDB)
- Concepts and theory in history of building engineering (Jürg Conzett)


Abstract
Topics of building research, historic building construction and building in existing structurers will be discussed in this project studio.

Objective
The project studio "Building and Conservation" offers a research-oriented subject for the Master program. Building research and historic building construction form the basis of the project studio. Through analyzing constructions and imparting contextual knowledge students will be enabled to meet challenges of building within existing structures. Questions on historical development of objects and theories, analytics of material and methods of repair will frame the discourse.

During the autumn semester 2014 the project studio will be focussing on the the main building of the ETH Zürich.

063-0417-15L Architecture and Structure  ■  W  2 credits 2G  J. Schwartz

Abstract
The focus is on structural and statical issues with respect to realization. Exemplary buildings are analyzed using graphic statics and specific properties of different materials discussed.

Objective
The course is centered around a design exercise where the form should be the result of a structural design implemented in an architectural design, combined with a deep knowledge of architectural space.

Content
Understanding of structural design as translation of structural concepts into building materials with respect to design concepts.

Prerequisites / notice
Enrolment on agreement with the lecturer only.

063-0419-15L Experimental Explorations on Space and Structure  ■  W  3 credits 3S  J. Schwartz, J. J. Castellón González, P. D'Acunto

Abstract
Introduction into an experimental approach to architectural design based on the application of methods that integrate structural and spatial parameters.

Objective
Basic understanding of the experimentation with design methods in architecture. Ability to build up models throughout digital and physical exploration integrating space and structure.

Content
In recent decades, new methodologies have emerged in architectural design that exploits the implementation of different parameters as generators of the design concept. Building on the programmatic idea of the Chair of Structural Design of reconciliation of the disciplines of engineering and architecture, the course experiments with the application of design methods that integrate structural and spatial principles from the early stages of the design process. These methods are based on simple geometrical rules that relate spatial and structural parameters. The experimental process will be carried out through the development and construction of physical and digital models. This will allow for the exploration of the permeability of the boundary between the physical and the digital realm.

063-1357-15L Digital Urban Simulation  W  4 credits 4G  R. König

Abstract
In this teaching unit architectural and urban design are analyzed by current computational methods. Based on these analyses the effects of plannings can be simulated and understood. An important focus of this course is the interpretation of the analysis and simulation results and the application of these correspondent methods in early planning phases.

Objective
The students learn how the design and planning of cities can be evidence based using scientific methods. The teaching unit convey knowledge in state-of-the-art and emerging spatial analysis and simulation methods and equip students with skills in modern software systems. The course consists of lectures, associated exercises and workshops, as well as of one integral project work.

Content
In a series of theory lectures we explore how the design and planning of cities can be evidence based using scientific methods. By various exercises the students are equipped with skills in modern software systems. In an integral project work knowledge in state-of-the-art and emerging spatial analysis and simulation methods is deepened. Based on the imparted methods the effects of planning and design interventions can be simulated and understood. An important focus of this course is the interpretation of the analysis and simulation results and the application of the correspondent computational methods in early planning phases.


Abstract
Urban physics: wind, wind comfort, pollutant dispersion, natural ventilation, driving rain, heat islands, climate change and weather conditions, urban acoustics and energy use in the urban context.

Objective
- Basic knowledge of the global climate and the local micrometeor around buildings
- Impact of urban environment on wind, ventilation, rain, pollutants, acoustics and energy, and their relation to comfort, durability, air quality and energy demand
- Application of urban physics concepts in urban design
- Climate Change. The Global Picture: global energy balance, global climate models, the IPCC process. Towards regional climate scenarios: role of spatial resolution, overview of approaches, hydrostatic RCMs, cloud-resolving RCMs
- Urban micro climate and comfort: urban heat island effect, wind flow and radiation in the built environment, convective heat transport modelling, heat balance and ventilation of urban spaces - impact of morphology, outdoor wind comfort, outdoor thermal comfort
- Urban energy and urban design. Energy performance of building quarters and cities, decentralized urban energy production and storage technologies, district heating networks, optimization of energy consumption at district level, effect of the micro climate, urban heat islands, and climate change on the energy performance of buildings and building blocks.
- Wind driving rain (WDR): WDR phenomena, WDR experimental and modeling, wind blocking effect, applications and moisture durability
- Pollutant dispersion, pollutant transport: emission, transport and deposition, air quality
- Urban acoustics, noise propagation through the urban environment, meteorological effects, urban acoustic modeling, noise reduction measures, urban vegetation

Lecture notes
All material is provided via the website of the chair (www.carmeliet.arch.ethz.ch/Education/).

Literature
All material is provided via the website of the chair (www.carmeliet.arch.ethz.ch/Education/).

Prerequisites / notice
No prior knowledge is required.

066-0427-00L Design and Building Process MBS  W  2 credits 2V  A. Paulus

Abstract
Lectures on twelve compact aspects gaining importance in a increasingly specialised, complex and international surrounding: Topics of the profession, design quality, the project, organisation, coordination, costing, contracts and agreements, tendering and construction management, life cycle, real estate market, building trade and getting started.
### 063-0311-15L

**Title:** Transitional Periods: Swiss Renaissance and Baroque Architecture

**Credit:** 1

**Objective:** The lecture discusses the striking presence of hybrid forms in Swiss architecture of the 16th to the 18th centuries by means of secular and religious buildings from all parts of Switzerland.

**Content:** Swiss architecture of the 16th to the 18th centuries often defies stylistic classifications under the headings of Renaissance and Baroque. The notion of "hybrid style" was applied, meaning e.g. the blending of Gothic and antique elements, and 17th-century buildings were ascribed to the Renaissance. All these features were termed as "stylistic belatedness" and explained as issuing from the political situation of Switzerland as a "borderland" (divided also in itself) that intended to preserve elements of its own against foreign forces. In revising opinions like these, the lecture discusses by means of the analysis of single buildings and their context (amongst others the Hôtel de Ville in Geneva, the cathedral of Lugano, the Maisons des Halles in Neuchâtel, the Stockalper Palace in Brig, the orphanage in Zurich or the Abbey church of St Gall) the qualities of hybrid forms and anachronisms (to be found also in the surrounding Europe) as an expression of the will to accommodate cultural changes.

**Abstract:** The lecture discusses the striking presence of hybrid forms in Swiss architecture of the 16th to the 18th centuries by means of secular and religious buildings from all parts of Switzerland.

**Literature:**
- SWISS RENAISSANCE AND BAROQUE ARCHITECTURE: THE EARLY MODERN ARCHITECTURAL HERITAGE, M. Gnehm
- SWISS ARCHITECTURE OF THE REnaissance AND BAROQUE: HYBRID FORMS AND ANACHRONISMS, M. Gnehm
- "The History of the Architecture of the City," M. Topalovic
- "The City in the 20th Century," Vittorio Magnago Lampugnani

**Prerequisites / notice:**
- No additional reader is on offer for this course.
- All lectures, readings and discussions will be held in English. If you wish to participate in the course, attendance at this first meeting is compulsory.

### 063-0363-00L

**Title:** Urban History Online. Methods for Text and Plan Analysis

**Credit:** 2

**Objective:** In obtaining the necessary knowledge and understanding of historical complexities, this in-depth course will give you at hand critical and analytical as well as strategic and planning skills. The course exists of three learning blocks (e-learning), which are embedded in an interactive learning environment, which have to be completed within a given time period.

**Content:** The course emphasizes on the profound discussion and examination of interrelations of selected, exemplary urban theories and projects thought and built in the 20th century. Within three conceptually designed learning blocks (e-learning) you will develop and train basal methods of analysing of texts and plans. The time of this examination can be chosen within a given time period.

**Literature:**
- "Design and Building Process MBS" is a brief manual covering the competencies and the responsibilities of all involved parties through the design and building process. Twelve compact aspects regarding the establish building culture are gaining importance in an increasingly specialised, complex and international surrounding. Lectures on the topics of the profession, design quality, the project, organisation, coordination, costing, contracts and agreements, tendering and construction management, life cycle, real estate market, building trade, and getting started will guide the participants, bringing the individual pieces of knowledge into a superordinate relationship.

**Prerequisites / notice:**
- All the three blocks of the course are related to the lecture "The History of the Architecture of the City". The course can be attended in two modes, either in combination with the above-mentioned lecture or independently as a single course. The entire course is held in German.

### 051-0317-15L

**Title:** History of Art and Architecture: Situating Climate Change

**Credit:** 3

**Objective:** This seminar explores the admittedly vast topic of global climate change by means of case studies that link specific sites with its various facets—ecological, legal, infrastructural, etc. It aims to offer entry points into a defining phenomenon of our age, one that moreover carries direct implications for architecture at the scale of territorial thinking/planning down to individual building design.

**Content:** This seminar explores the admittedly vast topic of global climate change, with the aim of rendering it simultaneously less abstract and more comprehensible. As a phenomenon, climate change is dizzyingly complex, entailing many things happening in many places at once, at varying rates and scales, and with myriad types and degrees of consequence.

The course is structured by way of individual case studies (one per week) that connect specific sites with specific facets of climate change—ecological, economic, legal, and so on. One week, for example, will focus on the Arctic Ocean as a geopolitical hotspot where countries are currently vying to stake claim on pathways for international shipping and oil exploration opened by melting ice. Other weeks will consider, among additional scenarios: a Swiss Valley with melting glacier and its infrastructural repercussions; the Maldives as a disappearing nation state relative to Rob Nixon's notion of "slow violence"; the upcoming COP meeting in Paris as a key site where climate-related policy is forged; and the atmosphere itself as a dynamic, planetary-scale "geography." As a whole, the seminar aims to offer new entry points into a defining phenomenon of our age, one that moreover carries direct implications for architecture at the scale of territorial thinking/planning down to individual building design.

**Prerequisites / notice:**
- All lectures, readings and discussions will be held in English. If you wish to participate in the course, attendance at this first meeting is compulsory.

**Data:** 06.02.2019 13:00

**Autumn Semester 2015**

**Page:** 73 of 1434
The course deals with spatial phenomena at the interface of film and architecture. The alternating influence of these two media will be
interacted by political, legal, economic and cultural structures which are given representative physical form.

K. Sander
C. Schärer

Photography
Criticism and Theory
Spatial Concepts in Film and Architecture (Prof

K. Sander

W

Talk about and devise architectonic ways of perceiving, studying and portraying urban territories that lay beyond the limits of the city. How can architecture extend beyond the limits of the city, into the field? How can architects look at, study and design the "city's constitutive outside": the periphery; the agglom; the country; the hinterland? What are the motives (aesthetic, political) we can have in these territories? What is the importance of being there, in the flesh, on-site? How to move in the field, how to discover it? What are the visual and narrative strategies that can capture the character of territory and its sites?

Content
Weekly studio exercises and on-site expeditions.
(Thet product of the weekly exercises are shown in a common booklet that will serve as a portrait, or a "map" of the chosen urban territory in Switzerland. The character of the work is positioned between architecture, urbanism and visual arts).

Electives

Architecture / Design

Number Title Type ECTS Hours Lecturers
051-0169-15L Seminar Architectural Criticism: The City and the Architectural Property W 2 credits 2G C. Schärer

Abstract
The seminar investigates the potential and the limitations of architectural criticism. The course comprises theoretical reflection, discussions of architectural objects, as well as work on texts.

Objective
The objective of the course is twofold: On the one hand, students will get to know and to apply a critical approach to architecture by means of such media as oral discourse, written reviews, and the image as a tool of criticism. On the other hand, the practice of architectural criticism itself shall be reflected upon by reading and discussing theoretical and historical texts on the subject.

Content
The seminar is structured in three sections. In a first step, theoretical foundations will be established based on reading and discussing seminal texts, as well as guest lectures by established critics. A second phase will include site visits of selected buildings in order to develop a critical vocabulary based on immediate spatial experience. The third part will be devoted to the craft of writing; students will be authoring their own arguments and hold a public discussion.

Lecture notes
Will be handed out at the beginning of the semester.

051-0173-15L Spatial Concepts in Film and Architecture (Prof A.Gigon/M.Guyer) W 1 credit 1V D. E. Agotai Schmid, M. Bächtinger Zwicky

Abstract
The course deals with spatial phenomena at the interface of film and architecture. The alternating influence of these two media will be analyzed, the disposishments of perception and effect will be compared and thus will sharpen the view for a architectural way of looking at space.

Objective
The examination of filmic space situations and performance discloses new perceptions of architecture which will be studied on behalf of film analyses and experimental topics. During the course space-effective creative means such as editing or framing will be introduced and discussed under perceptive aspects. Mediality within spatial perception can thus be integrated into a development of cultural history and leads towards a conception which goes beyond the limits of architecture and stimulates new processes of design.

051-0193-15L Performance and Intervention W 2 credits 2U S. Keller Roca

Abstract
The elective course invites participants to come up with unexpected answers to socially relevant questions raised by architecture through performance and intervention art.

Objective
The medium of performance art is the human being, whose voice and body send out messages into surrounding society. Performance art attempts to create an awareness of how such messages are sent and received. We will examine the significance of speech, posture, clothing and movement using selected examples from performance art.

Content
Interpersonal relationships are regulated by political, legal, economic and cultural structures which are given representative physical form by architecture. Intervention art critiques the relationship between social structure and built-up space. We seek to develop ways of intervening in situations in which we ourselves are implicated, raising questions about the relationship between architecture and social environment.

Prerequisites / notice
To enroll in the course, please consult the lecturer: stefan.keller@arch.ethz.ch

051-0195-15L Criticism and Theory W 2 credits 2S K. Sander

Abstract
Elective course on reading, understanding and writing of theoretical and critical texts.

Objective
The course teaches writing, understanding and reading of theoretical and critical texts on architecture and art. Which rhetorical forms are in use? Which language is spoken? How to formulate theoretical concerns? How to add theoretical background and criticality to a work of art or architecture? What kind of theories are circulating? What kind of critique is to be considered important? Special attention will be given to new forms of online writing, such as blogs or twitter.

Prerequisites / notice
To enroll in the course, please consult the lecturer Clemens Krümmel: kruemmel@arch.ethz.ch

051-0197-15L Photography W 2 credits 2U K. Sander

Abstract
Limited number of participants. Enrolment by agreement with the lecturer - Motivation letter to be sent to eydel@arch.ethz.ch by 31.8.15 at the latest.

Objective
Applying and understanding theoretical and practical aspects of photography from fine arts, architecture and society

Content
Participants will analyze the motivations, strategies, and technical methods of artists and photographers. These analyses will also include the effectiveness and the history of reception of the given work or artist. Based on practical examples, theories of photography will be applied, i.e. through discussing reference, reproducibility, image time, etc.

Prerequisites / notice
Places are limited. Enrolment by agreement with the lecturer. Please Motivation letter to be sent until 10.9.2015 to eydel@arch.ethz.ch

051-0199-15L Architecture and Photography W 2 credits 2S T. Wootton

Abstract
Since the mid 19th century the representation of architecture is inextricably linked to photography. Many buildings are being discussed on the basis of photographs. The artist and photographer Tobias Wootton (HfG Karlsruhe) will teach the students the various techniques (large scale, medium format, small format, digital photography).

Objective
Knowledge of architectural photography

Content
History, theory and practice in architectural photography

Page 74 of 1434
Autumn Semester 2015
Data: 06.02.2019 13:00
Digital Sculpture. Experimental use of a system for digitalizing and modeling 3D objects. Experimentation with digital tools and various design processes of 3D forms in fine arts, design and architecture. Practicing and playing with dimensionality and sense of space.

The department of Architecture and Fine Arts has a 3D-Bodyscanner available for the digitalization of persons and objects, and is complemented by a special software for modeling the 3D data. After a period of training and practice, participants are asked to develop ideas and concepts for their own projects. These concepts should be used to lead and expand the system and the possibilities of its application. The process of readjustment and its realization will be a continual part of developing the individual projects.

The number of participants is limited to 14 students and enrolments need the lecturer’s allowance! We Works with a 3D Touch Mouse, see Youtube https://www.youtube.com/watch?v=NF7nfkteZQ

Proficiency in Windows systems is a precondition for participation. To enroll in the course, please consult the lecturer: Adi Grüninger: grueninger@arch.ethz.ch

The seminar, of course, with its claim to teach the critical faculty to be astonished, is also part of these layers of mediation. We will approach the prelinguistic space of artistic thinking and agency from its context, which supports, mediates, criticizes, sells and preserves its productions - the artworks. We will listen to the various protagonists of this space - cultural agents in civil service institutions, art mediators, critics, curators, gallerists, custodians; for in this space surrounding the prelinguistic one, nothing is left to chance.

Brian O’Doherty: Inside the White Cube, The Ideology of the Gallery Space. When these essays first appeared in Artforum in 1976, their impact was immediate. They were discussed, annotated, cited, collected, and translated: the three issues of Artforum in which they appeared have become nearly impossible to obtain. Having Brian O’Doherty’s provocative essays available again is a signal event for the art world. This edition also includes "The Gallery as Gesture," a critically important piece published ten years after the others.

Brian O’Doherty: Inside the White Cube, The Ideology of the Gallery Space. This seminar aims at providing access to the prelinguistic space of artistic thinking and agency, in order to be able to observe the artists in their immediate working process. This space can only be entered if we successfully leave all layers of mediation behind us and cease to force an understanding.

We will approach the prelinguistic space of artistic thinking and agency from its context, which supports, mediates, criticizes, sells and preserves its productions - the artworks. We will listen to the various protagonists of this space - cultural agents in civil service institutions, art mediators, critics, curators, gallerists, custodians; for in this space surrounding the prelinguistic one, nothing is left to chance.

The number of participants is limited. Application for the course with the lecuturer also via e-mail: stefan.keller@arch.ethz.ch

With the architectural drawing we can refer to one of the most important and primary design tools. Imaginations, ideas, as also the

Development of individual expression in the realm of drawing; artistic flexibility and skill in the areas of working strategy and aesthetic impact.

The number of participants is limited. Application for the course with the lecuturer also via e-mail: Zilla Leutenegger <leutenegger@arch.ethz.ch>

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Development of individual expression in the realm of drawing; artistic flexibility and skill in the areas of working strategy and aesthetic impact.

The number of participants is limited. Application for the course with the lecuturer also via e-mail: Zilla Leutenegger <leutenegger@arch.ethz.ch>
Independently written scientific paper concerning a subject of planning of complex buildings - such as health facility planning and design - with special focus upon the dynamic changes in this context and the related planning and building reactions to them.

The objective is that the students engage in a debate of a differentiated functional planning as a basis for complex buildings which are to be successful functionally, operationally and in design. On the basis of a given scope of themes the students carry out research aiming for possible improvements for example in health facility planning. The scope of subjects is announced at the beginning of each semester.

Complex buildings such as health care buildings are subject to constant change. In a new hospital building 60% of the diagnostic and treatment areas are subject to building changes within the first 10 years of operation. Architecture has to develop concepts which accommodate this level of dynamics into the building structure in a better way. In the coming years this need for adaptability is going to be challenged even further by the even more reducing health care resources. The paper should discuss in this context a specific question in detail by analysing problems and developing and discussing potential planning solutions.

Presentations of the lecturer and guests will be made available

### Workshop on Sustainable Building Certification

**Number**: 101-0587-00L

**Title**: Workshop on Sustainable Building Certification

**Type**: W

**ECTS**: 3 credits

**Hours**: 2G

**Lecturers**: E. Christ

**Abstract**

Does not take place this semester.

**Number of participants limited to 25**

**Objective**

Building labels are used to certify buildings and neighbourhoods in term of sustainability. Many different labels have been developed and can be used in Switzerland (LEED, DGNB, SNBS, Minergie). In this course the differences between the certification labels and its application on 3 emblematic case study buildings will be discussed.

After this course, the students are able to understand and use the different certification labels. They have a clear view of what the labels take into consideration and what they don't.

Three buildings case study will be presented.

Different certification schemes, including LEED (American standard), DGNB (German Standard with Swiss adaptation), SNBS, MINERGIE-ECO and 2000-Watt-Society (Swiss standards) will be presented and explained by experts. After this overall general presentation and in order to have a closer look to specific aspects of sustainability, students will work in groups and assess during one or two weeks this specific criteria on one of the case studies presented before. This practical hands on the label will end with a presentation and a discussion where we will highlight differences between the labels.

This alternation of working session on one specific field criteria for one specific building followed by a group presentation and discussion to compare labels is repeated for the different focus point (operation energy, mobility, daylight, indoor air quality).

Data: 06.02.2019 13:00

Autumn Semester 2015

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In the training of architects, topics related to preservation can be demonstrated only through examples. This elective will build on the techniques and procedures that were taught during the basic studies and will provide a deeper level of understanding.

2G

2 credits

The slides from the presentations will be made available.

All documents for certification labels as well as detail plans of the buildings will be available for the students.

101-0177-00L

Building Physics: Moisture and Durability

W 3 credits 2G J. Carmeliet, T. Defraeye

Abstract

Moisture transport and related degradation processes in building and civil engineering materials and structures; concepts of poromechanics and multiscale analysis; analysis of damage cases.

Objective

- Basic knowledge of moisture transport and related degradation processes in building and civil engineering materials and structures
- Introduction to concepts of poromechanics and multiscale analysis
- Application of knowledge by the analysis of damage cases

Content

1. Introduction
   Moisture damage: problem statement
   Durability

2. Moisture Transport
   Description of moisture transport
   Determination of moisture transport properties
   Hysteresis
   Transport in cracked materials
   Damage and moisture transport in cracked media

3. Poromechanics
   Moisture and mechanics: poro-elasticity
   Poro-elasticity and salt crystallisation
   Poro-elasticity and damage
   Case studies

4. Multiscale analysis
   Problem statement
   Multiscale transport model
   Multiscale coupled transport - damage model

051-0415-15L

Negotiating Structural Forms: History of Structural Design

W 2 credits 2G J. Schwartz, M. Rinke

Prerequisite: Successful completion of Structural Design I-IV.

Abstract

Dealing with the structural necessity against the background of the formal intent often lead, besides discourses, to architectural and technical enrichment as well as unique buildings. This seminar focuses on the work of key figures, that will be discussed on the basis of texts, concepts and buildings.

Objective

- Getting to know key designers on the borderline between architecture and structural engineering, their positions, concepts and most important buildings.
- Seminar focusing on the discussion of important essays and buildings of distinguished builders and architects on the basis of short presentations, models, input lectures and invited guests, as well as films and excursions.

051-0761-15L

Construction Knowledge

W 2 credits 2G U. Hassler

Does not take place this semester.

Abstract

In the training of architects, topics related to preservation can be demonstrated only through examples.

Objective

In the elective subject of Construction Knowledge, students of architecture will learn methods of building analysis. They will practice these methods as they organize their insights in context, analyze sources and evaluate literature. Based on this, they will develop strategies for maintaining value, identifying and assessing possibilities for wise preservation measures.

Content

This elective will build on the techniques and procedures that were taught during the basic studies and will provide a deeper level of coverage of topics related to building research conducted on highly valuable and protected objects. As opposed to the more general topics that are taught in the Masters program Building within the Existing, the elective will focus on highly valuable objects. Besides teaching alternative methods of analysis, it also focuses on understanding of knowledge in context (theoretical, historical, material and engineering sciences) as well as on analysis connected to the development of concepts for maintenance and continuation of use.

051-0763-15L

New Focal Points of Construction

W 2 credits 2G D. Mettler, D. Studer

Abstract

The elective subject “New focal points of construction” investigates the complexe interaction of construction elements by means of exemplary architectonic tender points such as base, wall, chamber, roof etc. The comparative analysis of built constructions serves as a basis for further development of hypothetical future constructions.

Objective

- Target of the course is the understanding of the impacts of material, technology and construction to the architectural education of constructive points. With comparative analysis of built constructions of high architectonic relevance, by means of exemplary building elements such as base, wall, chamber, roof etc., the genesis of constructive building parts, the interaction of the building elements and stand of technique for the most of common constructive tender points is imparted. The conjunction to current constructive methods and basic conditions enables a critical evaluation of the constructive Status Quo within the contemporary producing architecture as well as a perspective to new konstruktive education.
- The comparative analysis of built constructions serves as a basis for further development of hypothetical future constructions.

Content

Lecture:
1. Comparative analysis for derivation and understanding of the constructive points base, wall, chamber, roof etc.
2. Description of current level of technique, typical methods, and set of problems.
3. Final colloquiums with guests of producing and processing companies.

Exercise:
New formulation of a future konstruktive point as a result of a diagnostic work.

051-0777-15L

Building Process: Realization

W 2 credits 2G M. W. Eglin

The number of participants is limited and enrolment is only possible in agreement with the lecturer.

Abstract

The participants of the diploma elective subject is in showing the building process by means of current examples of urban design with architectural relevance. The Chair views itself as the facilitator between those involved in construction and students. Active participation is a prerequisite.

Objective

- Visits to construction sites and interdisciplinary lectures on the topics of communication, complexity, landscape and investment are the main focus of the workshop. In addition, the term process is to be depicted by means of visits to manufacturers of construction components. The Chair views itself as the facilitator between those involved in construction and students. Active participation is a prerequisite.
A. Spiro

"Costruire correttamente" (Constructing Correctly), the 1955 book published by Pier Luigi Nervi, covers crucial factors for building that, outlined by him, are still today all the more relevant as a lesson for architecturally and structurally justified buildings. His thoughts represent valuable criteria and indispensable tools for observation and carrying out investigations of the built environment.

Lessons learned from this can enrich the design work of today's and tomorrow's architects. All of these (see abstract) i.e. analyses, observances, hypotheses, groupings and cross-comparisons, will help the students in their careers to find their own strategies and approaches to design and to be aware of them. And so, according to the advice of Pier Luigi Nervi: "...At every stage of his training, the future architect should be constantly and methodically guided to search for essential elements in each problem, be it large or small. The study of the architectural works of the past should consist in the critical examination of their functional and structural solutions and of the relation between these forms, in order to show that form is a consequence and not a determinant of functional and structural needs." [P. L. Nervi: Costruire correttamente, Milano 1955; English version titled "Structures", 1956, p.28].

The main thread of this course, that runs over two semesters (*), are buildings of all ages that could be categorised under notions such as « most viewed », « most technically daring », « most unknown », « most discussed » or « most worthy of discussion », and carry instructive aspects of the teachings of Pier Luigi Nervi ("costruire correttamente"). In the lecture, these buildings will be investigated on-the-spot, described from the designers' point-of-view and will be commented on with reference to any redesign resulting from the interplay of architectural and structural concepts. Harmonies and discords should be discovered. Occasionally there will be guest lectures. These people, who were directly involved with a certain building, will portray the emergence and development of the project.

In this sense, the course is also intended for civil / structural engineering students and presents a possible bridge between the two prospective project partners - architect and engineer.

(*) Begins in the autumn semester. Entry into the course in the spring is possible.

**051-0781-15L** Costruire correttamente/Constructing Correctly: Curved Bearing and Folded Bearing Structures  
**2 credits** G. Birindelli

**Abstract**  
In line with the approach of P. L. Nervi's book, our study is based on factors that, outlined by him, are still today all the more relevant as a lesson for architecturally and structurally justified buildings. We will observe selected buildings both of our time and of the past for their space, architecture and construction, understand them and interpret them according to universal values of design.

**Objective**  
'Costruire correttamente' (Constructing Correctly), the 1955 book published by Pier Luigi Nervi, covers crucial factors for building that, outlined by him, are still today all the more relevant as a lesson for architecturally and structurally justified buildings. His thoughts represent valuable criteria and indispensable tools for observation and carrying out investigations of the built environment.

Lessons learned from this can enrich the design work of today's and tomorrow's architects. All of these (see abstract) i.e. analyses, observances, hypotheses, groupings and cross-comparisons, will help the students in their careers to find their own strategies and approaches to design and to be aware of them. And so, according to the advice of Pier Luigi Nervi: "...At every stage of his training, the future architect should be constantly and methodically guided to search for essential elements in each problem, be it large or small. The study of the architectural works of the past should consist in the critical examination of their functional and structural solutions and of the relation between these forms, in order to show that form is a consequence and not a determinant of functional and structural needs." [P. L. Nervi: Costruire correttamente, Milano 1955; English version titled "Structures", 1956, p.28].

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(*) Begins in the autumn semester. Entry into the course in the spring is possible.

**051-0855-15L** Masterclass Construction: Brickwork  
**2 credits** C. Vogt

**Abstract**  
The 'Meisterkurs Konstruktion' is seeking a critical discussion on relevant constructive (and energetic) questions of our time. Alternating each semester, one of the typical construction methods will be examined: masonry, concrete, steel, woodworking and curtain wall facades. In the autumn semester 2015 we will focus on contemporary brickwork constructions.

**Objective**  
The prospective architect shall develop necessary skills to be able to think construction in its complex relationships and to face future discussions in practice competently.

**Content**  
The structure of the course contains:
1. Impartation of basic knowledge of construction  
2. Seminar / exercises on the state of technology / research  
3. Integration of practical case studies and problems

**051-0823-15L** Material-Workshop  
**3 credits** A. Spiro

**Abstract**  
Does not take place this semester.

**Objective**  
The elective is organised as a laboratory where one particular material will be explored on a theoretical and practical level. During this study the contemporary architectural potential of the material will be tested and applied.

**Prerequisites / notice**  
Enrolment on agreement with lecturer only.

**051-1219-15L** Integrated Discipline Building Systems (A. Schlüter)  
**3 credits** A. Schlüter

**Abstract**  
The integrated discipline Building Systems adresses specific questions about building systems and system concepts. Energetic analysis and system designs are carried out on the students individual design projects.

**010-0577-00L** An Introduction to Sustainable Development in the Built Environment  
**3 credits** G. Habert

**Abstract**  
This year the UN Conference in Paris will shape future world objectives to tackle climate change. This course provides an introduction to the notion of sustainable development when applied to our built environment.
Objective
At the end of the semester, the students have an understanding of the term of sustainable development, its history, the current political and scientific discourses and its relevance for our built environment.

In order to address current challenges of climate change mitigation and resource depletion, students will learn a holistic approach of sustainable development. Ecological, economical and social constraints will be presented and students will learn about methods for argumentation and tools for assessment (i.e. life cycle assessment).

For this purpose an overview of sustainable development is presented with an introduction to the history of sustainability and its today definition as well as the role of cities, urbanisation and material resources (i.e. energy, construction material) in social economic and environmetal aspects.

The course aims to promote an integral view and understanding of sustainability and describing different spheres (social/cultural, ecological, economical, and institutional) that influence our built environment.

Students will acquire critical knowledge and understand the role of involved stakeholders, their motivations and constraints, learn how to evaluate challenges, identify deficits and define strategies to promote a more sustainable construction.

After the course students should be able to define the relevance of specific local, regional or territorial aspects to achieve coherent and applicable solutions toward sustainable development.

The course offers an environmental, socio-economic and socio-technical perspective focussing on buildings, cities and their transition to resilience with sustainable development. Students will learn on theory and application of current scientific pathways towards sustainable development.

Content
The following topics give an overview of the themes that are to be worked on during the lecture.

- Overview on the history and emergence of sustainable development
- Overview on the current understanding and definition of sustainable development
- Case Study 1: Sustainable construction, the role of construction industry (national/international)
- Case Study 2: Cities, forms of settlements
- Case Study 3: Material resources, scenarios, energy, construction materials, urban metabolism
- Case Study 4: Buildings, heating/cooling, consumers, prosumers and other stakeholder, cooperations
- Method 1: Life cycle assessment (planning, construction, operation/use, deconstruction)
- Method 2: Economics for sustainable construction
- Method 3: Construction, flexibility, modularity
- Synthesis 1: Climate Change mitigation and adaptation in cities
- Synthesis 2: Transition to sustainable development

Lecture notes
All relevant information will be online available before the lectures. For each lecture slides of the lecture will be provided.

Literature
A list of the basic literature will be offered on a specific online platform, that could be used by all students attending the lectures.

Planning / Environmental Design

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

Abstract
The focus of the seminar is to understand the urban history of Zurich through selected case studies.

Objective
The aim of the seminar is to discuss the selected Zurich case studies against the background of the history of urban design.

Content
The City of Zurich rises there where Celtic tribes settled and the Romans founded a city. In the past two millennia authorities, planners of different disciplines, merchants and craftsmen, institutions and investors have shaped the city upon the Limmat. The physical outcome of these interventions stand in close relationship with the knowledge of the time and reflect the prevailing positions and theories, which were thought, published and built elsewhere. For that matter, the history of urban design of Zurich can be well understood as a branch of the history of European urban design, as well as the individual steps of development are offsprings of international reflections and tendencies. Presentations in the seminar room and the visit of the selected ensembles in Zurich will help to tell the story of the urban development from the Middle Ages up to today. With this basic knowledge gained in the seminar and the walks the students will have to discuss the historical theories and developments as well as the urban qualities of the ensembles. This will help the students not only to better understand the city but will also allow them to sample different urban situations and gather spatial experiences, which can also facilitate their design process.

The number of participants is limited to 24 persons.

Prerequisites / notice

<table>
<thead>
<tr>
<th>Number</th>
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<th>Lecturers</th>
</tr>
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<tbody>
<tr>
<td>051-0625-15L</td>
<td>Serendipity: Landscape Acoustics. Mapping Sounds in Kyoto Gardens (Ch.Girot) Number of participants limited (limitation due to technical equipment).</td>
<td>W</td>
<td>2 credits</td>
<td>4G</td>
<td>C. Girot</td>
</tr>
</tbody>
</table>

Abstract
How can the use of multimedia tools encourage the development of new and different viewpoints on landscape? A mix of digital tools will help us develop our field of experimentation in landscape. We will analyse the structure of these places and develop new theses on the contemporary perception and use of landscape.

Objective
Through the use of multimedia tools, this course will reflect on the contemporary use and perception of landscape.

Content
The glaciers formed the landscape we live in and remain a central element in our perception of the Swiss Alps - as 'wild' nature, aesthetic experience and natural resource - and soon may be gone forever.

We will investigate one remaining but slowly disappearing glacier and come in direct contact with the ice. We want to search for traces of movement and time, using two approaches: First, we will take pictures with an analog large-format photo camera. Second, we will record sounds with contact microphones to finally create an audio-visual experience from our own perception of this landscape.

Please find more information and the course schedule on our website: http://girot.arch.ethz.ch/blog/into-the-ice
The seminar will focus on case studies in order to reveal strategies for dealing with the modern city. Built urban-development ensembles of the Modern City. Strategies for Dealing with the Twentieth-Century City. The seminar will focus on case studies in order to reveal strategies for dealing with the modern city. Built urban-development ensembles from the twentieth century will be embedded in their architectural and historical context, studied with an eye to their constitutive elements and discussed in connection with current urban-planning projects. In addition to various forms of methodological engagement with urban contexts, students will experience how the disciplines of urban-planning history and urban development can be considered in a more integrated way. Moreover, they will receive feedback on how to present the result of their analyses in concise, well-structured talks and in drawings.

### 051-0627-15L
**Topology: Decomposing Röntgenplatz in Zürich**

- **Abstract**
  Investigating a new urban landscape proposal in Zürich

- **Objective**
  Green spaces create vibrant streetscapes and are key factors for attracting residents and businesses. Compared to the built substance of Zürich, their development remains paradoxically quite marginal and conservative. These spaces require new suitable design solutions for city life while enhancing natural qualities.

- **Content**
  Student in groups of 2 will set their landscape design goal as output of their designs with both cultural and ecological criteria in mind. They will work on and perfect a short animated sequence, as well as a representation in plans and sections, all through the 3D point cloud model of the square. In early 2016 the work can be further investigated and developed with the new acquired techniques through a Thesis Elective (Wahlfacharbeit, 8 ECTS).

- **Prerequisites / notice**
  - Introduction: Thursday Sept. 17th 2015, 3 PM, HIL-H40.8 (LVML)
  - The Wahlfach will be limited to 20 students in total
  - We will work in groups of 2
  - The lectures will be in English, assistance E/D
  - For the schedule see our Webpage: www.girot.arch.ethz.ch

- **Lecture notes**
  - Time and place: Thursday 12:45-14:45, HIL-H40.8 (LVML).
  - The course is accompanied by a workbook with texts and background information.

- **Enrolment after Agreement only!**

### 051-0629-15L
**Pairi-Daeza: Threshold**

- **Abstract**
  The term 'pairi-daeza', Persian for "a wall surrounding a garden", is the point of origin for an elective series addressing basic elements of landscape architecture. This semester, students will deal with the topic 'Threshold', developing a design for a metropolitan park in Lyon.

- **Objective**
  The term ‘paradise’ and its religious implications originate from ‘pairi-daeza’, Old Persian for ‘a wall surrounding a garden’. Pairi-daeza is the title of an elective course series addressing basic elements of landscape architecture within the context of public space in European Metropolis, including the topics of border, threshold, water, vegetation, topography, choreography, and metaphor. The elective course serves as an introduction to landscape architectural design. Architecture students develop a project based on the perception of place, cognizance of landscape-architectonic typologies, and conception of public space. They become familiar with model building as a design methodology as well as with representation in plan form. The design process is accompanied by workshops, lectures, excursions, critiques, and a workbook.

- **Prerequisites / notice**
  - The course is limited to 24 students. The restriction follows the time of the inscription. In order to enroll in the course, students must participate in a two-days trip to Lyon on the weekend of 3/4.10. The contribution to expenses will be 200.- CHF.
  - Enrolment after Agreement only!

### 051-0631-15L
**Urban Food**

- **Abstract**
  The term ‘Urban Food’ implicitly questions how the production, processing, distribution, consumption and disposal of food influence the relation between city and countryside. This semester, students will deal with the topic 'Threshold', developing a design for a metropolitan park in Lyon.

- **Objective**
  Specific knowledge about relation and various processes in cities and countrysides, with regard to production, handling, logistics, consumption habits and disposal of foodstuff.

- **Content**
  The production, processing, distribution, consumption, and disposal of food have perpetually affected the relationship between city and countryside. In that sense, the industrialization and globalization of food systems contributed to the urbanization of the landscape. On the other hand, logistic systems and consumer behavior are strongly affected by processes of urbanization, which shows that the city and its food system have a mutual influence on each other.

- **Prerequisites / notice**
  - Enrolment after Agreement only!

### 051-0667-15L
**Case Studies in Urban Design: Office Parks - A Global Typology**

- **Abstract**
  Case studies in urban design address specific themes in urban design and spatial development.

- **Objective**
  The aim of the elective is to gain a deeper understanding of topics and methods of urban design and urban research.

### 051-0701-15L
**Systematic Principles of Urban Design. Topic**

- **Abstract**
  Urban Ensembles of the Modern City. Strategies for Dealing with the Twentieth-Century City

- **Objective**
  The seminar will focus on case studies in order to reveal strategies for dealing with the modern city. Built urban-development ensembles from the twentieth century will be embedded in their architectural and historical context, studied with an eye to their constitutive elements and discussed in connection with current urban-planning projects. In addition to various forms of methodological engagement with urban contexts, students will experience how the disciplines of urban-planning history and urban development can be considered in a more integrated way. Moreover, they will receive feedback on how to present the result of their analyses in concise, well-structured talks and in drawings.
The approach to urban-planning ensembles of the twentieth-century city is characterized by their enormous quantity - which also makes dealing with them more difficult. The building stock dating from this era is immense. There is little discussion currently of how larger spatial contexts - housing estates, neighbourhoods, entire cities - can be not just designed and planned but also continuously developed as overall ensembles. Moreover, strategies, instruments and procedures for dealing with the vestiges of twentieth-century urban planning have yet to be established. In the seminar we will discuss how specific approaches to analysing, assessing and further developing of specific case studies have been formulated and explored recently as well as the extent to which they are experimental and deviate from traditional means for preserving and developing the city. Any discussion of an example of urban planning from the previous century must begin with precise analysis: taking up its original urban-planning principles in their historical dimension and all of the features that affect urban planning. The seminar will emphasise this sort of contextual discussion of modern urban space.

### Literature

There will be no script handed out.

- **051-0723-15L**: Information Architecture and Future Cities: Smart Cities
  - **Abstract**: What are SMART CITIES and how do they emerge? What is the role of architects and urban designers in this process? How do data turn into information as a building material for the future city? The course covers concepts, methods and techniques in design, simulation and communication of cities. The goal is to learn principles and preconditions for the design of sustainable and smart cities.
  - **Objective**: Students gain insight into the next generation of design processes for architects and urban designers, and into concepts of the Information Architecture of SMART CITIES, including the influence of Big Data. They learn about the expanded roles of information and of architecture: information and simulation in architecture as means to make the invisible visible, and architecture as a metaphor and ordering system to structure the immense amounts of data of the Information Society. The seminar is highly interactive and discusses visionary case studies in Europe and Asia and new techniques in Big Data informed smart urban design. Apart from learning about and experiencing Information Architecture and SMART CITIES, the course also introduces research and management skills that will distinguish the future ETH architect.

- **051-0725-15L**: Information Architecture and Future Cities: Smart Cities
  - **Abstract**: SMART CITIES - What will happen when cities change from static configurations into responsive and dynamic structures? What does it mean for buildings that undergo the same changes? What is the impact on architectural and urban design education? How can citizens influence this development? The SMART CITIES course will answer these questions and supply you with the necessary skills and knowledge to understand and design such dynamic structures. The intelligent use of data and information are at the core of this course. Data and information are now building materials of future cities. Citizens produce increasing amounts of data in their daily life, with stationary sensors and mobile smartphones. Using those data, citizens begin to influence the design of future cities and the re-design of existing ones. The course will be a first step towards the emerging citizen design science and cognitive design computing. Those will be the next generation of participatory design and design computing.

- **051-0815-15L**: Digital Urban Visualization, People as Flows
  - **Abstract**: We examine patterns of crowd-flows in an extraordinary urbanisation phenomena: festivals.
  - **Objective**: The course participants will learn how to program simulations using Processing/Java. Previous programming knowledge is not necessary. Furthermore they will gain insights into other analysis methods and learn about their significance, strengths and weaknesses.

- **051-0815-15L**: ACTION! On the real City - Play, Negotiate and Act!
  - **Abstract**: The elective course "Action! On the City" will focus on developing a board game that facilitates the decision-making and design processes to answer complex, real-life urban transformations. The course aims to explore the requisites for a sustainable urban development through the lens of various disciplines, such as architecture, engineering, and environmental sciences.

- **051-0821-15L**: Summer School: Markets in the Tropics - Barranquilla
  - **Abstract**: This summer school will function as an inter-disciplinary think-tank, exploring the requisites for sustainable urban development in Barranquilla through the lens of architecture, engineering, and environmental sciences. You will be challenged to work in an intensive cross-cultural setting and develop solutions in a complex, real-life context with local practitioners and stakeholders.
You will receive full support on-site from Universidad del Norte and ETH tutors from your discipline. In developing the scenarios you will work side by side with young professionals with a grounded knowledge of the field, and be joined by a wide variety of local stakeholders. The program will combine site visits, expert lectures and workshops to allow you to develop the following skills:

- The capacity to work to address urban challenges in an inter-disciplinary team
- Apply Scenario Analysis technique to structure and integrate knowledge from various fields
- Cross cultural understanding and skills in an international collaboration
- Mechanisms to collaborate and communicate with practitioners and stakeholders
- Understanding of integrated and sustainable urban development
- Ability to use stakeholder participation to solve real world problems

Mid-sized cities in Latin America are growing at unprecedented rates. The next decade will be decisive in terms of demographic and economic growth, creating a time window to respond to unprecedented demands on resources, such as land, water and energy.

Are these boomtowns doomed to follow the fate of megacities or will they successfully avoid the pitfalls of rapid urban development? This program is part of a three-year ambitious collaboration with the Inter American Development Bank’s Emerging and Sustainable Cities Initiative and the Swiss Ministry for Economic Cooperation (SECO). It will influence decision makers and engage with real issues.

ETH is teaming up with the leading Universidad del Norte in Colombia to focus on Barranquilla, a rapidly growing city of 1.2 million inhabitants on the Atlantic coast of Colombia. Following a period of decline, vast sums of foreign investment are now flowing into this port city, with the potential to reverse current inequities and spark more sustainable development.

In a team, you will produce alternative urban scenarios for the redevelopment of Barranquillas Central Market. You will contribute your expertise and unpack the realities of sustainable development in a tropical climate. How the knowledge from the ETH-Hebe combined with leading Colombian research and translated to a Latin American context? Through debate, controversy and collaboration it is expected you produce scenarios that integrate your different disciplines and question the preconceptions of sustainable urban development.

This immersive summer school will be structured in three interlocking modules:

1. In the first module you will investigate the central market and gain a strong understanding of the social, environmental and built context in Barranquilla. You will employ and combine your varied disciplinary methodologies to gain insight into the sustainability challenges facing the city and the redevelopment of the avenue.

2. In the second module, you will develop a series of scenarios for the central market in Barranquilla, proposing alternatives for its sustainable future. You will build on research from the first module, and explore the potential of your ideas with local stakeholders and professionals from your field. You will document these scenarios using creative and varied representational methods.

3. In the final module you will pitch your scenarios to decision makers. During this high-level event you will measure their preferences, debate the associated trade-offs, and provide a series of orientations for those planning the future of Barranquilla.

Students will be responsible for organising visa, health insurance, and transportation to and from Barranquilla. Flights to Barranquilla from Zurich cost approximately 1700 CHF. Additional travel grants are available for ETH students.

Applications can be submitted including curriculum vitae, portfolio where relevant and letter of motivation as portable document format (pdf) by May 30th, 17:00 CET to hertzog@usys.ethz.ch

Notification for admission June 1st.
We will be looking at urban territories through the eyes, lenses and concepts of an urban geographer, a cartographer, a photographer, an M. Topalovic

The seminar aims at a critical analysis of both material and ideological conventions of the architectural practice. On the basis of the Lecturers

Lecturers

Travellers is a series of five lectures and conversations about ways of perceiving, studying and portraying urban territories. Each of the

Travellers is a series of five lectures and conversations about ways of perceiving, studying and portraying urban territories. Each of the content

Content

The architectural ways of looking, concepts and techniques are unstable at large territorial scales, and yet, urban territories can be seen as crucial contexts for the production of architecture. Seeing an extended urban territory as part of the city - its mirror - can reflect back in the ways we see the city itself, and its architectures.

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Content

Abstract

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Content

Objective

The aim is to discuss concepts and techniques for territorial investigations and projects.

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Objective

Content

History of Art and Architecture: Utopias

Title: History of Art and Architecture: Utopias

ECTS: 2 credits

Type: W

Hours: 2G

Lecturers: N. K. Naehrig, I. Heinze-Greenberg

Prerequisites / notice

Not eligible as a Compulsory GESS Elective for students of D-ARCH.

Title: History of Art and Architecture: Utopias

ECTS: 2 credits

Type: W

Hours: 2G

Lecturers: N. K. Naehrig, I. Heinze-Greenberg

Prerequisites / notice

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Hours: 2G

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Type: W

Hours: 2G

Lecturers: N. K. Naehrig, I. Heinze-Greenberg

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Prerequisites / notice

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Title: History of Art and Architecture: Utopias

ECTS: 2 credits

Type: W

Hours: 2G

Lecturers: N. K. Naehrig, I. Heinze-Greenberg

Prerequisites / notice

Not eligible as a Compulsory GESS Elective for students of D-ARCH.

Title: History of Art and Architecture: Utopias

ECTS: 2 credits

Type: W

Hours: 2G

Lecturers: N. K. Naehrig, I. Heinze-Greenberg

Prerequisites / notice

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Title: History of Art and Architecture: Utopias

ECTS: 2 credits

Type: W

Hours: 2G

Lecturers: N. K. Naehrig, I. Heinze-Greenberg

Prerequisites / notice

Not eligible as a Compulsory GESS Elective for students of D-ARCH.

Title: History of Art and Architecture: Utopias

ECTS: 2 credits

Type: W

Hours: 2G

Lecturers: N. K. Naehrig, I. Heinze-Greenberg

Prerequisites / notice

Not eligible as a Compulsory GESS Elective for students of D-ARCH.
Students should be able to recognise and place in context the characteristic features of suburban and urban housing. They will get to know

Urban Mutations on the Edge: Concrete, Part 1

Taking the perspectives of building users (occupants and visitors) is vital for a human-centered design approach. Students will learn about

We will approach both the historical and theoretical dimensions of the interview as a research tool while also developing practical interview

The aim of the seminar series is to provide a sound methodological approach in analyzing urban space on the scale of the metropolis, the

Type
Preservation of Cultural Heritage:

Lecturers
B. Emo Nax,

Housing considered in context: architectural, cultural, social, technical and economic conditions and processes influence housing and

The architectural, socio-cultural aspects of suburban and urban housing. They will get to know

Literature
als grundlegende Einführung:

Leseliste: Obligatorische Literatur zum Thema ist unter www.wohnforum.arch.ethz.ch abrufbar

Urban Mutations on the Edge: Concrete, Part 1

W 2 credits 2S
M. Angéli
The Urban Mutations on the Edge seminar is a series of public lectures by ETH faculty and invited guests addressing the dynamic global peripheries that we believe are most actively changing our conception of the city.

Objective

Participants should leave the course with an understanding of current urban research issues and an introduction to the political dimension of contemporary architectural production.

Lecture notes

Texts to accompany and provide context for each lecture are sent weekly by email.

051-0813-1SL Sociology: Planetary Urbanization - A Theory Workshop

Abstract

In the last decades, urbanization has become a planetary phenomenon, leading to an intense debate about a new conceptionalization of urbanization. This theory seminar aims at giving an introduction into the actual debate on planetary urbanization, into urban theory, theoretical thinking and the work with scientific texts.

Objective

This elective course highlights the sociological perspective on architectural practice and provides an introduction to sociological research. It focuses on two main procedures: on the one hand, a systematic reading and discussion of theoretical texts, and on the other, empirical case studies of social aspects of the production of the built environment. In this course, a wide set of qualitative research methods is used (including various forms of interview, participant observation, image and text analyses). This approach enables students to gain their own experience by dealing with the various participants and constellations in the social field of architecture and building construction, and to familiarize themselves with the approaches and perceptions of various different participants.

Content

In this theory seminar we read and discuss a range of recent papers and book chapters which analyze these new phenomena of planetary urbanization, such as the implosion and explosion of urban regions, the disintegration of contiguous "hinterlands", the emergence of corridor urbanization, the large scale industrialization and urbanization of agricultural areas, the production of extended urban fabrics of logistics, the creation and extension of operational landscapes, as well as processes that lead to the end of the "wilderness" and the urbanization of ocean space.

Literature

The relevant texts will be distributed in the seminar. A very good overview is provided in the following edited volume: Brenner, Neil (ed.): Implosions / Explosions: Towards a Study of Planetary Urbanization. Jovis, Berlin, 2014.

 Thesis Electives

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>063-0165-1SL</td>
<td>Housing (Elective Thesis)</td>
<td>W</td>
<td>6</td>
<td>11A</td>
<td>G. Precht</td>
</tr>
<tr>
<td>063-0169-1SL</td>
<td>Seminar Architectural Criticism (Thesis Elective)</td>
<td>W</td>
<td>6</td>
<td>11A</td>
<td>L. Stalder</td>
</tr>
<tr>
<td>063-0187-1SL</td>
<td>Procedures in Design - Techniques of Construction (Thesis Elective)</td>
<td>W</td>
<td>6</td>
<td>11A</td>
<td>M. Peter</td>
</tr>
<tr>
<td>063-0193-1SL</td>
<td>Performance and Intervention (Thesis Elective)</td>
<td>W</td>
<td>6</td>
<td>11A</td>
<td>S. Keller Roca</td>
</tr>
<tr>
<td>063-0195-1SL</td>
<td>Criticism and Theory (Thesis Elective)</td>
<td>W</td>
<td>6</td>
<td>11A</td>
<td>K. Sander</td>
</tr>
</tbody>
</table>
Preservation of Cultural Heritage (Thesis Elective) 6 credits

U. Hassler

Z. Leutenegger Küng

The aim of the elective course paper is to discuss a topic freely selected from the field of architectural history, in agreement with the assistant lecturer(s). In addition to original ideas, positions taken in the history of research on the subject should also be discussed. It is important to use the correct scholarly format and clear language. The paper should be approximately 40'000 characters in length and should also include as much pictorial material as needed.

Prerequisites / notice
Application for the coursework with the lecturer also via e-mail: Katja Eydel / eydel@arch.ethz.ch

3D Scanning and Freeform Modeling (Thesis Elective) 6 credits

W 6 credits 11A K. Sander

I. Heinze-Greenberg

N. Freiherr von Rosen

The architectural drawing establishes itself from the very first sketch up to a representative image as an important "decision-maker" for the progress of the design project. The necessary intensity, technology and experimental keen, as also the search for new forms of representations should be sought.

Prerequisites / notice
Application for the coursework with the lecturer also via e-mail: San Keller <stefan.keller@arch.ethz.ch>

Artistic and Conceptual Thinking and Working (Thesis W Elective) 6 credits

S. Keller Roca.

N. Freiherr von Rosen

Abstract
Creative Experience: Definition of ones own interests and realization of an artistic project.

Objective
The ideas, questions, and above all the actual (partial) results of the artistic project will be discussed collectively. Input sessions are organized according to individual requirement.

Prerequisites / notice
Application for the coursework with the lecturer also via e-mail: San Keller <stefan.keller@arch.ethz.ch>

Free Drawing (Thesis Elective) 6 credits

W 6 credits 11A Z. Leutenegger Küng

R. Fässer

A. Moravanszky

Abstract
An elective project in drawing is an assignment with the characteristics of research. A topic, a graphic assignment or problem, selected by the student is furthered through independent work and its evolution documented.

Objective
Combining craft-based and technical processes with aesthetic reflection / developing creativity through structured praxis / solving formal and aesthetic problems / originality, productivity and flexibility.

Prerequisites / notice
Application for the coursework with the lecuturer also via e-mail: Zilla Leutenegger <leutenegger@arch.ethz.ch>

Architectural Drawing (Thesis Elective) 6 credits

W 6 credits 11A R. Fässer

The architectural drawing establishes itself from the very first sketch up to a representative image as an important "decision-maker" for the progress of the design project. The necessary intensity, technology and experimental keen, as also the search for new forms of representations should be sought.

Prerequisites / notice
The visit of the elective is assumed.

Project proposal please to: faesser@arch.ethz.ch

Theory of Architecture (Thesis Elective) 6 credits

W 6 credits 11A A. Moravanszky

N. Zschoeck

Abstract
An elective master thesis in architectural theory is a written student assignment of an architectural problem or question, which is to be elaborated into a scientific paper in consultation with the advisors of the chair. The examination of a specific problem asks for a conscious and critical reflection of interdisciplinary approaches and methods.

Objective
Within the framework of an elective master thesis the student can enhance the acquired knowledge in architectural theory in written form. The master thesis serves the acquisition of scientific methods, the derivation, development and verbalization of conclusions and the contextualization within a theoretical setting. In a broader sense it serves the training of verbal skills, the development of a critical verbal, cognitive and imaginary access to problems in the realm of architecture and its neighboring disciplines in the humanities.

Prerequisites / notice
Consultation for the individual elective thesis will be available during semester as well as during the free period. The oral examination at the end of the semester break is based on the written thesis, handed in before the the examination (watch the deadline in summer/winter).

Appointments for consultation with the junior faculty by arrangement.

History of Art and Architecture (Thesis Elective) 6 credits

W 6 credits 11A N. Zschoeck

H. Greenberg, N. K. Naehrig

Abstract
Independent and scientific thesis on a monographic or thematic topic within the scope of the history of art and architecture.

Objective
The objective is to write an independent thesis on a monographic or thematic topic within the scope of the history of art and architecture. The focus is to thus exemplify a comprehensive view of the approach and methods towards the modern history of art.

Content
The objective of the elective subject is, in coordination with the advisors, to work autonomously on a subject from the history of architecture. Beside own ideas also positions of research should be considered; we set value on a correct scientific form as well as a clear language. The work should cover 36'000 signs as well as image material if needed. At the beginning and before delivery of the work an elaborate discussion will take place.

History of Art and Architecture (Thesis Elective) 6 credits

W 6 credits 11A I. Heinze-Greenberg, N. K. Naehrig

Project preview: A monographic or thematic topic from the history of architecture.

Objective
The aim of the elective course paper is to discuss a topic freely selected from the field of architectural history, in agreement with the assistant lecturer(s). In addition to original ideas, positions taken in the history of research on the subject should also be discussed. It is important to use the correct scholarly format and clear language. The paper should be approximately 40'000 characters in length and should also include as much pictorial material as needed.

Content
http://www.toennesmann.arch.ethz.ch/papers

Prerequisites / notice
Please contact the assistants before the inscribtion.

Preservation of Cultural Heritage (Thesis Elective) 6 credits

W 6 credits 11A U. Hassler

The aim of the Thesis Elective is a independent engagement with the subjects of the related Elective Course.

Architectural Drawing (Thesis Elective) 6 credits

W 6 credits 11A W. Fässer
<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Type</th>
<th>Credits</th>
<th>Category</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>063-0515-15L</td>
<td>Building Physics (Thesis Elective)</td>
<td>W</td>
<td>6</td>
<td>11A</td>
<td>J. Carmeliet</td>
</tr>
<tr>
<td>063-0619-15L</td>
<td>Urban Mutations on the Edge (Thesis Elective)</td>
<td>W</td>
<td>6</td>
<td>11A</td>
<td>M. Angél</td>
</tr>
<tr>
<td>063-0625-15L</td>
<td>Serendipity (Thesis Elective)</td>
<td>W</td>
<td>6</td>
<td>11A</td>
<td>C. Girot</td>
</tr>
<tr>
<td>063-0627-15L</td>
<td>Topology (Thesis Elective)</td>
<td>W</td>
<td>6</td>
<td>11A</td>
<td>C. Girot</td>
</tr>
</tbody>
</table>

Abstract
The Elective Subject Degree Tests are meant to enable a deeper level of individual engagement with the contents of the elective subjects. Topics of electives can be elaborated into elective degree tests.

Objective
The general aim of this intensification is teaching competency in analysis and interpretation in the following areas: knowledge of artifacts, dynamics of systems, historical contexts, history of knowledge and theory as well as an approach to scholarly work.

Content
Contents depend on the specific curriculum of each semester and will be determined in consultation with the faculty advisor. Independent study is possible, however, only after consultation.

Prerequisites / notice
Einer Anmeldung zum Wahlfach muss ein Gespräch mit einem der Assistenten des Lehrstuhls vorangehen. Es ist daher vor einer Anmeldung ratsam Kontakt zu einem der Betreuungsassistenten aufzunehmen.

Prerequisites / notice
It's imperative that the topic of the work is discussed with and accepted by the chair in advance.

Prerequisites / notice
The script is provided by the teaching chair and can be purchased the day the elective course starts.

Prerequisites / notice
Limited admission due to technical equipment.

Prerequisites / notice
Please find more information and the course schedule on our website: http://girot.arch.ethz.ch/landscape-education/bachelor-master/current-courses
Within three elective courses the students need to fulfill an elective work (seminar work). Elective works serve the independent way of dealing with the contents of the according elective course. Free thesis is only possible after consultation with the tutor and has to be well prepared by the student (statement, catalogue of questions).

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Type</th>
<th>Credits</th>
<th>Faculty</th>
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<tbody>
<tr>
<td>063-0667-15L</td>
<td>Case Studies In Urban Design (Thesis Elective)</td>
<td>W</td>
<td>6</td>
<td>K. Christiaanse</td>
</tr>
<tr>
<td>063-0731-15L</td>
<td>CAAD Theory (Thesis Elective)</td>
<td>W</td>
<td>6</td>
<td>L. Hovestadt</td>
</tr>
<tr>
<td>063-0733-15L</td>
<td>CAAD Practice (Thesis Elective)</td>
<td>W</td>
<td>6</td>
<td>L. Hovestadt</td>
</tr>
</tbody>
</table>
Elective works serve the independent way of dealing with the contents of the according elective course.

To grasp the coherences of costs, income and income return. In-depth studies of the interaction of the market, building costs, finance and location.

Elective works serve the independent way of dealing with the contents of the according elective course.

Script only available in german.

"Economic modell for real estate development"

http://www.bauprozess.arch.ethz.ch/education/okonomie

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>063-0781-15L</td>
<td>Costruire correttamente/Constructing Correctly (Thesis Elective)</td>
<td>W</td>
<td>6</td>
<td>11A</td>
<td>G. Birindelli</td>
</tr>
<tr>
<td>063-0815-15L</td>
<td>ACTION! Empowering the Real City (Thesis Elective)</td>
<td>W</td>
<td>6</td>
<td>11A</td>
<td>A. Brillembourg, H. Klumpner</td>
</tr>
<tr>
<td>063-0823-15L</td>
<td>Material-Lab (Thesis Elective)</td>
<td>W</td>
<td>6</td>
<td>11A</td>
<td>A. Spiro</td>
</tr>
<tr>
<td>063-0855-15L</td>
<td>Master Class Construction (Thesis Elective)</td>
<td>W</td>
<td>6</td>
<td>11A</td>
<td>C. Vogt</td>
</tr>
</tbody>
</table>

**Seminar Weeks**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>051-0911-15L</td>
<td>Seminar Week Autumn Semester 2015</td>
<td>W</td>
<td>2</td>
<td>3A</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

**Compulsory Electives in Humanities, Social and Political Sciences**

Recommended GESS compulsory elective courses (Type)

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 89 of 1434
B) for D-ARCH.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses

ETH/UZH

Master Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>051-0141-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>33 credits</td>
<td>40D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Only students who fulfill the following criteria are allowed to begin with their master thesis:

a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to gain admission to the master programme.

Abstract: The Master-Thesis contains a written proposal due to a given master-programme within the work-field of an architect.

Objective: The Master-Thesis has to be an individual work by the students and be proof of the ability to independent design work.

Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>051-1100-AAL</td>
<td>Architectural Design V-IX</td>
<td>E-</td>
<td>13 credits</td>
<td>16U</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Enrolment only for MSc students who need this course as additional admission requirement.

Please register (www.mystudies.ethz.ch) only after the internal enrolment for the design classes (see http://www.einschreibung.arch.ethz.ch/design.php)

Abstract: For Master students with additional obligations only! - Out of the offered courses "Architectural Design V-IX" the student is required to achieve 13 ECTS. There are 2 attempts only.

Objective: Qualification to control the design process increasingly independent and with sole responsibility and to find to an individual design methodology and attitude.

Architecture Master - Key for Type

| O         | Compulsory                        | E-   | Recommended, not eligible for credits |
| W+        | Eligible for credits and recommended | Z    | Courses outside the curriculum       |
| W         | Eligible for credits              | Dr   | Suitable for doctorate               |

Key for Hours

| V         | lecture                          | P    | practical/laboratory course         |
| G         | lecture with exercise            | A    | independent project                 |
| U         | exercise                         | D    | diploma thesis                      |
| S         | seminar                          | R    | revision course / private study     |
| K         | colloquium                       |      |                                      |

ECTS: European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
The students can understand the role of land processes and associated feedbacks for the climate system.

**Land-Climate Interactions**

Overall goals of this course are given below. Focus is on the theoretical background and idealised concepts.

- **H. Wernli**
- Lecturers available (i.e. in English)
- **2V+1U**

**Cloud Microphysics**

- Pichler H., Dynamik der Atmosphäre, Bibliographisches Institut, 456 pp. 1997


- **G** - Dynamics of large-scale atmospheric flow

- **G** - Physics I, II, Environmental Fluid Dynamics

---

### Modules

#### Weather Systems and Atmospheric Dynamics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-1221-00L</td>
<td>Dynamics of Large-Scale Atmospheric Flow</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>H. Wernli, S. Pfahl</td>
</tr>
</tbody>
</table>

**Abstract**

Dynamic, synoptic Meteorology

**Objective**

Understanding the dynamics of large-scale atmospheric flow

**Content**

Dynamical Meteorology is concerned with the dynamical processes of the earth's atmosphere. The fundamental equations of motion in the atmosphere will be discussed along with the dynamics and interactions of synoptic system - i.e. the low and high pressure systems that determine our weather. The motion of such systems can be understood in terms of quasi-geostrophic theory. The lecture course provides a derivation of the mathematical basis along with some interpretations and applications of the concept.

**Lecture notes**

Dynamics of large-scale atmospheric flow

**Literature**

- Pichler H., Dynamik der Atmosphäre, Bibliographisches Institut, 456 pp. 1997

**Prerequisites / notice**

Physics I, II, Environmental Fluid Dynamics

---

#### Climate Processes and Feedbacks

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-1235-00L</td>
<td>Boundary Layer Meteorology</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>M. Rotach, P. Calanca</td>
</tr>
</tbody>
</table>

**Abstract**

The Planetary Boundary Layer (PBL) constitutes the interface between the atmosphere and the Earth's surface. Theory on transport processes in the PBL and their dynamics is provided. This course treats theoretical background and idealized concepts. These are contrasted to real world applications and current research issues.

**Objective**

Overall goals of this course are given below. Focus is on the theoretical background and idealised concepts.

Students have basic knowledge on atmospheric turbulence and theoretical as well as practical approaches to treat Planetary Boundary Layer flows. They are familiar with the relevant processes (turbulent transport, forcing) within, and typical states of the Planetary Boundary Layer, idealized concepts are known as well as their adaptations under real surface conditions (as for example over complex topography).

**Content**

- Introduction
- Turbulence
- Statistical treatment of turbulence, turbulent transport
- Conservation equations in a turbulent flow
- Closure problem and closure assumptions
- Scaling and similarity theory
- Spectral characteristics
- Concepts for non-ideal boundary layer conditions

**Lecture notes**

available (i.e. in English)

**Literature**


**Prerequisites / notice**

Umwelt-Fluidynamik (701-0479-00L) (environment fluid dynamics) or equivalent and basic knowledge in atmospheric science

---

#### Atmospheric and Climate Science Master

Atmospheric and Climate Science Master

**Modules**

**Weather Systems and Atmospheric Dynamics**

**Objective**

Understanding the dynamics of large-scale atmospheric flow

**Content**

Dynamical Meteorology is concerned with the dynamical processes of the earth’s atmosphere. The fundamental equations of motion in the atmosphere will be discussed along with the dynamics and interactions of synoptic system - i.e. the low and high pressure systems that determine our weather. The motion of such systems can be understood in terms of quasi-geostrophic theory. The lecture course provides a derivation of the mathematical basis along with some interpretations and applications of the concept.

**Lecture notes**

Dynamics of large-scale atmospheric flow

**Literature**

- Pichler H., Dynamik der Atmosphäre, Bibliographisches Institut, 456 pp. 1997

**Prerequisites / notice**

Physics I, II, Environmental Fluid Dynamics

---

**Climate Processes and Feedbacks**

**Objective**

Understanding the dynamics of large-scale atmospheric flow

**Content**

Dynamical Meteorology is concerned with the dynamical processes of the earth’s atmosphere. The fundamental equations of motion in the atmosphere will be discussed along with the dynamics and interactions of synoptic system - i.e. the low and high pressure systems that determine our weather. The motion of such systems can be understood in terms of quasi-geostrophic theory. The lecture course provides a derivation of the mathematical basis along with some interpretations and applications of the concept.

**Lecture notes**

Dynamics of large-scale atmospheric flow

**Literature**

- Pichler H., Dynamik der Atmosphäre, Bibliographisches Institut, 456 pp. 1997

**Prerequisites / notice**

Physics I, II, Environmental Fluid Dynamics

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### Autumn Semester 2015

**Number**

- **701-1235-00L**
  - **Cloud Microphysics**
  - **Type**
  - **ECTS**
  - **Hours**
  - **Lecturers**

**Abstract**

Clouds are a fascinating climate phenomenon central to the hydrological cycle and the Earth’s radiation balance. Interactions between cloud particles can result in precipitation, glaciation or evaporation of the cloud depending on its microstructure and microphysical processes. In this course the sought-after topic of ice formation in clouds is studied from a theoretical and empirical perspective.

**Objective**

Students will gain an appreciation and understanding of the complex processes in clouds and the necessary physical phenomenon that are involved and need to be accounted for in order to study cloud and precipitation formation.

**Content**

- Microstructure of clouds and precipitation, aerosol activation to form cloud droplets, ice crystal nucleation (homogeneous freezing of supercooled aerosol and heterogeneous freezing), precipitation formation

**Lecture notes**

Powerpoint slides will be made available

**Literature**


**Prerequisites / notice**

At least one introductory course in Atmospheric Science or Instructor’s consent.

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**Number**

- **701-1251-00L**
  - **Land-Climate Interactions**
  - **Type**
  - **ECTS**
  - **Hours**
  - **Lecturers**

**Abstract**

The purpose of this course is to provide fundamental background on the role of land surface processes (vegetation, soil moisture dynamics, land energy and water balances) for the climate system. The course consists of 2 contact hours per week, including 2 computer exercises.

**Objective**

The students can understand the role of land processes and associated feedbacks for the climate system.

**Lecture notes**

Powerpoint slides will be made available

**Prerequisites / notice**

Prerequisites: Introductory lectures in atmospheric and climate science

**Literature**


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**Number**

- **651-4911-00L**
  - **Climate and the Global Circulation of the Atmosphere**
  - **Type**
  - **ECTS**
  - **Hours**
  - **Lecturers**

**Abstract**

Key features of the surface climate (e.g., the wind and temperature distribution) can be understood by considering how basic physical balances such as the angular momentum and energy balance constrain global atmospheric circulations. This course gives an overview of the physical balances involved and explores some of their implications for maintaining the surface climate (winds, temperature, precipitation, etc.). Ability to reason how climate may change on long timescales.

**Literature**

- Prerequisites: Introductory lectures in atmospheric and climate science

**Prerequisites / notice**

At least one introductory course in Atmospheric Science or Instructor’s consent.

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Data: 06.02.2019 13:00 Autumn Semester 2015 Page 91 of 1434
Content
Introduction to the physical balances and dynamical mechanisms governing global atmospheric circulations and the surface climate: angular momentum balance and its role in controlling winds; energy balance and its role in controlling temperatures; the hydrologic cycle and its role in controlling humidity and aridity; tracer transport and connections to the surface. The relative importance of mean circulations, transient eddies, and stationary eddies in these balances will be discussed, as will the dynamics of their generation and maintenance.

The course gives an overview of the dominant processes that govern the surface climate, with a focus on phenomenology and order-of-magnitude physics that is applicable to climates generally, including those of Earth's distant past and of other planets.

Lecture notes
Available at http://climate-dynamics.org/courses/651-4911-00-climate-and-the-global-circulation-of-the-atmosphere/

Atmospheric Composition and Cycles

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0572-00L</td>
<td>Aerosols I: Physical and Chemical Principles</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>M. Gysel, U. Baltensperger, H. Burtcher</td>
</tr>
<tr>
<td>Abstract</td>
<td>Aerosols I deals with basic physical and chemical properties of aerosol particles. The importance of aerosols in the atmosphere and in other fields is discussed.</td>
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</tr>
<tr>
<td>Objective</td>
<td>Knowledge of basic physical and chemical properties of aerosol particles and their importance in the atmosphere and in other fields</td>
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<tr>
<td>Content</td>
<td>physical and chemical properties of aerosols, aerosol dynamics (diffusion, coagulation...), optical properties (light scattering, -absorption, - extinction), aerosol production, physical and chemical characterization.</td>
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<tr>
<td>Lecture notes</td>
<td>materiel is distributed during the lecture</td>
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</tbody>
</table>

| 102-0635-01L | Air Pollution Control                      | W    | 6    | 4G    | B. Buchmann, P. Hofer |
| Abstract     | The lecture provides in the first part an introduction to the formation of air pollutants by technical processes, the emission of these chemicals into the atmosphere and their im-pact on air quality. The second part covers different strategies and techniques for emis-sion reduction. The basic knowledge is deepened by the discussion of specific air pollution problems of today's society. |
| Objective    | The students gain general knowledge of the factors resulting in air pollution and the techniques used for air pollution control. The students can identify major air pollution sources and understand the methods for measurement, data collection and analysis. The students can evaluate possible control methods and equipment, design a control system and estimate the efficiency and cost. |
| Content      | Part 1 Emission, Immission, Transmission |
|              | Fluxes of pollutants and their environmental impact |
|              | - physical and chemical processes leading to emission of pollutants |
|              | - mass and energy of processes |
|              | - Emission measurement techniques and concepts |
|              | - quantification of emissions from individual and aggregated sources |
|              | - extent and development of the emissions (Switzerland and global) |
|              | - propagation and transport of pollutants (transmission) |
|              | - meteorological parameters influencing air pollution dispersion |
|              | - deterministic and stochastic models, describing the air pollution dispersion |
|              | - dispersion models (Gaussian model, box model, receptor model) |
|              | - measurement concepts for ambient air (immission level) |
|              | - extent and development of ambient air mixing ratios |
|              | - goal and instrument of air pollution control |
| Lecture notes | - Brigitte Buchmann, Air pollution control, Part I |
|              | - Peter Hofer, Air pollution control, Part II |
|              | - Lecture slides and exercises |
| Literature   | List of literature included in scrip |
| Prerequisites / notice | College lectures on basic physics, chemistry and mathematics |

| 701-1233-00L | Stratospheric Chemistry                  | W    | 4    | 2V+1U | T. Peter, A. Stenke |
| Objective    | The lecture gives an overview on the manifold reactions which occur in the gas phase, in stratospheric aerosol droplets and in polar cloud particles. The focus is on the chemistry of stratospheric ozone and its influence through natural and anthropogenic effects. Especially the intercontinental air traffic and the ozone depletion caused by FCKW CFC in the mid-latitude and the polar regions as well as coupling with the greenhouse effect. |
| Content      | Short presentation of thermodynamical and kinetic basics of chemical reactions: bi- and terthermo molecular reactions, photo-dissociation. Introduction to the chemical family concept: active species, their source gases and reservoir gases. Detailed treatment of the pure oxygen family (odd oxygen) according to the Chapman chemistry. Radical reactions of the oxygen species with nitric oxide, active halogens (chlorine and bromine) and odd hydrogen. Ozone depletion cycles. Methane depletion and ozone production in the lower stratosphere (photo-smog reactions). Heterogeneous chemistry on the background aerosol and its significance for heavy air traffic. Chemistry and dynamics of the ozone hole: Formation of polar stratospheric clouds and chlorine activation. |
| Lecture notes | Documents are provided in the contact hours. |
Prerequisites / notice

Prerequisites: Basics in physical chemistry are required and an overview equivalent to the bachelor course in atmospheric chemistry (lecture 701-0471-01) is expected.

701-1233-00 V starts in the first week of the semester. The exercises 701-1233-00 U will start only in the 2nd week of the semester.

Climate History and Paleoclimatology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-4049-00L</td>
<td>Conceptual and Quantitative Methods in Geochemistry</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>O. Bachmann, M. Schönächler, D. Vance, M. Ellwood</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course will introduce some of the main quantitative methods available for the quantitative treatment of geochemical data, as well as the main modelling tools. Emphasis will both be on conceptual understanding of these methods and as well as on their practical application, using key software packages to analyse real geochemical datasets.</td>
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<tr>
<td>Objective</td>
<td>Development of a basic knowledge and understanding of the main tools available for the quantitative analysis of geochemical data.</td>
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<tr>
<td>Content</td>
<td>The following approaches will be discussed in detail: major and trace element modelling of magmas, with application to igneous systems; methods and statistics for calculation of isochrons and model ages; reservoir dynamics and one-dimensional modelling of ocean chemistry; modelling speciation in aqueous (hydrothermal, fresh water sea water) fluids. A special emphasis will be put on dealing with geochemical problems through modeling. Where relevant, software packages will be introduced and applied to real geochemical data.</td>
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<tr>
<td>Lecture notes</td>
<td>Slides of lectures will be available.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Pre-requisite: Geochemistry (651-3400-00L), Isotope Geochemistry and Geochronology (651-3501-00L).</td>
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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>651-4057-00L</td>
<td>Climate History and Palaeoclimatology</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>G. Haug, A. Martinez-Garcia</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course &quot;Climate history and paleoclimatology gives an overview on climate through geological time and it provides insight into methods and tools used in paleoclimate research.</td>
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<tr>
<td>Objective</td>
<td>The student will have an understanding of evolution of climate and its major forcing factors -orbital, atmosphere chemistry, tectonics-through geological time. He or she will understand interaction between life and climate and he or she will be familiar with the use of most common geochemical climate &quot;proxies&quot;, he or she will be able to evaluate quality of marine and terrestrial sedimentary paleoclimate archives. The student will be able to estimate rates of changes in climate history and to recognize feedbacks between the biosphere and climate.</td>
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<tr>
<td>Content</td>
<td>Climate system and earth history - climate forcing factors and feedback mechanisms of the geosphere, biosphere, and hydrosphere. Geological time, stratigraphy, geological archives, climate archives, paleoclimate proxies</td>
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<td>Climate through geological time: &quot;lessons from the past&quot;</td>
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<tr>
<td>Cretaceous greenhouse climate</td>
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<td>The Late Paleocene Thermal Maximum (PETM)</td>
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<td>Cenozoic Cooling</td>
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<tr>
<td>Onset and Intensification of Southern Hemisphere Glaciation</td>
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<tr>
<td>Onset and Intensification of Northern Hemisphere Glaciation</td>
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<tr>
<td>Pliocene warmth</td>
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<tr>
<td>Glacial and Inter glacials</td>
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<td>Millennial-scale climate variability during glaciations</td>
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<td>The last deglaciation(s)</td>
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<td>The Younger Dryas</td>
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<tr>
<td>Holocene climate - climate and societies</td>
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<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-4043-00L</td>
<td>Sedimentology II: Biological and Chemical Processes in Lacustrine and Marine Systems</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>V. Picotti, A. Gilli</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course will focus on biological and chemical aspects of sedimentation in marine environments. Marine sedimentation will be traced from coast to deep-sea. The use of stable isotopes palaeoceanography will be discussed. Neritic, hemipelagic and pelagic sediments will be used as proxies for environmental change during times of major perturbations of climate and oceanography.</td>
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</tbody>
</table>
| Objective   | - You will understand chemistry and biology of the marine carbonate system  
- You will be able to relate carbonate mineralogy with facies and environmental conditions  
- You will be familiar with cool-water and warm-water carbonates  
- You will see carbonate and organic-carbon rich sediments as part of the global carbon cycle  
- You will be able to recognize links between climate and marine carbonate systems (e.g. acidification of oceans and reef growth)  
- You will be able to use geological archives as source of information on global change  
- You will have an overview of marine sedimentation through time |

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The course presents advanced hydrological analyses of rainfall-runoff processes. The course is given in English.

**Overall goals of this course are given below.** Focus is on the theoretical background and idealised concepts.

**Suggested literature:**

Tools for hydrological modelling are discussed at the event and continuous scale. The focus is on the description of physical processes and their modelisation with practical examples.

**Title**

- Land-Climate Interactions
- Hydrology II
- Analysis of Climate and Weather Data
- Boundary Layer Meteorology

**Number**

- 701-1251-00L
- 102-0237-00L
- 701-1253-00L
- 651-4053-05L

**Abstract**

- The purpose of this course is to provide fundamental background on the role of land surface processes (vegetation, soil moisture dynamics, land energy and water balances) for the climate system. The course consists of 2 contact hours per week, including 2 computer exercises.
- The course presents advanced hydrological analyses of rainfall-runoff processes. The course is given in English.
- Observation networks and numerical climate and forcasting models deliver large primary datasets. The use of this data in practice and in research requires specific techniques of statistical data analysis. This lecture introduces a range of frequently used techniques, and enables students to apply them and to properly interpret their results.
- The Planetary Boundary Layer (PBL) constitutes the interface between the atmosphere and the Earth's surface. Theory on transport processes in the PBL and their dynamics is provided. This course treats theoretical background and idealized concepts. These are contrasted to real world applications and current research issues.

**Objective**

- The students can understand the role of land processes and associated feedbacks for the climate system.
- Tools for hydrological modelling are discussed at the event and continuous scale. The focus is on the description of physical processes and their modelisation with practical examples.
- Observation networks and numerical climate and forcasting models deliver large primary datasets. The use of this data in practice and in research requires specific techniques of statistical data analysis. This lecture introduces a range of frequently used techniques, and enables students to apply them and to properly interpret their results.
- Overall goals of this course are given below. Focus is on the theoretical background and idealised concepts. Students have basic knowledge on atmospheric turbulence and theoretical as well as practical approaches to treat Planetary Boundary Layer flows. They are familiar with the relevant processes (turbulent transport, forcing) within, and typical states of the Planetary Boundary Layer. Idealized concepts are known as well as their adaptations under real surface conditions (as for example over complex topography).

**Lecture notes**

- Powerpoint slides will be made available.

**Literature**

- We will read and critically discuss scientific articles relevant for "biochemical and chemical processes in marine and lacustrine systems."

**Prerequisites / notice**

- The grading of students is based on in-class exercises and end-semester examination.

**ECTS / Hours / Lecturers**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-1251-00L</td>
<td>Land-Climate Interactions</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>S. I. Seneviratne, E. L. Davin</td>
</tr>
<tr>
<td>102-0237-00L</td>
<td>Hydrology II</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>P. Burlando, S. Fattich</td>
</tr>
<tr>
<td>701-1253-00L</td>
<td>Analysis of Climate and Weather Data</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>C. Frei</td>
</tr>
<tr>
<td>651-4053-05L</td>
<td>Boundary Layer Meteorology</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>M. Rotach, P. Calanca</td>
</tr>
</tbody>
</table>

**Prerequisites**

- Introductory lectures in atmospheric and climate science

**Suggested literature:**


**Additional literature is presented during the course.**
Content
- Introduction
- Turbulence
- Statistical treatment of turbulence, turbulent transport
- Conservation equations in a turbulent flow
- Closure problem and closure assumptions
- Scaling and similarity theory
- Spectral characteristics
- Concepts for non-ideal boundary layer conditions

Lecture notes
available (i.e. in English)

Literature

Prerequisites / notice
Umwelt-Fluidodynamik (701-0479-00L) (environment fluid dynamics) or equivalent and basic knowledge in atmospheric science

Electives
The students are free to choose individually from the entire course offer of ETH Zürich and the universities of Zürich and Bern.

Weather Systems and Atmospheric Dynamics
Courses are only offered in FS.

Climate Processes and Feedbacks
Two additional courses are offered in HS by University of Berne.

Number Title Type ECTS Hours Lecturers
651-4057-00L Climate History and Palaeoclimatology W 3 credits 2G G. Haug, A. Martinez-Garcia

Abstract
The course "Climate history and paleoclimatology gives an overview on climate through geological time and it provides insight into methods and tools used in paleoclimatic research.

Objective
The student will have an understanding of evolution of climate and its major forcing factors -orbital, atmospheric chemistry, tectonics-through geological time. He or she will understand interaction between life and climate and he or she will be familiar with the use of most common geochronological climate "proxies", he or she will be able to evaluate quality of marine and terrestrial sedimentary paleoclimatic archives. The student will be able to estimate rates of changes in climate history and to recognize feedbacks between the biosphere and climate.

Content
Climate system and earth history - climate forcing factors and feedback mechanisms of the geosphere, biosphere, and hydrosphere.
Geological time, stratigraphy, geological archives, climate archives, paleoclimate proxies
Climate through geological time: "lessons from the past"
Cretaceous greenhouse climate
The Late Paleocene Thermal Maximum (PETM)
Cenozoic Cooling
Onset and Intensification of Southern Hemisphere Glaciation
Onset and Intensification of Northern Hemisphere Glaciation
Pliocene warmth
Glacial and Interglacials
Millennial-scale climate variability during glaciations
The last glaciation(s)
The Younger Dryas
Holocene climate - climate and societies

701-1221-00L Dynamics of Large-Scale Atmospheric Flow

Abstract
Dynamic, synoptic Meteorology

Objective
Understanding the dynamics of large-scale atmospheric flow

Content
Dynamical Meteorology is concerned with the dynamical processes of the earth's atmosphere. The fundamental equations of motion in the atmosphere will be discussed along with the dynamics and interactions of synoptic system - i.e. the low and high pressure systems that determine our weather. The motion of such systems can be understood in terms of quasi-geostrophic theory. The lecture course provides a derivation of the mathematical basis along with some interpretations and applications of the concept.

Lecture notes
Dynamics of large-scale atmospheric flow

Literature
- Pichler H., Dynamik der Atmosphäre, Bibliographisches Institut, 456 pp. 1997

Physics I, II, Environmental Fluid Dynamics

Atmospheric Composition and Cycles

Number Title Type ECTS Hours Lecturers
701-1235-00L Cloud Microphysics

Abstract
Does not take place this semester.

Clouds are a fascinating climate phenomenon central to the hydrological cycle and the Earth’s radiation balance. Interactions between cloud particles can result in precipitation, glaciation or evaporation of the cloud depending on its microstructure and microphysical processes. In this course the sought-after topic of ice formation in clouds is studied from a theoretical and empirical perspective.
Objective
Students will gain an appreciation and understanding of the complex processes in clouds and the necessary physical phenomenon that are involved and need to be accounted for in order to study cloud and precipitation formation.

Content
Microstructure of clouds and precipitation, aerosol activation to form cloud droplets, ice crystal nucleation (homogeneous freezing of supercooled aerosol and heterogeneous freezing), precipitation formation

Lecture notes
Powerpoint slides will be made available

Literature

Prerequisites /
At least one introductory course in Atmospheric Science or Instructor's consent.

Abstract
The Planetary Boundary Layer (PBL) constitutes the interface between the atmosphere and the Earth's surface. Theory on transport processes in the PBL and their dynamics is provided. This course treats theoretical background and idealized concepts. These are contrasted to real world applications and current research issues.

Objective
Overall goals of this course are given below. Focus is on the theoretical background and idealised concepts.
Students have basic knowledge on atmospheric turbulence and theoretical as well as practical approaches to treat Planetary Boundary Layer flows. They are familiar with the relevant processes (turbulent transport, forcing) within, and typical states of the Planetary Boundary Layer. Idealized concepts are known as well as their adaptations under real surface conditions (as for example over complex topography).

Content
- Introduction
- Turbulence
- Statistical treatment of turbulence, turbulent transport
- Conservation equations in a turbulent flow
- Closure problem and closure assumptions
- Scaling and similarity theory
- Spectral characteristics
- Concepts for non-ideal boundary layer conditions

Lecture notes
available (i.e. in English)

Literature

Prerequisites /
Umwelt-Fluiddynamik (701-0479-00L) (environment fluid dynamics) or equivalent and basic knowledge in atmospheric science

Climate History and Paleoclimatology
Two courses are offered in autumn semester at University of Berne. ETH courses are only offered in FS.

Hydrology and Water Cycle

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-4023-00L</td>
<td>Groundwater</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>M. O. Saar, X.Z. Kong</td>
</tr>
</tbody>
</table>

Abstract
The course provides an introduction into quantitative analysis of groundwater flow and transport. It is focussed on formulating flow and transport problems in groundwater, which are to be solved analytically or numerically.

Objective
a) Students understand the basic concepts of flow and contaminant transport processes and boundary conditions in groundwater.

b) Students are able to formulate simple practical flow and transport problems.

c) Students are able to understand and apply simple analytical solutions to simple flow and transport problems.

d) Students are able to use simple numerical codes to adequately solve simple flow (and transport) problems.

Content
1. Flow equation. The generalized Darcy law.
2. The water balance equation.
4. Analytical solutions to flow problems I
5. Analytical solutions to flow problems II
7. Finite difference solution to flow problems.
8. Case studies for flow problems.
12. Analytical solutions to transport problems I.
13. Analytical solutions to transport problems II
### 102-0287-00L

**Fluvial Systems**

<table>
<thead>
<tr>
<th>Objective</th>
<th>Content</th>
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</thead>
<tbody>
<tr>
<td>The course presents an integrated view of the river basin and fluvial system. The fluvial system is viewed in terms of the dynamics in the transfer of water and sediment, the resulting geomorphology of the river network and streams, and finally the basin and river management options for conservation and restoration.</td>
<td>The goal of the course is to develop process-understanding of fluvial systems and to introduce the students to appropriate analysis tools. In the first section the estimation of basin sediment supply from upland sheet, rill and gully erosion, and basin sediment yield are discussed. The second section focuses on sediment transport in rivers in general, e.g. basic mechanics of sediment laden flows, bedforms, flow resistance, sediment type and load measurement and estimation, the morphology of rivers. It is illustrated how the river network can be analysed in terms of its connectivity and topological characteristics. Channel stability and channel erosion modelling are discussed. The third section looks at fluvial system management in terms of engineering and nonstructural sediment (e.g. upland and channel erosion protection) and water (e.g. the importance of the natural streamflow regime on rivers environment integrity, river rehabilitation) resource management.</td>
</tr>
</tbody>
</table>

**Lecture notes**

- There is no script.

**Study materials**

- Study materials (lecture handouts and selected papers) are distributed in class and available on the web.

**Prerequisites**

- Prerequisites: Hydrology 1 and Hydrology 2 (or contact instructor).

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### 701-0535-00L

**Environmental Soil Physics/Vadose Zone Hydrology**

<table>
<thead>
<tr>
<th>Objective</th>
<th>Content</th>
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</table>
| The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/ near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils. | Students are able to:
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media,
- quantify driving forces and resulting fluxes of water, solute, and heat in soils,
- apply modern measurement methods and analytical tools for hydrological data collection,
- conduct and interpret a limited number of experimental studies,
- explain links between physical processes in the vadose-zone and major societal and environmental challenges. |

**Lecture notes**

- Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

**Weekly topics**

- Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity

- Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing

**Weekly topics**

- Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:
  - Part 1: Laminar flow in tubes (Poiseuille's Law); Darcy’s Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement.
  - Lab #1: Measurement of saturated hydraulic conductivity in uniform and layered soil columns using the constant head method.
  - Part 2: Unsaturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.
  - Midterm exam
  - Lab #2: Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip's approximations; infiltration rates and wetting front propagation.
  - Part 3 - Use of Hydrus model for simulation of unsaturated flow

- Weeks 10 to 12: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface evaporation.

- Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

- Additional topics:
  - Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.
  - Biological Processes in the Vaodse Zone - An overview of below-ground biological activity (plant roots, microbial, etc.); interface between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.
The lecture provides an introduction to atmospheric chemistry at bachelor level. It introduces the kinetics of gas phase and heterogeneous reactions on aerosols and in clouds and explains the chemical and physical mechanisms responsible for global (e.g. stratospheric ozone depletion) as well as regional (e.g. urban air pollution) environmental problems.

The students will understand the basics of gas phase and heterogeneous reactions and will know the most relevant atmospheric chemical processes taking place in the gas phase as well as between different phases including aerosols and clouds. The students will also acquire a good understanding of atmospheric environmental problems including air pollution, stratospheric ozone destruction and changes in the oxidative capacity of the global atmosphere.

The students are able to:
- Explain the basic dynamics of the global circulation and of synoptic- and meso-scale flow phenomena, in particular the dynamics of extratropical cyclones, and the influence of mountains on the atmospheric flow.
- To explain the basic dynamics of the global circulation and of synoptic- and meso-scale flow features.
- To explain how mountains influence the atmospheric flow on different scales.
- Understand the mathematical basis of atmospheric dynamics, based on selected atmospheric flow phenomena.
- To discuss the mathematical basis of atmospheric dynamics, based on selected atmospheric flow phenomena.
- To evaluate the significance of clouds and aerosol particles for climate and artificial weather modification.
- To explain the impact of aerosols and clouds on climate and artificial weather modification.
- Explain the mechanisms of cloud and precipitation formation using knowledge of humidity processes and thermodynamics.
- To explain the mechanisms of cloud and precipitation formation using knowledge of humidity processes and thermodynamics.
- To explain the significance of clouds and aerosol particles for climate and artificial weather modification.
- To discuss the mathematical basis of atmospheric dynamics, based on selected atmospheric flow phenomena.
- To discuss the mathematical basis of atmospheric dynamics, based on selected atmospheric flow phenomena.
- To explain how mountains influence the atmospheric flow on different scales.
- To explain the impact of aerosols and clouds on climate and artificial weather modification.
- To explain the basic dynamics of the global circulation and of synoptic- and meso-scale flow features.
- To explain how mountains influence the atmospheric flow on different scales.
- To explain the impact of aerosols and clouds on climate and artificial weather modification.
- To explain the basic dynamics of the global circulation and of synoptic- and meso-scale flow features.
- To explain how mountains influence the atmospheric flow on different scales.

The students will also acquire a good understanding of atmospheric environmental problems including air pollution, stratospheric ozone destruction and changes in the oxidative capacity of the global atmosphere.

The students are able to:
- To explain the impact of aerosols and clouds on climate and artificial weather modification.
- To explain the basic dynamics of the global circulation and of synoptic- and meso-scale flow features.
- To explain how mountains influence the atmospheric flow on different scales.
- To explain the impact of aerosols and clouds on climate and artificial weather modification.
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- To explain how mountains influence the atmospheric flow on different scales.
### Additional Electives ETH

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4273-00L</td>
<td>Numerical Modelling in Fortran</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>P. Tackley</td>
</tr>
</tbody>
</table>

#### Objective
FORTRAN 95 is a modern programming language that is specifically designed for scientific and engineering applications. This course gives an introduction to programming in this language, and is suitable for students who have only minimal programming experience, for example with MATLAB scripts. The focus will be on Fortran 95, but Fortran 77 will also be covered for those working with already-existing codes. A hands-on approach will be emphasized rather than abstract concepts.

#### Literature
List of literature is provided.

#### Prequisites / notice
Die Vorlesung verlangt Vorkenntnisse in Linearer Algebra, Analysis und Physik (z.B. komplexe Zahlen, Beschreibung von ebenen Wellen, einfache gewöhnliche Differentialgleichungen)

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### Minors

#### Minor in Physical Glaciology

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<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>101-0289-00L</td>
<td>Applied Glaciology</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>M. Funk, A. Bauder</td>
</tr>
</tbody>
</table>

#### Objective
We will explain the fundamentals of physics of glaciers which are necessary for treating applied problems. We will go into climate-glacier interactions, flow of glaciers, lake ice and hydrology of glaciers.

#### Content
- Basics in physical glaciology
  - Dynamics of glaciers: deformation of glacier ice, role of water in glacier motion, reaction of glaciers to climate changes, glacier calving, surges, Ice falls, ice avalanches
  - Glacier floods
  - Lake ice and bearing capacity

#### Literature
Relevante Literatur wird während der Vorlesung angegeben.

#### Prequisites / notice
Für aktuelle Fallbeispiele werden risikobasierte Massnahmen bei glaziologischen Naturgefahren diskutiert.

#### Lecture notes
Handsonts are available

#### Number
651-4101-00L

#### Title
Physics of Glaciers

#### Abstract
Application of basic physical concepts to glaciers and ice caps. Understanding glaciers and ice sheets with simple physical concepts. Topics include the reaction of glaciers to the climate, ice rheology, temperature in glaciers and ice sheets, glacier hydrology, basal motion and calving glaciers. A special focus is the current development of Greenland and Antarctica.

#### Objective
The course outlines the physical principles governing the gravity-driven motion of glacier ice. This applies to understand the response of glaciers and ice sheets to changes in their environment. Polar ice caps, ice streams and mountain glaciers and their recent rapid changes are discussed.

#### Content
- The dynamics of glaciers and polar ice sheets is the key requisite to understand their history and their future evolution. We will take a closer look at ice deformation, basal motion, heat flow and glacier hydraulics. The specific dynamics of tide water and calving glaciers is investigated, as is the reaction of glaciers to changes in mass balance (and therefore climate).

#### Literature
http://people.ee.ethz.ch/~luethim/teaching.html

#### Lecture notes
http://people.ee.ethz.ch/~luethim/teaching.html

#### Number
651-4077-00L

#### Title
Quantification and Modeling of the Cryosphere: Dynamic Processes (University of Zurich)

#### Abstract
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: GEG815

#### Objective
Knowledge of the most prominent climate-related geomorphological processes and phenomena in high-mountain regions, understanding of primary research challenges.

#### Content
Erosion and sedimentation by glaciers as a function of topography, englacial temperature, sediment balance, sliding and melt water runoff. Processes and landforms in regions of seasonal and perennial frost (frost weathering, rock falls, debris cones/talus, solifluction, permafrost creep/rock glaciers, debris flows).

#### Lecture notes
Glacial and periglacial geomorphodynamics in high-mountain regions. Ca. 100 pages. references in script

#### Number
651-1581-00L

#### Title
Seminar in Glaciology

#### Abstract
Studium aktueller und klassischer Arbeiten der glaziologischen Forschung

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Data: 06.02.2019 13:00
Autumn Semester 2015
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Minor in Biogeochemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<tbody>
<tr>
<td>701-1313-00L</td>
<td>Isotopic and Organic Tracers in Biogeochemistry</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>R. Kipfer, C. Schubert</td>
</tr>
<tr>
<td></td>
<td>Abstract: The course introduces the scientific concepts and typical applications of tracers in biogeochemistry. The course covers stable and radioactive isotopes, geochemical tracers and biomarkers and their application in biogeochemical processes as well as regional and global cycles. The course provides essential theoretical background for the lab course &quot;Isotopic and Organic Tracers Laboratory&quot;.</td>
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<td>Objective: The course aims at understanding the fractionation of stable isotopes in biogeochemical processes. Students learn to know the origin and decay modes of relevant radiogenic isotopes. They discover the spectrum of possible geochemical tracers and biomarkers, their potential and limitations and get familiar with important applications</td>
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<td>Content: Geogenic and cosmogenic radionuclides (sources, decay chains); stable isotopes in biogeochemistry (natural abundance, fractionation); geochemical tracers for processes such as erosion, productivity, redox fronts; biomarkers for specific microbial processes.</td>
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<td>Lecture notes: Handouts will be provided for every chapter</td>
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<tr>
<td></td>
<td>Literature: A list of relevant books and papers will be provided</td>
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<td></td>
<td>Prerequisites / notice: Students should have a basic knowledge of biogeochemical processes (BSc course on Biogeochemical processes in aquatic systems or equivalent)</td>
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<tbody>
<tr>
<td>701-1315-00L</td>
<td>Biogeochemistry of Trace Elements</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>A. Voegelin, J. G. Wiederhold, L. Wittke</td>
</tr>
<tr>
<td></td>
<td>Abstract: The course addresses major biogeochemical processes that drive the cycling of different groups of trace elements (heavy metals, redox-sensitive trace elements, chalcophile elements) in the environment, and the chemical methods that are used to study the behavior of these elements in the geosphere.</td>
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<td>Objective: The students gain a detailed understanding of the sources and the cycling of trace elements in the terrestrial and aquatic environment. The interaction of environmentally important trace elements with abiotic and biotic geosphere components as well as their abiotically and biotically driven transformations will be discussed. Relevant methods/techniques to study these processes will be presented.</td>
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<td>Content: The course deals in-depth with the major biogeochemical processes controlling the cycling of different groups of trace elements (heavy metals, redox-sensitive and chalcophile elements) in the environment. Sources and cycling of trace elements as related to interactions with abiotic and biotic geosphere components, and abiotically and biotically driven transformations will be discussed. The techniques most commonly used to study these processes will be presented as well.</td>
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<td>Lecture notes: Selected handouts (lecture notes, literature, exercises) will be distributed during the course.</td>
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<td>Prerequisites / notice: Students are expected to be familiar with the concepts of aquatic or soil chemistry covered in the respective classes at the bachelor level.</td>
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<tbody>
<tr>
<td>701-1341-00L</td>
<td>Water Resources and Drinking Water</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>S. Hug, M. Berg, F. Hammes, U. von Gunten</td>
</tr>
<tr>
<td></td>
<td>Abstract: The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Natural processes, anthropogenic pollution, legislation of groundwater and surface water and of drinking water as well as water treatment will be discussed for industrialized and developing countries.</td>
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<td>Objective: The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality.</td>
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<td>Content: The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. The various water resources, particularly groundwater and surface water, are discussed as part of the natural water cycle influenced by anthropogenic activities such as agriculture, industry, urban water systems. Furthermore legislation related to water resources and drinking water will be discussed. The lecture is focused on industrialized countries, but also addresses global water issues and problems in the developing world. Finally unit processes for drinking water treatment (filtration, adsorption, oxidation, disinfection etc.) will be presented and discussed.</td>
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<td>Lecture notes: Handouts will be distributed</td>
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<td>Literature: Will be mentioned in handouts</td>
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<tbody>
<tr>
<td>701-1346-00L</td>
<td>Carbon Mitigation</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>N. Gruber</td>
</tr>
<tr>
<td></td>
<td>Abstract: The reduction of CO2 emissions is the only option for keeping future climate change within reasonable bounds. In this course, we will discuss a portfolio of options involving the alteration of natural carbon sinks and carbon sequestration. The course includes introductory lectures, presentations from guest speakers from industry and the public sector, and final presentations by the students.</td>
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<td>Objective: The goal of this course is to investigate, as a group, a particular set of carbon mitigation/sequestration options and to evaluate their potential, their cost, and their consequences.</td>
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<td>Content: From the large number of carbon sequestration/mitigation options, a few options will be selected and then investigated in detail by the students. The results of this research will then be presented to the other students, the involved faculty, and discussed in detail by the whole group.</td>
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<td>Lecture notes: None</td>
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<tr>
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<td>Literature: Will be identified based on the chosen topic.</td>
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<td>Prerequisites / notice: Exam: No final exam. Pass/No-Pass is assigned based on the quality of the presentation and ensuing discussion.</td>
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Minor in Global Change and Sustainability

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<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-0015-00L</td>
<td>Seminar on Transdisciplinary Research for</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>C. E. Pohl, M. Stauffacher</td>
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<td>Sustainable Development</td>
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<td>Abstract: The seminar is designed for students and researchers (MA, PhD, PostDoc) who use inter- and transdisciplinary elements in their projects. It addresses the challenges of this research: How to integrate disciplines? How (and in what role) to include societal actors? How to bring results to fruition? We discuss these questions based on case studies and theories and on the participant's projects.</td>
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<td>Objective: The participants understand the specific challenges of inter- and transdisciplinary research in general and in the context of sustainable development in particular. They know methods and concepts to address these challenges and apply them to their research projects.</td>
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</table>
The seminar covers the following topics:
(1) Theories and concepts of inter- and transdisciplinary research
(2) The specific challenges of inter- and transdisciplinary research
(3) Involving stakeholders
(4) Collaborating disciplines
(5) Exploration of tools and methods
(6) Analysing participants’ projects to improve inter- and transdisciplinary elements

Literature

The seminar is specifically suitable for PhD or PostDoc researchers. It is open to master students (minor "global change and sustainability") and further interested people, who preferably are preparing, or working on, a project/thesis.

701-1551-00L Sustainability Assessment

Abstract
The course deals with the concepts and methodologies for the analysis and assessment of sustainable development. A special focus is given to the social dimension and to social justice as a guiding principle of sustainability as well as to trade-offs between the three dimensions of sustainability.

Objective
At the end of the course students should

Know:
- core concepts of sustainable development, and;
- the concept of social justice - normatively and empirically - as a core element of social sustainability;
- important empirical methods for the analysis and assessment of local / regional sustainability issues.

Understand and reflect on:
- the challenges of trade-offs between the different goals of sustainable development;
- and the respective impacts on individual and societal decision-making.

Content
The course is structured as follows:
- Overview of rationale, objectives, concepts and origins of sustainable development;
- Importance and application of sustainability in science, politics, society, and economy;
- Sustainable (local / regional) development in different national / international contexts;
- Analysis and evaluation methods of sustainable development with a focus on social justice;
- Tradeoffs in selected examples.

Lecture notes
Handouts.

Literature
Selected scientific articles & book chapters

Minor in Sustainable Energy Use

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<tr>
<th>Number</th>
<th>Title</th>
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<tbody>
<tr>
<td>051-0551-00L</td>
<td>Energy- and Climate Systems I</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>A. Schlüter</td>
</tr>
<tr>
<td>Abstract</td>
<td>The lecture contains concepts, physics and components of building technologies for the efficient and sustainable energy supply and climatisation of buildings and their interaction with architecture and urban design. Using calculations, students learn to acquire relevant numbers and assess the performance of solutions.</td>
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<tr>
<td>Objective</td>
<td>The lecture's target is the knowledge of the physical basics and technical components of relevant systems for an efficient and sustainable climatisation and maintenance of buildings and their interdependency with the architeconic design and construction. By learning rough calculation methods, determination of relevant dimensions and identification of important parameters become possible. Hence, adequate approaches for the own design can be chosen, reviewed quantitatively and qualitatively and set in with a synergistic effect.</td>
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<tr>
<td>Content</td>
<td>1. Introduction</td>
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<tr>
<td></td>
<td>2. Thermal systems</td>
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<td></td>
<td>3. Ventilation</td>
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<td></td>
<td>4. Daylight and artificial lighting</td>
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<tr>
<td>Lecture notes</td>
<td>The Slides from the lecture serve as lecture notes and are available as download.</td>
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<tr>
<td>Literature</td>
<td>A bibliography will be distributed at the beginning of the lecture.</td>
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227-0731-00L Power Market I - Portfolio and Risk Management

Abstract
Portfolio and risk management in the electrical power business, Pan-European power market and trading, futures and forward contracts, hedging, options and derivatives, performance indicators for the risk management, modelling of physical assets, cross-border trading, ancillary services, balancing power market, Swiss market model, strategy development and positioning.

Objective
Content

1. Pan-European power market and trading
   1.1. Power trading
   1.2. Development of the European power markets
   1.3. Energy economics
   1.4. Spot and OTC trading
   1.5. European energy exchange EEX

2. Market model
   2.1. Market place and organisation
   2.2. Balance groups / balancing energy
   2.3. Ancillary services
   2.4. Market for ancillary services
   2.5. Cross-border trading
   2.6. Capacity auctions

3. Portfolio and Risk management
   3.1. Portfolio management 1 (introduction)
   3.2. Forward and futures contracts
   3.3. Risk management 1 (m2m, VaR, hpfc, volatility, cVaR)
   3.4. Risk management 2 (PaR)
   3.5. Contract valuation (HPFC)
   3.6. Portfolio management 2
   2.8. Risk Management 3 (enterprise wide)

4. Energy & Finance I
   4.1. Options 1 basics
   4.2. Options 2 hedging with options
   4.3. Introduction to derivatives (swaps, cap, floor, collar)
   4.4. Financial modelling of physical assets
   4.5. Trading and hydro power
   4.6. Incentive regulation

5. Strategy
   5.1. Strategic Positioning
   5.2. Development of strategies and examples
   5.3. Cases for team work

Lecture notes
Handouts of the lecture
1 excursion per semester, 2 case studies, guest speakers for specific topics

529-0193-00L Renewable Energy Technologies I

The lectures Renewable Energy Technologies I (529-0193-00L) and Renewable Energy Technologies II (529-0191-01L) can be taken independently from one another.

Abstract
Scenarios for world energy demand and CO2 emissions, implications for climate. Methods for the assessment of energy chains. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaic electricity, solar chemistry). Wind and ocean energy, heat pumps, geothermal energy, energy from waste. CO2 sequestration.

Objective
Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals.

Content

Lecture notes
Lecture notes will be distributed during the course.

Literature

Prerequisites / notice
Fundamentals of chemistry and physics are a prerequisite for this course.

Topics are available to carry out a Project Work (Semesterarbeit) on the contents of this course.

► Seminars and Colloquia

<table>
<thead>
<tr>
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<tr>
<td>651-4095-01L</td>
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<td>O</td>
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<td>1K</td>
<td>U. Lohmann, E. M. Fischer, N. Gruber, R. Knutti, T. Peter, C. Schär, S.I. Seneviratne, H. Wernli, M. Wild</td>
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<td>1 credit</td>
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<td>U. Lohmann, E. M. Fischer, N. Gruber, R. Knutti, T. Peter, C. Schär, S.I. Seneviratne, H. Wernli, M. Wild</td>
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The students are exposed to different atmospheric science topics and learn how to take part in scientific discussions.

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<td>O</td>
<td>3</td>
<td>2S</td>
<td>E. M. Fischer, T. Ewen, O. Stebler, M. A. Wüest</td>
</tr>
<tr>
<td>701-1211-02L</td>
<td>Master's Seminar: Atmosphere and Climate 2</td>
<td>O</td>
<td>3</td>
<td>2S</td>
<td>E. M. Fischer, T. Ewen, O. Stebler, M. A. Wüest</td>
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<tr>
<td>701-1213-00L</td>
<td>Introduction Course to Master Studies Atmosphere and Climate</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>E. M. Fischer, T. Peter</td>
</tr>
</tbody>
</table>

Abstract

In this seminar scientific project management is introduced and applied to your master project. The course concludes with a presentation of your project including an overview of the science and a discussion of project management techniques applied to your thesis project.

Objective

Training scientific project management skills.

Content

In this seminar, the process of writing a scientific proposal will be introduced. The essential elements of a proposal, including the peer review process, will be outlined and class exercises will train scientific writing skills. Knowledge exchange between class participants is promoted through the preparation of a master thesis proposal and evaluation of each other’s work.

Prerequisites / notice

Attendance is mandatory.

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 103 of 1434
### 701-0471-AAL Atmospheric Chemistry
- **Enrolment only for MSc students who need this course as additional admission requirement.**

**Abstract**
This is a self-study course targeted at Master students who did not follow the bachelor course "atmospheric chemistry" or similar. The course provides a general introduction into atmospheric chemistry.

**Objective**
The learning target of this lecture is a general overview on the most important processes of atmospheric chemistry and the various problems of the anthropogenic change in the structure of Earth's atmosphere.

**Content**
- Origin and properties of the atmosphere: structure, large scale dynamics, UV radiation
- Thermodynamics and kinetics of gas phase reactions: enthalpy and free energy of reactions, rate laws, mechanisms of biomolecular and termolecular reactions.
- Tropospheric photochemistry: Photolysis reactions, photochemical O3 formation, role and budget of HOx, dry and wet deposition
- Aerosols and clouds: properties, aerosol properties, aerosol properties, aerosol properties
- - Multiphase chemistry: heterogeneous kinetics, solubility and hygroscopicity, N2O5 chemistry, SO2 oxidation, secondary organic aerosols
- - Temperature: role of planetary boundary layer, summer versus winter-smog, environmental problems, legislation, long-term trends
- Stratospheric chemistry: Chapman cycle, Brewer-Dobson circulation, catalytic ozone destruction cycles, polar ozone hole, Montreal protocol
- Global aspects: global budgets of ozone, methane, CO and NOx, air quality - climate interactions

**Prerequisites / notice**
Basic courses in chemistry and physics are expected.

### 701-0475-AAL Atmospheric Physics
- **Enrolment only for MSc students who need this course as additional admission requirement.**

**Abstract**
The fundamental background of cloud and precipitation formation (including thermodynamics and aerosol physics) and their relevance for climate are discussed.

**Objective**
The students can appreciate the processes leading to cloud and precipitation formation and their importance for climate. This lecture is the prerequisite for the MSc lectures cloud microphysics and cloud dynamics.

**Content**
- Moist processes/thermodynamics: aerosol physics; cloud formation; precipitation processes, storms; importance of aerosols and clouds for climate; measurements of clouds (radar and satellites)

**Lecture notes**
Powerpoint slides and script will be made available

**Literature**
Rogers and Yau, A Short Course in Cloud Physics, Pergamon Press, 1989; Wallace and Hobbs, Atmospheric Science: An Introductory Survey, Elsevier, 2006

### 701-0473-AAL Weather Systems
- **Enrolment only for MSc students who need this course as additional admission requirement.**

**Abstract**
Satellite observations; analysis of vertical soundings; geostrophic and thermal wind; cyclones at mid-latitude; global circulation; north-atlantic oscillation; atmospheric blocking situtations; Eulerian and Lagrangian perspective; potential vorticity; Alpine dynamics (storms, orographic wind); planetary boundary layer

**Objective**
Introduction to basic aspects of atmospheric dynamics. Focus is given to the global-scale atmospheric circulation, synoptic-scale processes (in particular low-pressure systems), and the influence of mountains on the atmospheric flow.

**Content**
- Satellite observations; analysis of vertical soundings; geostrophic and thermal wind; cyclones at mid-latitude; global circulation; north-atlantic oscillation; atmospheric blocking situtations; Eulerian and Lagrangian perspective; potential vorticity; Alpine dynamics (storms, orographic wind); planetary boundary layer

**Lecture notes**
Lecture notes and slides

**Literature**
Atmospheric Science, An Introductory Survey
John M. Wallace and Peter V. Hobbs, Academic Press

### 701-0461-AAL Numerical Methods in Environmental Sciences
- **Enrolment only for MSc students who need this course as additional admission requirement.**

**Abstract**
This lecture treats the mathematical and computational basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

**Objective**
This lecture treats the mathematical and computational basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

**Content**
Classification of numerical problems, introduction to finite-difference methods, time integration schemes, non-linearity, conservative numerical techniques, an overview of spectral and finite-element methods. Examples and exercises from a diverse cross-section of Environmental Science.

Three tutorials, each two hours in length, are integrated into the lecture. The implementation language is Matlab (previous experience not necessary, a Matlab introduction is provided). Example programs and graphics tools are supplied.

**Lecture notes**
Provided on the webpage of the course: Lecture notes in German, tutorials in English.

**Literature**
List of literature is provided.

### 701-1901-AAL Systems Analysis
- **Enrolment only for MSc students who need this course as additional admission requirement.**

**Abstract**
Self study course in Systems Analysis to fulfill requirements for enrollment into the master program. Topics covered include linear box models with one and several variables; non-linear box models with one or several variables; discrete-time models; and continuous models in space and time.

**Objective**
The aim of this course is to develop an understanding of the dynamical behavior of environmental systems and how this behavior can be captured and understood using mathematical concepts.

**Lecture notes**
For English Speaking students:


### 701-0106-AAL Mathematics V: Applied Deepening of Mathematics I - III
- **Enrolment only for MSc students who need this course as additional admission requirement.**

**Abstract**
This lecture treats the mathematical and computational basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

**Objective**
Classification of numerical problems, introduction to finite-difference methods, time integration schemes, non-linearity, conservative numerical techniques, an overview of spectral and finite-element methods. Examples and exercises from a diverse cross-section of Environmental Science.

Three tutorials, each two hours in length, are integrated into the lecture. The implementation language is Matlab (previous experience not necessary, a Matlab introduction is provided). Example programs and graphics tools are supplied.

**Lecture notes**
Provided on the webpage of the course: Lecture notes in German, tutorials in English.

**Literature**
List of literature is provided.
Abstract
Selected mathematical topics are presented for later use in more specialised lectures. Part of the topics were already discussed in the lectures Mathematics I-III. Here, they should be shortly recapitulated and most importantly applied to practical problems. If necessary, new mathematical concepts and methods will be introduced in order to solve challenging and inspiring problems from practice.

Objective
The aim of this lecture is to prepare the students for the more specialised lectures. They should become more familiar with the mathematical background, the mathematical concepts and most of all with their application and interpretation.

Content
Practical examples from the following areas will be discussed: ordinary differential equations; eigenvalue problems from linear algebra; systems of linear and nonlinear differential equations; partial differential equations (diffusion, transport, waves).

Atmospheric and Climate Science Master - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Type</th>
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<tbody>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<td>G</td>
<td>lecture with exercise</td>
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<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
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<td>R</td>
<td>revision course / private study</td>
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</table>

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Educational Science for Teaching Diploma and TC

These are the general course offerings of the programmes Teaching Diploma (TD) - categories Educational Science and Compulsory Elective Courses - and Teaching Certificate (TC) - category Educational Science.

Educational Science Teaching Certificate

<table>
<thead>
<tr>
<th>Number</th>
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<td>851-0240-00L</td>
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<td>E. Stern</td>
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<td></td>
<td>This lecture is only apt for students who intend to enrol in the programs “Teaching Diploma” or “Teaching Certificate”. It is about learning in childhood and adolescence.</td>
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<td>Abstract</td>
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<td>This course looks into scientific theories and also empirical studies on human learning and relates them to the school.</td>
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<td>Anyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.</td>
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<td>Themenliche Schwerpunkte:</td>
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<td></td>
<td>Lernen als Verhaltensänderung und als Informationsverarbeitung; Das menschliche Gedächtnis unter besonderer Berücksichtigung der Vermittlung symbolischer Information; Lernen als Wissenskonstruktion und Kompetenzerwerb unter besonderer Berücksichtigung des Wissenstransfers; Lernen durch Instruktion und Erklärungen; Die Rolle von Emotion und Motivation beim Lernen; Interindividuelle Unterschiede in der Lernfähigkeit und ihre Ursachen; Intelligenztheorien, Geschlechtsunterschiede beim Lernen</td>
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<td>Prerequisites / notice</td>
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851-0240-22L Coping with Psychosocial Demands of Teaching (EW 4 W 3G)

Number of participants limited to 20.

Abstract

In this class, students will learn concepts and skills for coping with psychosocial demands of teaching

Objective

Students possess theoretical knowledge and practical competences to be able to cope with the psychosocial demands of teaching.

- They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents).
- They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions).

851-0240-16L Current Research on MINT Learning

W 1 credit 1K E. Stern, P. Greutmann, E. Hafen, J. Hromkovic, N. Hungerbühler, A. Togni, A. Vaterlaus

Abstract

This colloquium focusses on the presentation of research projects conducted by the professors participating in the competence center EducETH which concern learning in the STEM subjects. STEM stands for science, technology, engineering, and mathematics. Doctoral students and postdoctoral researchers will present their current projects and theoretical and methodological aspects will be discussed

Objective

Participants are exemplarily introduced to different research methods used in research on learning and instruction and learn to weigh advantages and disadvantages of these approaches.

851-0242-06L Cognitively Activating Instructions in MINT Subjects

W 2 credits 2S R. Schumacher

Number of participants limited to 30.

Abstract

This course unit can only be enrolled after successful participation in, or during enrollment in the course “Human Learning (EW 1)”. This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.

Objective

- Get to know cognitively activating instructions in MINT subjects
- Get information about recent literature on learning and instruction

Prerequisites / notice

Für eine reibungsfreie Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

851-0242-07L Human Intelligence

W 1 credit 1S E. Stern, P. Edelsbrunner, B. Rütsche

Number of participants limited to 30.

This course unit can only be enrolled after successful participation in, or during enrollment in the course “Human Learning (EW 1)”.

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 106 of 1434
The focus will be on the book "Intelligenz: Grosse Unterschiede und ihre Folgen" by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.

### Objective
- Understanding of research methods used in the empirical human sciences
- Getting to know intelligence tests
- Understanding findings relevant for education

#### Research Methods in Educational Science

**Number of participants limited to 30.**

This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)"

**Objective**
- Understand research methods used in the empirical educational sciences
- Understand and critically examine information from scientific journals and media
- Understand pedagogically relevant findings from the empirical educational sciences

#### Introduction to Test Theory and Test Construction in Educational Contexts (University of Zürich)

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: 200u809x

Enrolment only possible with Teaching Diploma or DC matriculation.

**Objective**
- Describe the scientific fundamentals of test theory and test structure.
- Evaluate examples of scientifically-developed tests in their application context.
- If necessary, critically question the performance assessment that they employ in practice and professionalize it still further.

**Content**
- Testentwicklung
- Gütekriterien von Tests
- Aufgabenkonstruktion
- Datenauswertung
- Rasch-Modell
- Internationale Vergleichstests
- Zulassungstests

**Literature**
Als Grundlagenliteratur werden folgende Werke empfohlen:
- Weitere Literatur wird in der Lehrveranstaltung genannt.

**Prerequisites / notice**
Die Leistungsanforderungen richten sich im Umfang nach der Zahl zu erwerbender ECTS-Punkte, wobei 1 ECTS-Punkt einem Zeitaufwand von ca. 30 Arbeitsstunden entspricht. ETHZ-Studierende können im Rahmen dieser Veranstaltung 3 ECTS-Punkte erwerben. Dazu sind folgende Leistungen zu erbringen:
- Präsenz und aktive mündliche Mitarbeit in der Lehrveranstaltung (MA)
- Pflichtlektüre entsprechend der Angaben in der Lehrveranstaltung
- Referat (RE)
- Schreiben einer schriftlichen Arbeit

Weitere Angaben zu den Leistungsanforderungen werden im Rahmen der Startveranstaltung abgegeben und erläutert.

### Educational Science Teaching Diploma

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This lecture is only apt for students who intend to enrol in the programs "Teaching Diploma" or "Teaching Certificate". It is about learning in childhood and adolescence.

**Objective**
Anyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.
**Coping with Psychosocial Demands of Teaching (EW4)**

**Enrollment:** Possible with Teaching Diploma matriculation, except for students of Sport Teaching Diploma, who complete the sport-specific course unit EW4.

**Objective:** Students possess theoretical knowledge and practical competences to be able to cope with the psychosocial demands of teaching.

1. They know the basic rules of negotiation and conflict management (e.g., in conversations with parents).
2. They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions; crisis intervention).
3. They know stress coping strategies to prevent burnout (e.g., psychosocial support) and are familiar with relevant institutions.

**Major Themes:**
- Counseling and counseling techniques
- Conflict management and mediation
- Classroom management
- Supporting students in a psychological crisis
- Preventing stress and burnout

**Forms of Learning:**
Theoretical foundations will be taught in workshops which contain different means of activation and interaction such as group work, panel discussions, and individual work. Subsequently, this knowledge will be transferred and applied in different school-relevant situations by means of role plays, discussing of cases and video sequences, as well as reflections of practical experiences.

**Support and Diagnosis of Knowledge Acquisition Processes (EW3)**

**Enrollment:** Only possible with matriculation in Teaching Diploma, except for students of Sport Teaching Diploma, who complete the sport-specific course unit EW3.

**Objective:**
1. You have a deep understanding about the cognitive mechanisms of knowledge acquisition.
2. You have a basic understanding about psychological test theory and can appropriately administer tests.
3. You know various techniques of formative assessment and can apply these to uncover students' misconceptions.

**Prerequisites:**
- Successful participation in 851-0240-00L "Human Learning (EW1)"

**Designing Educational Environments in Physical Education (EW2 Sport)**

**Compulsory Course Requirements for EW2 Sport:** This course is required to be taken prior to EW4 Sport.

**Objective:**
- Students learn principles of teaching beyond classroom and regular PE-Lessons:
  - Planning and organizing camps and events
  - Teaching the "Ergänzungsfach Sport"
  - Long-term-curricula in PE
- As a practical part students design the Outdoor event in EW4 of the following term

**Prerequisites:**
- EW2 is a compulsory requirement for EW4 Sport.

**Effective Learning Environments (EW 5)**

**Objective:**
This is a mandatory course for students of the teacher's diploma for secondary schools, who have not completed
the course 851-0238-01L "Unterstützung und Diagnose von Wissenserwerbsprozessen" (EW 3) until the end of spring semester 2014 (except for students of Sport Teaching Diploma, who have completed the sport-specific course units EW2-4).

The successful completion of ALL modules relevant for the teacher's diploma is required for participation in this course.

**Abstract**

The students have to read the book "Lernwirksam unterrichten" from Felten/Stern and they have to answer the questions addressed on http://www.ifvll.ethz.ch/education/ew5. In individual or small-group sessions, Elisbeth Stern and the students will discuss how insights from learning research can inform classroom practice.

**Objective**

The focus of all classes on educational psychology is on scientific insights which help to reflect on instructional learning. In order to become professionals, teachers have to better understand students' behavior and achievement and thereby become aware of their scope of classroom practice. Students get a final opportunity to ask questions about psychological learning research.

**Literature**

Buch "Lernwirksam unterrichten" (Felten/Stern)

**Prerequisites / notice**

Detailed information: http://www.ifvll.ethz.ch/education/ew5

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0242-07L</td>
<td>Human Intelligence</td>
<td>1</td>
<td>S</td>
<td>E. Stern, P. Edelsbrunner, B. Rütsche</td>
</tr>
<tr>
<td>851-0242-06L</td>
<td>Cognitively Activating Instructions in MINT Subjects</td>
<td>2</td>
<td>S</td>
<td>R. Schumacher</td>
</tr>
<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science</td>
<td>1</td>
<td>S</td>
<td>P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler</td>
</tr>
</tbody>
</table>
Abstract

Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and two further meetings will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.

Objective

- Understand research methods used in the empirical educational sciences
- Understand and critically examine information from scientific journals and media
- Understand pedagogically relevant findings from the empirical educational sciences

851-0250-05L Introduction to "Nature of Science" and "Scientific Inquiry" W 1 credit 1S J. Egli

Enrolment only possible with matriculation in Teaching Diploma (excluding Teaching Diploma Sport).

Number of participants limited to 20.

Abstract

This seminar will begin with a review of the literature on the teaching and learning of nature of science and scientific inquiry. It focuses on the development of adequate and functional understandings of nature of science and scientific inquiry.

Objective

Student teachers will develop an understanding of the concepts of nature of science and scientific inquiry. They will design a variety of instructional materials for teaching students about these concepts.

Compulsory Elective Courses Teaching Diploma

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0240-15L</td>
<td>Current Research on MINT Learning</td>
<td>W</td>
<td>1</td>
<td>1K</td>
<td>E. Stern, P. Greutmann, E. Hafen, J. Hromkovic, N. Hungerbühler, A. Togni, A. Vaterlaus</td>
</tr>
<tr>
<td>851-0250-05L</td>
<td>Introduction to &quot;Nature of Science&quot; and &quot;Scientific Inquiry&quot;</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>J. Egli</td>
</tr>
<tr>
<td>851-0594-00L</td>
<td>International Environmental Politics</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>T. Bernauer</td>
</tr>
</tbody>
</table>

Objective

- Understand pedagogically relevant findings from the empirical educational sciences
- Understand and critically examine information from scientific journals and media
- Understand research methods used in the empirical educational sciences

Number of participants limited to 20.

Abstract

This course focuses on the conditions under which cooperation in international environmental politics emerges and the conditions under which such cooperation and the respective public policies are effective and/or efficient.

Objective

The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a social sciences viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems.

Content

Examples of international environmental politics are discussed: the management of international water resources, the protection of the stratospheric ozone layer, the nuclear power plants in Eastern Europe, political responses to global warming, the protection of the stratospheric ozone layer, and the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

The course is open to all ETH students. Participation does not require previous coursework in the social sciences.

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 4 ECTS credit points. The workload is around 120 hours (meetings, reading assignments, preparation of test).

Lecture notes

Slides and reading material will be made available at www.ib.ethz.ch (teaching, materials, then menu on the left side of the screen). They are password protected. Use your ETHz username and password to access the material.

Prerequisites / notice

Students from ETH will receive 4 ECTS credit points if they attend classes regularly and obtain a grade of 4.0 or higher for the written exam in the final week of the semester. Students who obtain a grade of less than 4.0 for the end-of-semester test will have a second chance in the first week of the following semester. The rules of the game are defined in detail on the course syllabus. Students who do not participate in the end of semester test will not have access to the repeat exam unless they submit compelling and documented reasons for why they were unable to participate in the first test. Except for language dictionaries, no additional materials and no laptops and mobile phones are allowed during the exam.

The workload for this course is approx. 120 hours (all inclusive).
Simultaneous enrolment in course "Lehr- und Lernort Berufsfachschule II: Förderung und Unterstützung von Berufslernenden" (UZH Module Code: 098GyZ03) is compulsory.

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
"The Vocational Schools as Sites of Teaching and Learning - Teaching Structure" sets out and discusses how to implement the specifications in the framework curriculum. This module is aimed at teachers in high schools awarding vocational school-leaving certificates (Berufsmatura) and all types of vocational schools. It also covers the link established with the company as a learning location.

Objective
- Formulating learning objectives at different levels, and implementing and monitoring these.
- Steering tuition in terms of content and method to fit in with the objectives.
- Formulating examination questions and assignments on the basis of the learning objectives set out in the curriculum and the teaching given.
- Selectively deploying different examination types and procedures/structuring selected learning contents logically in terms of the subject matter and learning process (from the concrete to the abstract, from the simple to the complex) and implementing these with different didactic visual aids.

Content
In der Veranstaltung werden die Rahmen- und Schullehrpläne der Berufsmaturität (alle Richtungen) analysiert und deren Fachinhalt in Übungen und Hospitationen didaktisch umgesetzt. Der Unterricht an der Berufsmaturität wird im Hinblick auf die Herausforderung "Viel Stoff- wenig Zeit" erarbeitet.

Lecture notes
Von den Dozierenden.

Literature
Unterrichten an Berufsfachschulen: Berufsmaturität, hep Verlag Bern


G. Steiner (2007): Der Kick zum effizienten Lernen. hep Verlag

Rahmen- und Schullehrpläne der Berufsmaturität

Prerequisites / notice
Die Lehrveranstaltung ist seit September 2008 vom Bundesamt für Berufsbildung und Technologie akkreditiert.

<table>
<thead>
<tr>
<th>851-0237-02L</th>
<th>Vocational Schools as Sites of Teaching and Learning W II: Providing Encouragement &amp; Support (UZH)</th>
<th>3 credits</th>
<th>2S</th>
<th>University lecturers</th>
</tr>
</thead>
</table>

No enrolment to this course at ETH Zürich. Book the corresponding module directly at UZH.

UZH Module Code: 098GyZ03

Enrolment only possible with Teaching Diploma matriculation.

Simultaneous enrolment in course "Lehr- und Lernort Berufsfachschule I: Unterrichtsgestaltung" (UZH Module Code: 098GyZ01) is compulsory.

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
The module "vocational schools as sites of teaching and learning: providing encouragement and support for apprentices" aims to provide teachers at VET and professional baccalaureate institutions with ways of dealing with learners problems, particularly in connection with their being fed up with school, with job-seeking, school-to-work transition, or continuing education.

Objective
- Die spezielle Situation der Berufslernenden in ihrer Doppelbelastung Beruf und Schule wahrnehmen und pädagogisch berücksichtigen können.
- Die Übertrittsthematik in Bezug auf die Leistungsmotivation kennen Mit Konflikten, Störungen und allgemein schwerigen Situationen im BM-Unterricht lösungsorientiert umgehen können.
- Die Formen des betrieblichen Lernens kennen und diese für den Unterricht nutzbar machen.
- Krisenentwicklungen diagnostizieren und fördernde Massnahmen ergreifen.
- Wesentliche Aspekte eines förder- und unterstützungsortsorientierten Unterrichtsmanagements kennen.
- Rollensicherheit als Lehrperson finden und deren Grenzen definieren.
- Einblicke in die konkrete Ausbildungssituation der Berufslernenden gewinnen.

Content
- Positionierung des Berufsfachschulunterrichts innerhalb des dualen (triaLEN) Systems.
- Berufsmaturität: Entwicklung von Kernkompetenzen für die Wirtschaft?
- "Verakademisierung" der Berufsbildung?
- "Lernenden-Porträt: Die Umwelten des Berufslernenden - Entwicklungschancen und Problembereiche im Zusammenhang mit der Ausbildungssituation.
- Sozialisations- und Lernprozesse im beruflichen Umfeld / Führungsverständnis im Umgang mit Jugendlichen an Berufsfachschulen.
- Konfliktmanagement I: Wahrnehmungsinstrumente und Interventionsstrategien, Konfliktvermeidung und niederschwelliges Konfliktmanagement.
- Konfliktmanagement II: Der ressourcenorientierte Ansatz im Umgang mit Störungen.
- Das lösungsorientierte Konfliktgespräch in schulischen Kontext / Beratung und Coaching: Beratungssituationen im Kontext des Unterrichtsalltags.
- Rollenverständnis und Rollengrenzen.
- Berufslernendengerechtes Unterrichtsmanagement.
- Mobbing in der Schule.
- Konzepte und Praxis der betrieblichen Betreuung und Förderung.
- Jugendkriminalität und Jugendgewalt.
- Jugendkrise und Krisenintervention.

Lecture notes
Handouts vom Dozenten und Sammlung von Arbeitsmaterialien auf dem BSCW-Server.


Prerequisites / notice
Die Lehrveranstaltung ist seit September 2008 vom Bundesamt für Berufsbildung und Technologie akkreditiert.
At the end of the seminar, participants will be in a position to understand various strands in philosophy of science in a critical way, focusing on the notion of rationality in science, especially in relation to the natural sciences, social sciences, and humanities.

The lecture explores the following main topics: Social perception and interpersonal judgement; attitudes; group dynamics and group influence processes; leadership behavior and leadership styles.

The participants should develop competencies in the structuring of communication, interaction, and management processes. They should be able to:

- describe the scientific fundamentals of test theory and test structure,
- evaluate examples of scientifically-developed tests in application context,
- if necessary, critically question the performance assessment that they employ in practice and professionalise it further.

Weitere Angaben zu den Leistungsanforderungen werden im Rahmen der Startveranstaltung abgegeben, dazugerechnet auch die Handouts der Veranstalter. Dazu gehören Lehreinheiten, Prüfungsleistungen und Seminararbeiten. Im Rahmen der Startveranstaltung wird eine Liste mit möglichen Themen abgegeben und erläutert. Schwerpunkte der Themenübersicht sind:

- Testentwicklung
- Gütekriterien von Tests
- Aufgabenkonstruktion
- Datenauswertung
- Rasch-Modell
- Internationale Vergleichstests
- Zulassungsprozeduren

Lecture notes

Im Verlaufe des Semesters werden einzelne Unterlagen in den Veranstaltungen abgegeben. Dazu gehören die Handouts der Veranstalter, ausführliche Präsentationen (Slides), Leitideen für Autoritäten, und andere Materialien.

Literature

Als Grundlagenliteratur werden folgende Werke empfohlen:

- Weitere Literatur wird im Vorveranstaltung genannt.

The participants should develop competencies in the structuring of communication, interaction, and management processes.

Andere Angaben zu den Leistungsanforderungen werden im Rahmen der Startveranstaltung abgegeben, dazugerechnet auch die Handouts der Veranstalter. Dazu gehören Lehreinheiten, Prüfungsleistungen und Seminararbeiten. Im Rahmen der Startveranstaltung wird eine Liste mit möglichen Themen abgegeben und erläutert. Schwerpunkte der Themenübersicht sind:

- Testentwicklung
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- Aufgabenkonstruktion
- Datenauswertung
- Rasch-Modell
- Internationale Vergleichstests
- Zulassungsprozeduren

Lecture notes

Im Verlaufe des Semesters werden einzelne Unterlagen in den Veranstaltungen abgegeben. Dazu gehören die Handouts der Veranstalter, ausführliche Präsentationen (Slides), Leitideen für Autoritäten, und andere Materialien.

Literature

Als Grundlagenliteratur werden folgende Werke empfohlen:

- Weitere Literatur wird im Vorveranstaltung genannt.

Themenübersicht für Vorträge und Seminararbeiten. Im Rahmen der Startveranstaltung wird eine Liste mit möglichen Themen abgegeben und erläutert. Schwerpunkte der Themenübersicht sind:

- Testentwicklung
- Gütekriterien von Tests
- Aufgabenkonstruktion
- Datenauswertung
- Rasch-Modell
- Internationale Vergleichstests
- Zulassungsprozeduren

Lecture notes

Die Leistungsanforderungen richten sich im Umfang nach der Zahl zu erwerbender ECTS-Punkte, wobei 1 ECTS-Punkt einem Zeitaufwand von ca. 30 Arbeitsstunden entspricht. ETHZ-Studierende können im Rahmen dieser Veranstaltung 3 ECTS-Punkte erwerben.

Dazu sind folgende Leistungen zu erbringen:

- Präsenz und aktive mündliche Mitarbeit in der Lehrveranstaltung (MA)
- Pflichtlektüre entsprechend der Angaben in der Lehrveranstaltung
- Referat (RE)
- Schreiben einer schriftlichen Arbeit


The lecture covers the following main topics: Social perception and interpersonal judgement; attitudes; group dynamics and group performance; leadership behavior and leadership styles.

The aim of the lecture is to impart a well-founded scientific understanding of social influence processes in individuals, groups, organizations, and social settings.

The participants should develop competencies in the structuring of communication, interaction, and management processes.

Im Einzelnen sollen die Teilnehmerinnen und Teilnehmer lernen:

- an den Beispielen von Kaufverhalten oder ökologischem Verhalten zu beschreiben, wie Normen und Einstellungen Einfluss auf das Verhalten nehmen,
- die Subjektivität und die Fehlerquellen sozialer Wahrnehmung verstehen,
- Prinzipiern der Psychologie der Kommunikation zu nutzen für eine Verbesserung der Kommunikation in Studium und Beruf,
- Merkmale und Strukturen von Gruppen zu identifizieren und mit geeigneten Methoden zu analysieren,
- die Grundlagen von Konformität und Gehorsam gegenüber Autoritäten zu erkennen,
- gruppenphänomenologische, sozialen Faulenzeiten, Risiko- und Konservativisms-Schub und Gruppenentscheidungen entgegenzuwirken,
- die Grundlagen und -entscheidungen zu optimieren,
- Führungskriterien zu unterschieden lernen,
- Techniken zur Moderation von interagierenden Gruppen kennen zu lernen.

Literature


Es werden für D-ITET-Studierende Gruppenarbeiten (6 Kreditpunkte) in Form eines 3-tägigen computer-unterstützten Assessments fachübergreifender Kompetenzen angeboten (Teilnehmerzahl beschränkt auf 12 Studierende). Die Teilnehmenden verfassen Berichte, die benotet werden.

The lecture explores various strands in philosophy of science in a critical way, focusing on the notion of rationality in science, especially with regards to environmental research. It addresses the significance and limits of empirical, mathematical and logical methods, as well as problems and ethical issues raised by the use of science in society.

Students learn to engage with problems in the philosophy of science and to relate them to natural and environmental sciences, thus developing their skills in critical thinking about science and its use. They know the most important positions in philosophy of science and the objections they face. They can identify, structure and discuss issues raised by the use of science in society.

The lecture covers the following main topics: social perception and interpersonal judgement; attitudes; group dynamics and group performance; leadership behavior and leadership styles.

The aim of the lecture is to impart a well-founded scientific understanding of social influence processes in individuals, groups, organizations, and social settings.

The participants should develop competencies in the structuring of communication, interaction, and management processes.

Im Einzelnen sollen die Teilnehmerinnen und Teilnehmer lernen:

- an den Beispielen von Kaufverhalten oder ökologischem Verhalten zu beschreiben, wie Normen und Einstellungen Einfluss auf das Verhalten nehmen,
- die Subjektivität und die Fehlerquellen sozialer Wahrnehmung verstehen,
- Prinzipiern der Psychologie der Kommunikation zu nutzen für eine Verbesserung der Kommunikation in Studium und Beruf,
- Merkmale und Strukturen von Gruppen zu identifizieren und mit geeigneten Methoden zu analysieren,
- die Grundlagen von Konformität und Gehorsam gegenüber Autoritäten zu erkennen,
- gruppenphänomenologische, sozialen Faulenzeiten, Risiko- und Konservativisms-Schub und Gruppenentscheidungen entgegenzuwirken,
- die Grundlagen und -entscheidungen zu optimieren,
- Führungskriterien zu unterschieden lernen,
- Techniken zur Moderation von interagierenden Gruppen kennen zu lernen.

Literature


Es werden für D-ITET-Studierende Gruppenarbeiten (6 Kreditpunkte) in Form eines 3-tägigen computer-unterstützten Assessments fachübergreifender Kompetenzen angeboten (Teilnehmerzahl beschränkt auf 12 Studierende). Die Teilnehmenden verfassen Berichte, die benotet werden.
Students can engage with problems in the philosophy of science and relate them to natural and environmental sciences. They learn to analyze and summarize philosophical texts. In this way, they develop their skills in critical thinking with a focus on the rationality of science.

**Prerequisites / notice**

Data: 06.02.2019 13:00

**Educational Science for Teaching Diploma and TC - Key for Type**

<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>ECTS</th>
</tr>
</thead>
</table>
| V lecture     |      | European Credit Transfer and Accumulation System
| G exercise    |      | Special students and auditors need special permission from the lecturers.
| S seminar     |      |
| K colloquium  |      | **Prerequisites / notice**

<table>
<thead>
<tr>
<th>Literature</th>
<th>A list of introductory literature and handbooks will be distributed to the students.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prerequisites / notice</td>
<td>Oral examination during the Prüfungssession. The optional exercises accompany the lecture and offer the opportunity for an in-depth discussion of selected texts from the reader.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>701-0791-00L</th>
<th>Environmental History - Introduction and Overview</th>
<th>W</th>
<th>2 credits</th>
<th>2V</th>
<th>D. Speich Chassé</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>Our society faces a serious ecological crisis. Of what historical dimension is this crisis? How have human societies already in earlier times changed their environment, and, consequently, perhaps also ours? What were the main ecological challenges for societies and how did they change over time? How did societies adapt to changing environmental conditions?</td>
<td></td>
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</tr>
<tr>
<td><strong>Objective</strong></td>
<td>Introduction into environmental history: survey of long-term development of human-nature-interrelations; discussion of selected problems. Improved ability to assess current problems from a historical perspective and to critically interrogate one's own standpoint.</td>
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</tr>
<tr>
<td><strong>Lecture notes</strong></td>
<td>Course material is provided on OLAT.</td>
<td></td>
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</tr>
<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Students are asked to write an exam during the second last session (11.12.2015).</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>701-0701-01L</th>
<th>Philosophy of Science: Exercises</th>
<th>W</th>
<th>1 credit</th>
<th>1U</th>
<th>G. Hirsch Hadorn, C. J. Baumberger</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>The exercises in philosophy of science serve to develop skills in critical thinking by discussing seminal texts about the rationality of science. Topics discussed include the significance and limits of empirical, mathematical and logical methods, as well as problems and ethical issues raised by the use of science in society.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Objective</strong></td>
<td>Students can engage with problems in the philosophy of science and to relate them to natural and environmental sciences. They learn to analyze and summarize philosophical texts. In this way, they develop their skills in critical thinking with a focus on the rationality of science.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Content</strong></td>
<td>The optional exercises accompany the lecture and serve to develop skills in critical thinking with a focus on the rationality of science, based on discussing seminal texts. The texts cover important positions in the philosophy of science and their critics. Topics discussed include the significance and limits of empirical, mathematical and logical methods, as well as problems and ethical issues raised by the use of science in society.</td>
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</tr>
<tr>
<td><strong>Lecture notes</strong></td>
<td>A reader will be available for students.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Literature</strong></td>
<td>A list of literature will be distributed to the students together with the reader.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Students that want to subscribe for this course also have to subscribe for the lecture &quot;Wissenschaftsphilosophie&quot;. Credit points are given for preparing a structure and a summary of one of the texts.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>401-9951-58L</th>
<th>Didactics of Mathematics at the College Level I (University of Zurich)</th>
<th>W</th>
<th>3 credits</th>
<th>2S</th>
<th>R. Schelldorfer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>The exercises in philosophy of science serve to develop skills in critical thinking by discussing seminal texts about the rationality of science. Topics discussed include the significance and limits of empirical, mathematical and logical methods, as well as problems and ethical issues raised by the use of science in society.</td>
<td></td>
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<tr>
<td><strong>Objective</strong></td>
<td>Students are familiarised with the subjects taught at high-school level I (the first three years of the full-length high school, or the first year of the reduced-length high school). The central contents of geometry, arithmetic and algebra, and also written mathematical problems are explained.</td>
<td></td>
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<tr>
<td><strong>Content</strong></td>
<td>Students are familiarised with the subjects taught at high-school level I (the first three years of the full-length high school or the first year of the reduced-length high school), central concepts and approaches adopted in mathematics are introduced and observed in greater depth. These include variables, function, proof. This calls for a careful didactic analysis on the part of the teacher, requiring them to study and reflect on the prerequisites for the pupils and the requirements in terms of mathematics and cognitive psychology. Beispiele von Schülerarbeiten geben in diesem Seminar einen Einblick in die mathematische Denkwelt der Schülerinnen und Schüler. Vielfältige Aufgaben zum Einsatz im Unterricht werden vorgestellt, selber gelöst und diskutiert.</td>
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</tr>
<tr>
<td><strong>Lecture notes</strong></td>
<td>Zahlreiche begleitende Unterlagen werden abgegeben.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Seminar mit Übungen</td>
<td></td>
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</tr>
</tbody>
</table>

**Key for Hours**

- V lecture
- G lecture with exercise
- U exercise
- S seminar
- K colloquium
- P practical/laboratory course
- A independent project
- D diploma thesis
- R revision course / private study

**Notice**

Enrolment only possible with matriculation in Teaching Diploma or TC at ETH or in Teaching Diploma at UZH.

**Enrolment deadlines at UZH:**

http://www.uzh.ch/studies/application/mobilitaet_en.html

**Prerequisites / notice**

- Alaric: Alaricus: Zahlbereiche, Form und Inhalt in der Algebra
- Geometrie: Konstruieren-Berechnen-Beweisen, dynamische Geometrie (Geogebra).
- Sachrechnen: Funktionsbegriff, mathematische Modellierung.
- Aktuelle mathematikdidaktische Aspekte wie Lernprozesse, Grundvorstellungen, Kompetenzen, offene Aufgaben.

**Literature**

### Civil Engineering (General Courses)

#### Generally Accessible Seminars and Colloquia

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-1187-00L</td>
<td>Colloquium in Structural Engineering</td>
<td>E-</td>
<td>0 credits</td>
<td>2K</td>
<td>B. Stojadinovic, E. Chatzi, M. Fontana, A. Frangi, W. Kaufmann, B. Sudret, T. Vogel</td>
</tr>
</tbody>
</table>

**Abstract**

Professors from national and international universities, technical experts from the industry as well as research associates of the institute of structural engineering (IBK) are invited to present recent research results and specific projects from the practice. This colloquium is addressed to members of universities, practicing engineers and interested persons in general.

**Objective**

Learn about recent research results in structural engineering.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-1387-00L</td>
<td>Colloquia in Geotechnics</td>
<td>E-</td>
<td>0 credits</td>
<td>A. Puzrin, G. Anagnostou, S. M. Springman</td>
</tr>
</tbody>
</table>

**Abstract**

The Institute for Geotechnical Engineering invites distinguished speakers from research and practice, nationally and internationally. The colloquia are directed towards staff and students from Universities as well as engineers and scientists working in industry. Details can be obtained from www.igt.ethz.ch by following Events & Public Events. Some colloquia are available via webcast.

**Objective**

Learn about recent research results in geotechnics.

---

**Civil Engineering (General Courses) - Key for Type**

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

**Key for Hours**

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Civil Engineering Bachelor

Bachelor Studies (Programme Regulations 2014)

1. Semester

First Year Examinations

In place of the German course 851-0703-03L Introduction to Law for Civil Engineering students can take the French course 851-0709-00L Droit civil.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0241-00L</td>
<td>Analysis I</td>
<td>O</td>
<td>7 credits</td>
<td>5V+2U</td>
<td>M. Akveld</td>
</tr>
<tr>
<td>401-0141-00L</td>
<td>Linear Algebra and Numerical Analysis</td>
<td>O</td>
<td>5 credits</td>
<td>3V+1U</td>
<td>P. Grohs</td>
</tr>
<tr>
<td>252-0845-00L</td>
<td>Computer Science I</td>
<td>O</td>
<td>5 credits</td>
<td>2V+2U</td>
<td>M. Hirt</td>
</tr>
<tr>
<td>151-0501-00L</td>
<td>Kinematics and Statics</td>
<td>O</td>
<td>5 credits</td>
<td>3V+2U</td>
<td>E. Mazza</td>
</tr>
<tr>
<td>651-0032-00L</td>
<td>Geology and Petrography</td>
<td>O</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>C. A. Heinrich, S. Löw, K. Rauchenstein</td>
</tr>
</tbody>
</table>

Abstract

Mathematical tools for the engineer

Introduction to Linear Algebra and Numerical Analysis with emphasis on both abstract concepts and algorithms.

The course covers the basic concepts of computer programming.

Master students in Human Movement Sciences and Sport MSc must enroll in "Kinematics and Statics" and "Mechanics of Materials" as a yearly course.

Basic understanding of programming concepts. Students will be able to write and read simple programs and to modify existing programs.

Basic understanding of computer programming. Concepts. Students will be able to write and read simple programs and to modify existing programs.

Basic understanding of Kinematic and Statics and "Mechanics of Materials" as a yearly course.

Lecturers

Sayir, M.B., Dual J., Kaufmann S., Ingenieurmechanik 1: Grundlagen und Statik, Teubner

Prerequisites / notice

Written session examination in "Kinematics and Statics" and "Mechanics of Materials" for D-MAVT Students, Students in Human Movement Sciences and Sport and all other Students, who take "Kinematics and Statics" and "Mechanics of Materials":

Part 1: 20 minutes: Neither notes nor calculators allowed right afterwards:


Data: 06.02.2019 13:00 Autumn Semester 2015 Page 115 of 1434
Introduction to Law for Civil Engineering

**Abstract**

This course gives an overview of the basic concepts of geology and petrography and shows some links to the application of these concepts. The course consists of lectures and exercises in groups. The lectures cover all aspects of the dynamic earth, from the history of the earth, to the formation of rocks, mountains, and oceans, and the degradation processes shaping the uppermost earth's crust.

**Objective**

This course gives an overview of the basic concepts of geology and petrography and shows some links to the application of these concepts.

**Content**


**Lecture notes**

Übungen zum Gesteinsbestimmen und Lesen von geologischen, tektonischen und geotechnischen Karten, einfache Konstruktionen.

**Literature**

Press, F.; Siever, R.: Allgemeine Geologie, Spektrum Akademischer Verlag, Heidelberg

---

**Kinematics and Statics (Colloquium)**

**Abstract**

Basics: Position of a material point, velocity, kinematics of rigid bodies, forces, reaction principle, mechanical power

Statics: Groups of forces, moments, equilibrium of rigid bodies, reactions at supports, parallel forces, center of gravity, statics of systems, principle of virtual power, trusses, frames, forces in beams and cables, friction

**Objective**

The understanding of the fundamentals of Statics for engineers and their application in simple settings.

**Content**

Statics: equivalence and reduction of groups of forces; rest and equilibrium; basic theorem of statics; kinematic and static boundary conditions, applications to supports and clamps of rods and beams; procedures for determination of forces at supports and clamps; parallel forces and centre of gravity; statics of systems, solution using basic theorem and using the principle of virtual power, statically indeterminate systems; statically determinate truss structures, ideal truss structures, nodal point equilibrium, methods for truss force determination; friction, static friction, sliding friction, friction at joints and supports, rolling resistance; forces in cables; beam loading, force and moment vector.

**Lecture notes**

Übungsblätter

**Literature**

Sayir, M.B., Dual J., Kaufmann S., Ingenieurmechanik 1: Grundlagen und Statik, Teubner

---

**Analysis III**

**Number**

401-0243-00L

**Title**

Analysis III

**Type**

O

**ECTS**

3 credits

**Hours**

2V+1U

**Lecturers**

M.h. Akka Ginosar

---

Data: 06.02.2019 13:00
Autumn Semester 2015
Page 116 of 1434
Abstract
We will model and solve scientific problems with partial differential equations. Differential equations which are important in applications will be classified and solved. Elliptic, parabolic and hyperbolic differential equations will be treated. The following mathematical tools will be introduced: Laplace and Fourier transforms, Fourier series, separation of variables, methods of characteristics.

Objective
Learning to model scientific problems using partial differential equations and developing a good command of the mathematical methods that can be applied to them. Knowing the formulation of important problems in science and engineering with a view toward civil engineering (when possible). Understanding the properties of the different types of partial differential equations arising in science and in engineering.

Content
Classification of partial differential equations

Study of the Heat equation general diffusion/parabolic problems using the following tools:
* Separation of variables
* Fourier series
* Fourier transform
* Laplace transform

Study of the wave equation and general hyperbolic problems using similar tools and the method of characteristics.

Study of the Laplace equation and general elliptic problems using similar tools and generalizations of Fourier series.

Accompanying material will be posted on the course website throughout the semester.

We will loosely follow the following books:

Stanley J. Farlow - Partial Differential Equations for Scientists and Engineers (a Dover reprint and can be bought for less than 20 CHF)

Chapters 11 and 12 of E. Kreyszig, Advanced Engineering Mathematics.

Two good sources in German are:

Norbert Hungerbühler, "Einführung in die partiellen Differentialgleichungen"

http://www.math.ethz.ch/~ufelder/Teaching/PGD.

Prerequisites / notice
Analysis I and II, in particular, knowing how to solve ordinary differential equations is an important prerequisite.

402-0023-01L

Physics O 7 credits 5V+2U L. Degiorgi

Abstract
This course will cover the basic topics in Physics and will show/display/explain with a variety of experiments the most important physical effects. The course will address classical as well as modern physics, and the interoperability between basic research and applications.

Objective

Content

Lecture notes
Manuskript und Übungsblätter

Literature
Hans J. Paus, Physik in Experimenten und Beispielen, Carl Hanser Verlag München Wien (als unterrichtsbegleitendes und ergänzendes Lehrbuch)

101-0203-01L

Hydraulics I O 5 credits 3V+1U R. Stocker

Abstract
The course teaches the basics of hydromechanics, relevant for civil and environmental engineers.

Objective
Familialization with the basics of hydromechanics of steady state flows

Content
Properties of water, hydrostatics, continuity, Euler equation of motion, Navier Stokes equation, similarity, Bernoulli principle, momentum equation for finite volumes, potential flows, ideal fluids-real fluids, boundary layer, pipe flow, open channel flow, flow in porous media, flow measurements, demonstration experiments in the lecture hall and in the laboratory

Lecture notes
Script and collection of problems available

Literature
Bollrich, Technische Hydromechanik 1, Verlag Bauwesen, Berlin

151-0503-00L

Dynamics O 6 credits 4V+2U G. Haller

Abstract
Kinematics, dynamics and oscillations: Motion of a single particle - Motion of systems of particles - 2D and 3D motion of rigid bodies

Objective
This course provides Bachelor students of mechanical engineering with fundamental knowledge of kinematics and dynamics of mechanical systems. By studying motion of a single particle, systems of particles and rigid bodies, we introduce essential concepts such as work and energy, equations of motion, and forces and torques. Further topics include stability of equilibria and vibrations. Examples presented in the lectures and weekly exercise lessons help students learn basic techniques that are necessary for advanced courses and work on engineering applications.

Content
1. Motion of a single particle || Kinematics: trajectory, velocity, acceleration, inertial frame, moving frames - Forces and torques. Active- and reaction forces. - Linear momentum principle, angular momentum principle, work-energy principle - Equations of motion;
2. Motion of systems of particles || Internal and external forces - Linear momentum principle, angular momentum principle, work-energy principle - Rigid body systems of particles; conservative systems
3. 3D motion of rigid bodies || Kinematics: angular velocity, velocity transport formula, instantaneous center of rotation - Linear momentum principle, angular momentum principle, work-energy principle - Parallel axis theorem. Angular momentum transport formula

Lecture notes
Hand-written slides will be downloadable after each lecture.

Literature
Typed course notes from the previous year

Prerequisites / notice
Please log in to moodle (https://moodle-app2.let.ethz.ch/auth/shibboleth/login.php), search for "Dynamics", and join the course there. All exercises sheets, lecture materials etc. will be uploaded there.

Extra notice

In place of the German course 851-0703-01 Grundzüge des Rechts für Bauwissenschaften students can take the French course 851-0709-00 Droit civil.
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0113-00L</td>
<td>Theory of Structures I</td>
<td>O</td>
<td>5</td>
<td>3V+2U</td>
<td>S. Zweidler</td>
</tr>
</tbody>
</table>

**Abstract**

Introduction, statically determinate beams and frames, stresses and deformations, application of the principle of virtual work, statically indeterminate beams and frames (force method).

**Objective**

Understanding the response of elastic beam and frame structures

- Ability to correctly apply the equilibrium conditions
- Ability to determine elastic deformations
- Ability to apply the force (flexibility) method for statically indeterminate structures

**Content**

- Introduction
- Reactions, internal forces and moments
- Arches and cables
- Trusses
- Influence lines
- Stresses and deformations
- Principle of virtual work
- Flexure and axial force, shear, torsion
- Deflections, work equation
- Statically indeterminate systems

**Lecture notes**

Script and handouts available at


**Literature**


---

**Bachelor Studies (Programme Regulations 2010)**

**5. Semester**

**Compulsory Courses 5. Semester**

**Examination Block 1**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0505-00L</td>
<td>Mechanics III for Civil Engineers</td>
<td>O</td>
<td>3</td>
<td>2V+1U</td>
<td>to be announced</td>
</tr>
</tbody>
</table>

**Abstract**

Contents: basic concepts: planar dynamics with (principle of) linear and angular momentum, moment of inertia, kinetic energy. - linear vibration systems. (higher-order) eigenvectors, modal decoupling, - wave equation: normal form, characteristics, reflection.

**Objective**

This lecture gives the student a well-founded basic education in the technical theory of oscillations. The focus of the lecture lies - in addition to directly applicable methods - in the methodical introduction to the theory of vibrations. This should enable the student to work independently in the praxis-oriented area of oscillation analysis and to study further at a high level. The material used in the lectures is mathematically oriented and strictly causally structured and makes use of vector and matrix calculus. Particular importance is given to demanding and practice-oriented exercises.

**Content**


2. Linear oscillations - 1 degree of freedom: force and kinematic excitation, state space, damped and undamped free oscillations, Lehr's damping, phase space portraits, eigenvalue plots, harmonic excitation, amplitude and phase responses, power consumption, beat frequencies, resonance.

3. Linear oscillation - 1 degrees of freedom: MDGKN system, representation in configuration and state space, eigenvalues, eigenvectors, higher order eigenvectors, undamped and damped systems, Rayleigh damping, modal decoupling.

4. Wave equation: String under tension, longitudinal dynamics of rods, torsional vibrations of circular cylindrical rods, boundary conditions in space and time, canonical transformation, normal form of the wave equation, d'Alembert solution, characteristics, left and right waves, reflection at free and restrained ends, standing waves and oscillations.

**Lecture notes**


**Literature**

Als Zusatzliteratur wird empfohlen: Mechanik 3, Dynamik, M.B. Sayir, Eigenverlag (CHF 32.-)

**Examination Block 3**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0315-00L</td>
<td>Geotechnical Engineering</td>
<td>O</td>
<td>5</td>
<td>4G</td>
<td>A. Puzrin</td>
</tr>
</tbody>
</table>

**Abstract**

The course explores the fundamental principles of Geomechanics and Geotechnical Engineering, with the following objectives:

- Recognition of the basic consequences of the ground construction;
- Understanding of the important fundamental concepts of Soil mechanics and Geotechnical Engineering;
- Independent analysis of the basic geotechnical problems.

**Objective**

The course explores the fundamental principles of Geomechanics and Geotechnical Engineering, with the following objectives:

- Recognition of the basic consequences of the ground construction;
- Understanding of the important fundamental concepts of Soil mechanics and Geotechnical Engineering;
- Independent analysis of the basic geotechnical problems.

**Content**

Overview of stability problems; Bearing capacity of shallow and deep foundations; Soil-foundation interaction; Analysis and design of shallow and deep foundations; Earth pressure on retaining structures; Analysis and design of retaining walls; Excavations: dewatering, analysis and design; Soil improvement; Safety considerations.

**Lecture notes**

Examples

**Literature**

Abstract
Theoretical basic knowledge and detailing of plate girders, trusses and composite beams and columns. Local load introduction, design structural analysis stability and detailing of buildings. A global approach including aspects of structural safety, architecture, use and durability is given. The course includes practical examples and exercises done by the students to enhance their knowledge.

Objective
Students know the theoretical basis and the detailing of structural steel elements. They understand how to cope with local load introduction and redirection. They know the basics of design, detailing and dimensioning of steel structures for buildings, respecting aspects of safety, architecture, use, durability and flexibility etc.

Content
After having attended Steel structures I and II students are able to design, detail and dimension the structure of common steel buildings.

Lecture notes
Autography on plate girders, trusses, load introduction and redirection, steel concrete composite elements. Copies of presentations.

Literature
- Stahlbaukalender, Ernst & Sohn, Berlin

Prerequisites / notice
The content of steel structures I is a prerequisite

<table>
<thead>
<tr>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Concrete I</td>
<td>5 credits</td>
<td>4G</td>
<td>W. Kaufmann</td>
<td></td>
</tr>
</tbody>
</table>

Biological Sciences

101-0415-01L
Railway Infrastructures (Transportation II) O 3 credits 2G U. A. Weidmann

Abstract
Fundamentals of railroad technology and interactions between track and vehicles, network development and infrastructure planning, planning of rail infrastructure, planning and design of railway stations, construction and dimensioning of tracks, approval and beginning service on complex infrastructure facilities, special issues of maintenance. Teach the basic principles of public transport network and topology design, geometrical design, dimensioning and construction as well as the maintenance of railway infrastructures. Teaches students to recognize the interactions between the infrastructure design and the production processes. Provides the background for Masters degree study.

Objective
Teaches the basic principles of public transport network and topology design, geometrical design, dimensioning and construction as well as the maintenance of railway infrastructures. Teaches students to recognize the interactions between the infrastructure design and the production processes. Provides the background for Masters degree study.

Content
(1) Fundamentals: Infrastructures of public transport systems; interaction between track and vehicles; passengers and goods as infrastructure users; management and financing of networks; railway standards and norms. (2) Infrastructure planning: Planning processes and decision levels in network development and infrastructure planning, planning of railway tracks and rail topologies; planning of the passenger parts of stations. (3) Infrastructure design: Fundamentals of the layout of a line; track geometry; switches and crossings; design of station platforms. (4) Construction of railway infrastructures: Assembly and evolution of the railway track; elements of the railway track; dimensioning of the track; track stability. (5) Approval and beginning service on complex infrastructure facilities: Definitions and limitations; fundamentals of the legal situation; test and approval processes; processing of the railway systems into operation. (6) Maintenance of railway infrastructures: Fundamentals of infrastructure maintenance; kinds of deprevations; supervision methods; steps of infrastructure maintenance; estimation of maintenance need; methods to minimize maintenance costs.

Lecture notes
Course notes will be provided in German. Slides are made available some days before each lecture.

Literature
References to technical literature will be included in the course script. An additional list of literature will be given during the course.

Prerequisites / notice
No remarks.

101-0515-00L
Project Management O 2 credits 2G M. Kersting

Abstract
General introduction to the development, the life cycle and the characteristics of projects. Introduction to, and experience with, the methods and tools to help with the preparation, evaluation, organisation, planning, controlling and completion of projects.

Objective
To introduce the methods and tools of project management. To impart knowledge in the areas of project organisation and structure, project planning, resource management, project controlling and on team leadership and team work.

Content
- From strategic planning to implementation (Project phases, goals, constraints, and feasibility)
- Project leadership (Leadership, Teams)
- Project organization (Structure)
- Project planning (Schedule, cost and resource planning)
- Project controlling
- Risk and Quality Management
- Project completion

Lecture notes
Yes.

The transparencies will be available for download from the website at least one week before each class.

Copies of all necessary documents will be distributed at appropriate times.

101-0325-01L
Rock Mechanics O 2 credits 2G G. Anagnostou

Abstract

Objective
To introduce the methods and tools of project management. To impart knowledge in the areas of project organisation and structure, project planning, resource management, project controlling and on team leadership and team work.

Content
- From strategic planning to implementation (Project phases, goals, constraints, and feasibility)

Lecture notes
Autographie

Literature
Empfehlungen

>>> Examination Block 4

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0125-00L</td>
<td>Structural Concrete I</td>
<td>O</td>
<td>5 credits</td>
<td>4G</td>
<td>W. Kaufmann</td>
</tr>
</tbody>
</table>

Abstract
Contents: Introduction, historical development of structural concrete, materials and material behaviour (cement, concrete, reinforcing steel, prestressing steel), linear members (axial force, flexure and axial force, compression members and columns, shear, bending and shear, torsion and combined actions), strut-and-tie models and simple stress fields, detailing.

Objective
Knowing the materials concrete and reinforcing steel and understanding their interaction; Understanding the response of typical structural members; Knowing elementary models and ability to apply them to practical problems; Ability to correctly dimension and detail simple structures.

Content
Introduction, historical development of structural concrete, materials and material behaviour (cement, concrete, reinforcing steel, prestressing steel), linear members (axial force, flexure and axial force, compression members and columns, shear, bending and shear, torsion and combined actions), strut-and-tie models and simple stress fields, detailing.

Lecture notes
- SIA Codes 260 (Basis of structural design), 261 (Actions on structures) and 262 (concrete structures).
Prerequisites: "Theory of Structures I" and "Theory of Structures II".

Additional Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0615-00L</td>
<td>Materials III</td>
<td>O</td>
<td>5 credits</td>
<td>4P</td>
<td>R. J. Flatt, I. Burgert, P. Lura, H. Richner, F. Wittel</td>
</tr>
</tbody>
</table>

Abstract: Introduction into the basic and practical knowledge of important building materials and testing methods.

Objective: Introduction into the basic and practical knowledge of important building materials and testing methods.

Content:
- Introduction of material testing equipment, with various examples of experiments on metals (tensile behaviour, hardness, bending and impact loading).
- Theoretical background and practical aspects of concrete technology: mixture design, casting and setting; determination of mechanical properties.
- Properties of bricks and mortar: individual materials and the composite brickwork. Parameters like strength, Youngs modulus, water absorption and thermal conductivity are determined.
- Understanding the characteristic properties of wood: anisotropy, hygroscopic behaviour, shrinkage and swelling, and effect of size on strength. Introduction to test-methods for wood and wood-products.
- Introduction into the basics of scanning electron microscopy: practical exercises with the Environmental Scanning Electron Microscope (ESEM).
- Introduction to fundamentals of Finite Element Methods and their application in examples.
- Introduction to durability of building materials and building structures: assessment of potentials for detecting and locating corrosion of steel reinforcement in concrete.

Lecture notes: For each topic a script will be provided, that can be downloaded under www.ifb.ethz.ch/education

Bachelor Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0006-00L</td>
<td>Bachelor’s Thesis</td>
<td>O</td>
<td>10 credits</td>
<td>20D</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Abstract: The Bachelor Programme concludes with the Bachelor Thesis. This project is supervised by a professor. Writing up the Bachelor Thesis encourages students to show independence and to produce structured work.

Objective: Encourages students to show independence, to produce scientifically structured work and to apply engineering working methods.

Content: The contents base upon the fundamentals of the Bachelor Programme. Students can choose from different subjects and tasks. The thesis consists of both a written report and an oral presentation.

Electives

The entire course programs of ETH Zurich and the University of Zurich are open to the students to individual selection.

Electives of Bachelor Programme

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0185-01L</td>
<td>CAD for Civil Engineers</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>T. Vogel, K.H. Hamel</td>
</tr>
</tbody>
</table>

Abstract: Introduction to computer aided design and drafting in 2D and 3D with examples from structural engineering

Objective: Having followed the course, students are able to develop a 2D-structure (formwork drawing) and they know the principle of a reinforcement module. They have also got an introduction to a 3D program (reinforcement in 3D).

Above all they practice spatial sense and acquire contextual knowledge as future superiors of draftsmen and designers.

Lecture notes: CAD für Bauingenieure

Prerequisites / notice: Spezialbewilligung der Dozierenden notwendig.

For students of 5th semester. Number of participants is limited to 30. Point in time of enrolment of course is decisive.

Courses outside the curriculum: Arbeit ausschliesslich am eigenen Laptop. Die rechtzeitige Installation der Software ist Bedingung für die Teilnahme. Eine Anleitung zur Installation wird ausgegeben.

Electives Courses ETH Zurich

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-BAUG.

- see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability
- see GESS Compulsory Electives: Language Courses ETH/UZH

Civil Engineering Bachelor - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>E-</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
</tr>
</tbody>
</table>
Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS  European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
Civil Engineering Master

1. Semester

Seminar Work

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0007-00L</td>
<td>Conceptual Design</td>
<td>O</td>
<td>4</td>
<td>3S</td>
<td>T. Vogel, H. Figi, H. Schnetzer</td>
</tr>
</tbody>
</table>

**Abstract**
Procurement of consistent procedures to solve typical problems of civil engineering. Consolidation of the knowledge of the bachelor courses; integration of bachelors of other universities. Practice of the holistic approach of conceptual design, parallel and iterative operations on varying levels of detailing. Integration of different fields of knowledge and experiences.

**Objective**
Procurement of consistent procedures to solve typical problems of civil engineering. Consolidation of the knowledge of the bachelor courses; integration of bachelors of other universities. Practice of the holistic approach of conceptual design, parallel and iterative operations on varying levels of detailing. Integration of different fields of knowledge and experiences.

**Content**

- Basic tools:
  - Literature research, quotations
  - Technical report and presentations
  - Basics of graphical representation

- Elements of the design process:
  - Service criteria and respective agreement
  - Design requirements and design boundary conditions
  - Design alternatives
  - Preliminary dimensioning
  - Cost effectiveness
  - Optimization
  - Detailing

- Exemplary consolidations:
  - Geotechnical basics of retaining walls
  - Conceptual design and shaping of retaining walls
  - Drainage of structures
  - Case study conceptual bridge design

- Implementation with a planning tutorial:
  - Presentation of the objects
  - Survey and inventory
  - Design options
  - Intermediate review
  - Final presentation

Lecture notes
Autografieblätter zum Vorlesungsstoff, zum Teil als Download http://www.ibk.ethz.ch/vo/downloads/index

Literature
Normen

Weiterführende Literatur

Major Courses

Major in Construction and Maintenance Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0579-00L</td>
<td>Infrastructure Maintenance Processes</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>B. T. Adey</td>
</tr>
</tbody>
</table>

**Abstract**
This course provides an introduction to:
- how to model the changes in infrastructure objects over time,
- how to monitor these changes and assess the benefits of monitoring,
- how to intervene to improve infrastructure performance and assess the benefits of interventions, and
- how to model the changes in stakeholders interests over time.

**Objective**
To provide the basic information and tools to be used to make decisions with respect to existing infrastructure

**Content**

- Deterioration
  - manifest and latent processes,
  - modeling

- Monitoring
  - non-destructive and destructive techniques,
  - evaluation of benefits of monitoring

- Intervention
  - types of intervention,
  - evaluation of benefits of intervention

**Benefits**
- modeling of stakeholder benefits over time

Lecture notes
All necessary materials (e.g. transparencies and hand-outs) will be handed out at the beginning of each class.

Literature
Appropriate reading material will be assigned when necessary.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0517-01L</td>
<td>Project Management: Pre-tender to Contract Execution</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>to be announced</td>
</tr>
</tbody>
</table>

*Does not take place this semester.*
Abstract
This course will provide a comprehensive overview and understanding of the techniques, processes, tools and terminology to manage the Project Triangle (time, cost, quality) and to organize, analyze, control and report a complex project from Pre-Tender stage to Contract signature and Notice to Proceed. This is part 1 of a 3 part course, see notice below.

Objective
Upon successful completion of this course students will have the understanding of the Project Management duties and responsibilities from the Pre-Tender stage of a project to Contract Execution.

Content
- Project scope definition and project organization
- Technical specification proposals
- Work Breakdown Structure
- Estimating
- Schedule development
- Interface management
- Resource and cost integration
- Risk and opportunity identification and quantification
- Contract review and analysis
- Project life cycle
- Contract Execution - Project Manager Check List

Lecture notes
The slides will either be distributed at the beginning of the class, or made available online (via Moodle) prior to class. A copy of the appropriate chapter of the script, the assignment and any other assigned reading materials will be available via Moodle.

Literature
Appropriate reading material (e.g., chapters out of certain textbooks or trade articles) will be assigned when necessary and made available via Moodle.

Prerequisites / notice
This is part 1 of a 3 part course. Part 2 will take the student through Project Execution of complex Projects. Part 3 will take the student through advanced topics in Project Management.

The students will be randomly assigned to teams of 3 max. Students will be graded as a team based on the Project Proposal report and the in-class oral presentation of the Project Proposal. The Project Proposal will consist of an accumulation of the homework assignments.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>V+U</th>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>066-0415-00L</td>
<td>Building Physics: Theory and Applications</td>
<td>W 4</td>
<td>3V+1U</td>
<td>J. Carmelet, D. Derome, K. Orehounig</td>
</tr>
<tr>
<td>529-0193-00L</td>
<td>Renewable Energy Technologies I</td>
<td>W 4</td>
<td>3G</td>
<td>A. Steinfeld, Wokaun, A. Paulus</td>
</tr>
<tr>
<td>066-0427-01L</td>
<td>System and Network Planning</td>
<td>W 6</td>
<td>4G</td>
<td>U. A. Weidmann</td>
</tr>
</tbody>
</table>

Abstract
- Principles of heat and mass transport, hygro-thermal performance, durability of the building envelope and interaction with indoor and outdoor climates, applications.

Objective
- The students will acquire in the following fields:
  - Principles of heat and mass transport and their mathematical description.
  - Indoor and outdoor climate and driving forces.
  - Hydrothermal properties of building materials.
  - Building envelope solutions and their construction.
  - Hydrothermal performance and durability.

Abstract
- Scenarios for world energy demand and CO2 emissions, implications for climate. Methods for the assessment of energy chains. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaic electricity, solar chemistry), heat pumps, geothermal-energy, energy from waste. CO2 sequestration.

Objective
- Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals.

Abstract

Abstract
- Lectures on twelve compact aspects gaining importance in a increasingly specialised, complex and international surrounding: Topics of the profession, design quality, the project, organisation, coordination, costing, contracts and agreements, tendering and construction management, life cycle, real estate market, building trade and getting started. Twelve compact aspects regarding the establish building culture are gaining importance in an increasingly specialised, complex and international surrounding. Lectures on the topics of the profession, design quality, the project, organisation, coordination, costing, contracts and agreements, tendering and construction management, life cycle, real estate market, building trade, and getting started will guide the participants, bringing the individual pieces of knowledge into a superordinate relationship.

Abstract
- “Design and Building Process MBS” is a brief manual covering the competencies and the responsibilities of all involved parties through the design and building process. Lectures on the topics of the profession, design quality, the project, organisation, coordination, costing, contracts and agreements, tendering and construction management, life cycle, real estate market, building trade, and getting started will guide the participants, bringing the individual pieces of knowledge into a superordinate relationship. The course introduces the key figures, depicts the measurable and non-measurable criteria of the project and highlights the provided services of the consultants. In addition to discussing the basics, the terminologies and the tendencies, the lecture units will refer to the standards as well as the practive: Teaching-based case studies will compliment and deepen the understanding of the twelve selected aspects. The course is presented as a moderated seminar to allow students the opportunity for individual input: active collaboration between the students and their tutor therefore required.

Abstract
- Public transports in the context of the transport systems; customer needs in the transport market; service planning processes for regular public transport services; long distance, regional and urban public transport service strategies; access to public transport and the last mile via Moodle.

Objective
- Students will develop a basic knowledge of all stages of the public transport planning process from market demand to service planning; they will understand the most relevant planning methods and will be able to use them.

Prerequisites / notice
Topics are available to carry out a Project Work (Semesterarbeit) on the contents of this course.

Lecture notes
Lecture notes will be distributed during the course.

Literature
- Fundamentals of chemistry and physics are a prerequisite for this course.

Prerequisites / notice
- Fundamentals of chemistry and physics are a prerequisite for this course.

Lecture notes
Lecture notes will be distributed during the course.

Literature
- Fundamentals of chemistry and physics are a prerequisite for this course.

Prerequisites / notice
- Fundamentals of chemistry and physics are a prerequisite for this course.

Lecture notes
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Literature
- Fundamentals of chemistry and physics are a prerequisite for this course.

Prerequisites / notice
- Fundamentals of chemistry and physics are a prerequisite for this course.


### Major in Geotechnical Engineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0357-00L</td>
<td>Theoretical and Experimental Soil Mechanics</td>
<td>W+</td>
<td>6</td>
<td>4G</td>
<td>R. Herzog, S. M. Springman</td>
</tr>
<tr>
<td></td>
<td>Pre-requisites: Mechanics I, II and III.</td>
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<td></td>
<td>Abstract</td>
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<td></td>
<td>Overview of soil behaviour</td>
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<td></td>
<td>Explanation of typical applications: reality, modelling, laboratory tests with transfer of results to the practical examples</td>
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<td></td>
<td>Consolidation theory and typical applications in practice</td>
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<td>Triaxial &amp; direct shear tests: consolidation &amp; shear, drained &amp; undrained response</td>
<td>May</td>
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<tr>
<td></td>
<td>Plasticity theory &amp; Critical State Soil Mechanics, Cam Clay</td>
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<td></td>
<td>Application of plasticity theory</td>
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<td>Objective</td>
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<td></td>
<td>Extend knowledge of theoretical approaches that can be used to describe soil behaviour to enable students to carry out more advanced geotechnical design and to plan the appropriate laboratory tests to obtain relevant parameters for coupled plasticity models of soil behaviour</td>
<td>May</td>
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<td>A further goal is to give students the wherewithal to be able to select an appropriate constitutive model and set up insitu stress conditions in preparation for subsequent numerical modelling (e.g. with finite elements).</td>
<td>May</td>
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<td></td>
<td>Content</td>
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<tr>
<td></td>
<td>Overview of soil behaviour</td>
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<td></td>
<td>Discussion of general gaps between basic theory and soil response</td>
<td>May</td>
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<td></td>
<td>Stress paths in practice &amp; in laboratory tests</td>
<td>May</td>
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<td></td>
<td>Explanation of typical applications: reality, modelling, laboratory tests with transfer of results to the practical examples</td>
<td>May</td>
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<tr>
<td></td>
<td>Consolidation theory for incremental and continuous loading oedometer tests and typical applications in practice</td>
<td>May</td>
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<td></td>
<td>Triaxial &amp; direct shear tests: consolidation &amp; shear, drained &amp; undrained response</td>
<td>May</td>
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<tr>
<td></td>
<td>Plasticity theory &amp; Critical State Soil Mechanics, Cam Clay</td>
<td>May</td>
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<td></td>
<td>Application of plasticity theory</td>
<td>May</td>
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<td>Lecture notes</td>
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<td></td>
<td>Printed script with web support</td>
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<td></td>
<td>Exercises</td>
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<tr>
<td></td>
<td>Literature</td>
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<td><a href="http://geotip.igt.ethz.ch/">http://geotip.igt.ethz.ch/</a></td>
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<td></td>
<td>Prerequisites / notice</td>
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<tr>
<td></td>
<td>Lectures will be conducted as Problem Based Learning within the framework of a case history</td>
<td>May</td>
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<td>Virtual laboratory in support of 'hands-on' experience of selected laboratory tests</td>
<td>May</td>
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<tr>
<td></td>
<td>Pre-requisites: Basic knowledge in soil mechanics as well as knowledge of advanced mechanics</td>
<td>May</td>
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<tr>
<td></td>
<td>Laboratory equipment will be available for 60 students. First priority goes to those registered for the geotechnics specialty in the Masters, 2nd year students then first year students, doctoral students qualifying officially for their PhD status and then 'first come, first served'.</td>
<td>May</td>
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<tr>
<td>101-0307-00L</td>
<td>Design and Construction in Geotechnical Engineering</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>A. Thielen, P. A. Mayor</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
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<tr>
<td></td>
<td>This lecture deals with the practical application of the knowledge gained in the fundamental lectures from the Bachelor degree.</td>
<td>W</td>
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<td></td>
<td>The basics of planning and design of geotechnical structures will be taught for the main topics geotechnical engineers are faced to in practice.</td>
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<td>Objective</td>
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<tr>
<td></td>
<td>Transfer of the fundamental knowledge taught in the Bachelor degree to practical application.</td>
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<td></td>
<td>Ability to plan and design geotechnical structures based on the state of the art.</td>
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<td></td>
<td>Content</td>
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<tr>
<td></td>
<td>Introduction to Swisscode SIA</td>
<td>W</td>
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<td></td>
<td>Foundations and settlements</td>
<td>W</td>
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<td></td>
<td>Pile foundations</td>
<td>W</td>
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<td>Excavations</td>
<td>W</td>
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<td></td>
<td>Slopes</td>
<td>W</td>
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<td></td>
<td>Soil nailing</td>
<td>W</td>
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<td></td>
<td>Reinforced geosystems</td>
<td>W</td>
<td></td>
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<tr>
<td></td>
<td>Ground improvement</td>
<td>W</td>
<td></td>
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<tr>
<td></td>
<td>River levees</td>
<td>W</td>
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<tr>
<td></td>
<td>Lecture notes</td>
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<tr>
<td></td>
<td>Script in the form of chapters and powerpoint overheads with web support (<a href="http://geotip.igt.ethz.ch">http://geotip.igt.ethz.ch</a>)</td>
<td>May</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Exercises</td>
<td>May</td>
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<tr>
<td></td>
<td>Literature</td>
<td>May</td>
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<tr>
<td></td>
<td>relevant literature will be stated during the lectures</td>
<td>May</td>
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</tbody>
</table>

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 124 of 1434
The course aims to teach students the most important aspects of the road structure, its building and design methods. An essential part of the course is devoted to understanding the influence of the insitu conditions: soil, underground, climate, water, as well as of the characteristics of building materials and of road surface on the durability of the pavement.

**Objective**

- Road design criteria, technology of road construction materials, geotechnical testing methods in laboratory and in situ, planning, monitoring and interpretation of soil field tests, soil classification for traffic construction, compaction of road structures and dams, frost characteristics of soil materials, soil stabilization

**Content**

- Road design criteria, technology of road construction materials, geotechnical testing methods in laboratory and in situ, planning, monitoring and interpretation of soil field tests, soil classification for traffic construction, compaction of road structures and dams, frost characteristics of soil materials, soil stabilization

**Lecture notes**

- As indicated in the course

**Literature**

- Autographie, Uebungsblätter, Handouts

Voraussetzungen: Grundlagenkenntnisse in "Bodenmechanik/Grundbau" sowie in "Projektierung von Verkehrsanlagen"

### Major in Structural Engineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0117-00L</td>
<td>Structural Analysis III</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>D. Heinzmans, S. Zweidler</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
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<td></td>
<td>Enhanced understanding of the load-deformation response of beam and frame structures. Systematic treatment of elementary and combined load carrying mechanisms of elastic beams, cables, arches and rings.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>Axially loaded members, shear deformation of girders, torsion, beams, cables, arches and rings, shear walls and frames, combined cable and flexural action.</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
<td></td>
<td>Systematic treatment of elementary and combined load carrying mechanisms of elastic beams, cables, arches and rings.</td>
</tr>
</tbody>
</table>

| 101-0127-00L | Structural Concrete III        | O    | 3    | 2G    | W. Kaufmann |
|              | Abstract                      |      |      |       | This course supplements the courses Structural Concrete I and II regarding the analysis and dimensioning of reinforced and prestressed concrete structures. It focuses on lower bound and upper bound limit analysis methods for girders, discs and shells, particularly regarding their applicability to the safety assessment of existing structures. |
|              | Objective                     |      |      |       | Enhancement of the understanding of the load-deformation response of reinforced and prestressed concrete: refined knowledge of models and ability to apply them to general problems, particularly regarding the structural safety assessment of existing structures; awareness of the limits of applicability of limit analysis methods and ability to check their applicability. |
|              | Content                       |      |      |       | Fundamentals (structural analysis, theorems of limit analysis, applicability of limit analysis methods); membranes and webs of girders (stress fields and truss models, yield conditions, failure mechanisms, load-deformation behaviour); deformation capacity of girders; slabs (equilibrium solutions, yield conditions, failure mechanisms, shear in slabs); complements (long term effects, fire resistance). |

| 101-0137-00L | Steel Structures III          | O    | 3    | 2G    | M. Knobloch |
|              | Abstract                      |      |      |       | Enhance theoretical considerations and detailing of structural steel design including aspects of economy and erection. E.g. Cranes, composite construction (compression and bending, continuous girders, partial connection, serviceability), fire design, stability of frames and buckling of plates with stiffeners, cold rolled sections, corrosion protection, price calculation and quality control |
|              | Objective                     |      |      |       | Enhance theoretical considerations and detailing of structural steel design including aspects of economy and erection. |
|              | Content                       |      |      |       | Constructive design of cranes, composite construction (compression and bending, continuous girders, partial connection, serviceability), fire design, stability of frames and buckling of plates with stiffeners, cold rolled sections, corrosion protection, price calculation and quality control |
|              | Lecture notes                 |      |      |       | Autography, Copies of presentations |

| 101-0187-00L | Structural Reliability and Risk Analysis | W | 3 | 2G | B. Sudret |
|              | Abstract                      |      |      |       | Structural reliability aims at quantifying the probability of failure of systems due to uncertainties in their design, manufacturing and environmental conditions. Risk analysis combines this information with the consequences of failure in view of optimal decision making. The course presents the underlying probabilistic modelling and computational methods for reliability and risk assessment. |
|              | Objective                     |      |      |       | The goal of this course is to provide the students with a thorough understanding of the key concepts behind structural reliability and risk analysis. After this course the students will have refreshed their knowledge of probability theory and statistics to model uncertainties in view of engineering applications. They will be able to analyze the reliability of a structure and to use risk assessment methods for decision making under uncertain conditions. They will be aware of the state-of-the-art computational methods and software in this field. |

**Prerequisites / notice**

- Pre-condition: Successful examinations (pass) in the geotechnical studies (soil mechanics and ground engineering, each 5 credits) in the Bachelor degree of Civil Engineering (ETH), or equivalent for new students.
Engineers are confronted every day to decision making under limited amount of information and uncertain conditions. When designing new structures and systems, the design codes such as SIA or Euro- codes usually provide a framework that guarantees safety and reliability. However, the level of safety is not quantified explicitly, which does not allow the analyst to properly choose between design variants and evaluate a total cost in case of failure. In contrast, the framework of risk analysis allows one to incorporate the uncertainty in decision making.

The first part of the course is a reminder on probability theory that is used as a main tool for reliability and risk analysis. Classical concepts such as random variables and vectors, dependence and correlation are recalled. Basic statistical inference methods used for building a probabilistic model from the available data, e.g. the maximum likelihood method, are presented.

The second part is related to structural reliability analysis, i.e. methods that allow one to compute probabilities of failure of a given system with respect to prescribed criteria. The framework of reliability analysis is first set up. Reliability indices are introduced together with the first order-second moment method (FORM) and the first order reliability method (FORM). Methods based on Monte Carlo simulation are then reviewed and illustrated through various examples. By-products of reliability analysis such as sensitivity measures and partial safety coefficients are derived and their links to structural design codes is shown. The reliability of structural systems is also introduced as well as the methods used to reassess existing structures based on new information.

The third part of the course addresses risk assessment methods. Techniques for the identification of hazard scenarios and their representation by fault trees and event trees are described. Risk is defined with respect to the concept of expected utility in the framework of decision making. Elements of Bayesian decision making, i.e. pre-, post- and pre-post risk assessment methods are presented. Bayesian networks are introduced as a generic numerical tool for solving such problems. The course also includes a tutorial using a software dedicated to real world structural reliability analysis.

<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
<th>Basic course on probability theory and statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0157-01L</td>
<td>Structural Dynamics and Vibration Problems</td>
</tr>
<tr>
<td>Abstract</td>
<td>Fundamentals of structural dynamics are presented. Computing the response of elastic and inelastic single-DOF, continuous-mass and multiple-DOF structural systems subjected to harmonic, periodic, pulse, impulse, and random excitation is discussed. Practical solutions to vibration problems in flexible structures excited by humans, machinery, wind and explosions are developed.</td>
</tr>
<tr>
<td>Objective</td>
<td>After successful completion of this course the students will be able to: 1. Explain the dynamic equilibrium of structures under dynamic loading. 2. Use second-order differential equations to theoretically and numerically model the dynamic equilibrium of structural systems. 3. Model structural systems using single-degree-of-freedom, continuous-mass and multiple-degree-of-freedom models. 4. Compute the dynamic response of structural system to harmonic, periodic, pulse, impulse and random excitation using time-history and response-spectrum methods. 5. Apply structural dynamics principles to solve vibration problems in flexible structures excited by humans, machines, wind or explosions. 6. Use dynamics of structures to identify the basis for structural design code provisions related to dynamic loading.</td>
</tr>
<tr>
<td>Content</td>
<td>This is a course on structural dynamics, an extension of structural analysis for loads that induce significant inertial forces and vibratory response of structures. Dynamic responses of elastic and inelastic single-degree-of-freedom, continuous-mass and multiple-degree-of-freedom structural systems subjected to harmonic, periodic, pulse, impulse, and random excitation are discussed. Theoretical background and engineering guidelines for practical solutions to vibration problems in flexible structures caused by humans, machinery, wind or explosions are presented. Laboratory demonstrations of single- and multi-degree-of-freedom system dynamic response and use of viscous and tuned-mass dampers are conducted.</td>
</tr>
<tr>
<td>Lecture notes</td>
<td>The electronic copies of the learning material will be uploaded to ILIAS and available through myStudies. The learning material includes: the lecture presentations, additional reading material, and exercise problems and solutions.</td>
</tr>
<tr>
<td>Prequisites / notice</td>
<td>Knowledge of the fundamentals in structural analysis, and in structural design of reinforced concrete, steel and/or wood structures is mandatory. Working knowledge of matrix algebra and ordinary differential equations is required. Familiarity with Matlab and with structural analysis computer software is desirable.</td>
</tr>
<tr>
<td>051-0551-00L</td>
<td>Energy- and Climate Systems I</td>
</tr>
<tr>
<td>Abstract</td>
<td>The lecture contains concepts, physics and components of building technologies for the efficient and sustainable energy supply and climatisation of buildings and their interaction with architecture and urban design. Using calculations, students learn to acquire relevant numbers and assess the performance of solutions.</td>
</tr>
<tr>
<td>Objective</td>
<td>The lecture's target is the knowledge of the physical basics and technical components of relevant systems for an efficient and sustainable climatisation and maintenance of buildings and their interdependency with the architectural design and construction. By learning rough calculation methods, determination of relevant dimensions and identification of important parameters becomes possible. Hence, adequate approaches for the own design can be chosen, reviewed quantitatively and qualitatively and set in with a synergistic effect.</td>
</tr>
<tr>
<td>Content</td>
<td>1. Introduction 2. Thermal systems 3. Ventilation 4. Daylight and artificial lighting</td>
</tr>
<tr>
<td>Lecture notes</td>
<td>EK I lectures focus on technical components in use as well as their rough calculation methods and their integration into design and construction. Based on EK I, the EK II lectures focus on all possible systems and concepts available to the architect for a sustainable design.</td>
</tr>
<tr>
<td>Literature</td>
<td>The Slides from the lecture serve as lecture notes and are available as download. A bibliography will be distributed at the beginning of the lecture.</td>
</tr>
<tr>
<td>101-0177-00L</td>
<td>Building Physics: Moisture and Durability</td>
</tr>
<tr>
<td>Abstract</td>
<td>Moisture transport and related degradation processes in building and civil engineering materials and structures; concepts of poromechanics and multiscale analysis; analysis of damage cases.</td>
</tr>
<tr>
<td>Objective</td>
<td>- Basic knowledge of moisture transport and related degradation processes in building and civil engineering materials and structures - Introduction to concepts of poromechanics and multiscale analysis - Application of knowledge by the analysis of damage cases</td>
</tr>
</tbody>
</table>
Public transports in the context of the transport systems; customer needs in the transport market; service planning processes for regular

**1. Introduction**
Moisture damage: problem statement

**2. Moisture Transport**
Description of moisture transport
Determination of moisture transport properties
Hysteresis
Transport in cracked materials
Damage and moisture transport in cracked media

**3. Poromechanics**
Moisture and mechanics: poro-elasticity
Poro-elasticity and salt crystallisation
Poro-elasticity and damage
Case studies

**4. Multiscale analysis**
Problem statement
Multiscale transport model
Multiscale coupled transport - damage model

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**101-0167-01L Fibre Composite Materials in Structural Engineering**

**Abstract**
1) Lamina and Laminate Theory
2) FRP Manufacturing and Testing Methods
3) Design and Application ofExternally Bonded Reinforcement to Concrete, Timber, Masonry, and metallic Structures
4) FRP Reinforced Concrete, All FRP Structures
5) Measurement Techniques and Structural Health Monitoring

**Objective**
At the end of the course, you shall be able to
1) Design advanced FRP composites for your structures,
2) To consult owners and clients with necessary testing and SHM techniques for FRP structures,
3) Continue your education as a PhD student in this field.

**Content**
Fibre Reinforced Polymer (FRP) composites are increasingly being used in civil infrastructure applications, such as reinforcing rods, tendons and FRP profiles as well as wraps for seismic upgrading of columns and repair of deteriorated structures. The objective of this course is on one hand to provide new generation of engineering students with an overall awareness of the application and design of FRP reinforcing materials for internal and external strengthening (repair) of reinforced concrete structures. The FRP strengthening of other structures such as metallic, timber and masonry will also be shortly discussed. On the other hand the course will provide guidance to students seeking additional information on the topic. Many practical cases will be presented analysed and discussed. An ongoing structural health monitoring of these new materials is necessary to ensure that the structures are performing as planned, and that the safety and integrity of structures is not compromised. The course outlines some of the primary considerations to keep in mind when designing and utilizing structural health monitoring technologies. During the course, students will have the opportunity to design FRP strengthened concrete beams, apply the FRP by themselves, and finally test their samples up to failure.

**Lecture notes**
1) Power Point Printouts
2) Handouts

**Literature**
2) fib bulletin 14, Externally Bonded FRP Reinforcement for RC Structures, 2001
3) ISIS Canada Short Courses, http://www.isiscanada.com/

**Prerequisites**
1) Laboratory Tours and Demonstrations: Empa Structural Engineering Laboratory including Empa FRP Footbridge, Smart Composites, Large Scale Testing of Structural Components
2) Working with Composite Materials in the Laboratory (application, testing, etc)

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**101-0427-01L System and Network Planning**

**Abstract**
Public transports in the context of the transport systems; customer needs in the transport market; service planning processes for regular public transport services; long distance, regional and urban public transport service strategies; access to public transport and the last mile

**Objective**
Students will develop a basic knowledge of all stages of the public transport planning process from market demand to service planning; they will understand the most relevant planning methods and will be able to use them

**Content**
1) Fundamentals of system and network planning: Mobility and transport systems; public transport systems; customer needs versus supply characteristics of regular services. (2) System and network planning in public passenger services: Goals of the system and network planning: generic planning process; decision making, analysis of the situation, setting of targets; design of public transport services; evaluation and optimization; system planning. (3) Public transport services: long distance service offers; suburban and urban service offers; regional and local service offers; access to public transport and the last mile.

**Lecture notes**
A script in German will be provided for the course. The slides are made available.

**Literature**
References to technical literature will be included in the course script. An additional list of literature will be given during the course.

**Prerequisites**
No remarks.

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**101-0437-00L Traffic Engineering**

**Abstract**
Fundamentals of traffic flow theory and operations.

**Objective**
The objective of this course is to fully understand the fundamentals of traffic flow theory in order to effectively manage traffic operations. By the end of this course students should be able to apply basic techniques to model different aspects of urban and inter-urban traffic performance, including congestion.

**Content**
Introduction to fundamentals of traffic flow theory and operations. Includes understanding of traffic data collection and processing techniques, as well as data analysis, and traffic modeling.

**Lecture notes**
The lecture notes and additional handouts will be provided during the lectures.
The course provides the necessary knowledge to develop models supporting the solution of given planning problems. Examples of such problems include the estimation of traffic volumes, prediction of estimated utilization of new public transport lines, and evaluation of effects (e.g., change in emissions of a city) triggered by building new infrastructure and changes to operational regulations.

To cope with the forecasting problem it is first divided into sub-problems. Then, these are solved using various algorithms like iterative proportional fitting, shortest path algorithms, and the method of successive averages.

The course is composed of a lecture part, providing the theoretical knowledge, and an applied part, in which students create their own models. This part takes place in form of a tutorial and consists in the development of a computer program. The programming part is closely guided and particularly suited for students with little programming experience.

The slides of the lecture are provided electronically.

Lecture notes

The documents for the lecture can be found on the homepage of the Chair of Spatial Development.

Literature


K. W. Axhausen

Spatial development deals with the development and the design of our living space. To meet the expectations, the interests and the plans of the different actors, it is needed a planning approach considering the overview of both the actual and future situation. The concept of sustainable development in spatial planning leads necessarily to an efficient management of the resources, especially regarding the resource land. The basics of this important discipline will be the subject of this lecture, which is therefore organised in three parts:

- Integrated spatial and infrastructure development
- Inner development
- Integrated spatial and infrastructure development
- Cross-border issues in spatial development

Contents

Tasks of Spatial Planning and development
- Issues of local and supra-local interest
- Recurring spatial changes, impacts and key figures
- Formal and informal instruments and procedures in spatial planning
- Spatial Design - Ideas about the future
- Reasoning and assessing the situation in spatial planning
- Spatial planning as a sequence of decisions and interventions
- Process and procedures management
- Focus issues - Inner development before external development
- Focus issues - Cross-border tasks
- Focus Issues - Integrated spatial and infrastructure development

Further information and the documents for the lecture can be found on the homepage of the Chair of Spatial Development.

Lecture notes

4 credits

Sustainable Spatial Development I

Only for master students, otherwise a special permission by the lecturer is required.

The goal is to get a good understanding of some of the most important mathematical optimization techniques used to solve linear programs and basic combinatorial optimization problems.

Topics covered in this course include:
- Linear programming (simplex method, duality theory, shadow prices, ...).
- Basic combinatorial optimization problems (spanning trees, network flows, knapsack problem, ...).

Information about relevant literature will be given in the lecture.

Literature

Prerequisites / notice

This course is means for students who did not already attend the course "Mathematical Optimization", which is a more advance lecture covering similar topics and more.

401-0647-00L

Introduction to Mathematical Optimization

W 5 credits 2V+1U R. Zenklusen

Objective

The goal is to get a good understanding of some of the most important mathematical optimization techniques used to solve linear programs and basic combinatorial optimization problems.

Content

Topics covered in this course include:
- Linear programming (simplex method, duality theory, shadow prices, ...).
- Basic combinatorial optimization problems (spanning trees, network flows, knapsack problem, ...).

Literature

Content

This course is intended for students who did not already attend the course "Mathematical Optimization", which is a more advanced lecture covering similar topics and more.

Prerequisites / notice

This course is meant for students who did not already attend the course "Mathematical Optimization", which is a more advance lecture covering similar topics and more.

401-0317-00L

Sustainable Spatial Development I

W 3 credits 2G B. Scholl

Only for master students, otherwise a special permission by the lecturer is required.

Abstract

The lectures impart important knowledge for solving spatial relevant conflicts and problems. Case studies will be used to demonstrate the implementation in practice.

Objective

Spatial development deals with the development and the design of our living space. To meet the expectations, the interests and the plans of the different actors, it is needed a planning approach considering the overview of both the actual and future situation.

The concept of sustainable development in spatial planning leads necessarily to an efficient management of the resources, especially regarding the resource land. The basics of this important discipline will be the subject of this lecture, which is therefore organised in three parts:

- Integrated spatial and infrastructure development
- Inner development
- Integrated spatial and infrastructure development
- Cross-border issues in spatial development

Contents

Tasks of Spatial Planning and development
- Issues of local and supra-local interest
- Recurring spatial changes, impacts and key figures
- Formal and informal instruments and procedures in spatial planning
- Spatial Design - Ideas about the future
- Reasoning and assessing the situation in spatial planning
- Spatial planning as a sequence of decisions and interventions
- Process and procedures management
- Focus issues - Inner development before external development
- Focus issues - Cross-border tasks
- Focus Issues - Integrated spatial and infrastructure development

Further information and the documents for the lecture can be found on the homepage of the Chair of Spatial Development.

Lecture notes

4 credits

Basics in Air Transport

W 4 credits 3G P. Wild


Abstract

The course explains main principles of air transport in general and elaborates on simple interdisciplinary topics.

Since working on broad topics like aerodynamics, manufacturers, airport operation, business aviation, business models etc. the students gets a good overview in air Transportation.

Objective

Understand and explain basics, principles and contexts in the broader air transport industry.

Lay the foundation of working in or with the air transport industry.
Content: The basic equations are derived from first principles. Possible simplifications relevant for practical problems are shown and their

Content: Transport as part of the overall transportation scheme; Aerodynamics; Aircraft (A/C) Designs & Structures; A/C Operations; Law

Guided tour: This course includes a guided tour at Zurich Airport (baggage sorting system, apron, ATC Tower).

Examination: written, 60 min, with open book

Literature: We will also use English papers

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### Numerical Hydraulics

Hydraulic structures and their function within a hydraulic scheme are explained. The basic concepts of their layout and design with regard
to economy and safety are provided.

#### Prerequisites / notice

Information: Enrolment of Hydraulic Engineering II is strongly based on Hydraulic Engineering (101-0206-00L). Previously, it is recommended without having attended Hydraulic Engineering (101-0206-00L).

#### Literature

- Lecture notes, powerpoints shown in the lecture and programs used can be downloaded. They are also available in German.
- Additional literature is provided during the course.

#### Lectures

- Tools for hydrological modelling are discussed at the event and continuous scale. The focus is on the description of physical processes and

#### Examination

- Written, 60 min, with open book

#### Guided tour

- This course includes a guided tour at Zurich Airport (baggage sorting system, apron, ATC Tower).

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### Major in Hydraulic Engineering and Water Resources Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0247-01L</td>
<td>Hydraulic Engineering II</td>
<td>O</td>
<td>6</td>
<td>4G</td>
<td>R. Boes</td>
</tr>
<tr>
<td>101-0267-01L</td>
<td>Numerical Hydraulics</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>M. Holzner</td>
</tr>
<tr>
<td>102-0237-00L</td>
<td>Hydrology II</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>P. Burlando, S. Fatichi</td>
</tr>
<tr>
<td>102-0455-01L</td>
<td>Groundwater I</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>M. Willmann</td>
</tr>
</tbody>
</table>

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### Additional Content

- The course provides an introduction into quantitative analysis of groundwater flow and transport. It is focussed on formulating flow and
- The finite volume method as well as the method of characteristics are used for the solution of the shallow water equations. Special aspects such as wave propagation and turbulence modelling are also treated.

- The finite volume method as well as the method of characteristics are used for the solution of the shallow water equations. Special aspects such as wave propagation and turbulence modelling are also treated.

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### Examination

- Written, 60 min, with open book

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### Guided tour

- This course includes a guided tour at Zurich Airport (baggage sorting system, apron, ATC Tower).

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### Literature

- Lecture notes, powerpoints shown in the lecture and programs used can be downloaded. They are also available in German.
- Additional literature is presented during the course.

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### Prerequisites / notice

- Information: Enrolment of Hydraulic Engineering II is not recommended without having attended Hydraulic Engineering (101-0206-00L).
- Previously, it is strongly based on Hydraulic Engineering (101-0206-00L).

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### Objective

- a) Students understand the basic concepts of flow and contaminant transport processes and boundary conditions in groundwater.
- Students are able to formulate simple practical flow and transport problems.
- Students are able to understand and apply simple analytical solutions to simple flow and transport problems.
- Students are able to use simple numerical codes to adequately solve simple flow (and transport) problems.
Introduction, aquifers, groundwater use, sustainability, porosity.

Properties of porous media.

Exercises: Groundwater use, porosity, grain size analysis.

Flow properties, Darcy's law, filter.

Flow equations, stream function.

Exercises: Darcy's law.

Analytical solutions, confined aquifers, steady-state flow.

Exercises: Head isolines.

Use of superposition principles, transient flow, free surface flow.

Exercises: Analytical solutions to flow problems.

Finite difference solutions to flow problems I.

Exercises: Analytical solutions to flow problems.

Finite difference solutions to flow problems II.

Exercises: Finite difference formulations to flow problems.

Transport processes.

Exercises: Computer workshop using PMWIN.

Analytical solutions to transport problems I.

Exercises: Computer workshop using PMWIN.

Analytical solutions to transport problems II.

Exercises: Analytical solutions to transport problems.

Path lines, groundwater protection.

Exercises: Analytical solutions to transport problems.

Groundwater remediation, groundwater management.

Exercises: Groundwater remediation.

Lecture notes

Folien auf Internet unter www.ihw.ethz.ch/GWH/education/index

Altes Skript auf Internet www.ihw.ethz.ch/GWH/education/index

Weitere Texte auf Internet www.ihw.ethz.ch/GWH/education/index

Literature


W. Kinzelbach, R. Rausch, Grundwassermodellierung, Gebrüder Bornträger, Stuttgart, 1995

Krußmann, de Ridder, Untersuchung und Anwendung von Pumpversuchen, Verl. R. Müller, Köln, 1970

G. de Marsily, Quantitative Hydrogeology, Academic Press, 1986

River Engineering

Abstract

Main subjects treated:
- Fundamentals (e.g. sediment sampling methods), alluvial channel hydraulics, incipient motion, bed forms, bed load and suspended load, sediment budget and morphological changes, river morphology, scour, river management concepts and selected measures (e.g. bank and bed protection works).
- A practical exercise (voluntary, unmarked) is offered to deepen the learned subjects.

Objective

The students shall:
- be able to describe quantitatively the interrelation between discharge, sediment transport and channel evolution
- know the fundamentals and be able to apply the approaches and methods to treat river engineering problems associated with flood protection and river restoration

Content

The first part of the lecture treats the fundamentals required to deal with river engineering problems. Sampling methods for the river bed material and methods to calculate the discharge in alluvial rivers are presented. The process of river bed armoring and the principles of incipient motion, of bed load and suspended load transport are treated.

In the second part of the lecture the procedures to quantify the sediment budget and the morphological changes (erosion, aggradation) in river systems are explained. Furthermore, the process of natural channel formation and the different plan forms of rivers (straight, meandering, braided) are discussed. Own chapters are dedicated to the topics of bed forms, river morphology and scour.

The last part of the lecture concentrates on the design and dimensioning of river engineering works. The topics treated are the stabilization of banks and of the longitudinal profile of rivers.

Lecture notes

Autography River Engineering (in German)

Literature

The autography contains a comprehensive list of references to relevant literature.

Prerequisites / notice

The voluntary and unmarked exercise bases on field data, which are collected by the students on a river in nature. Besides the collection of fundamentals and field data, the exercise comprehends the calculation of the stage-discharge relationship, of the critical discharges at the onset of bed load transport and bed erosion and of the annual sediment load in a given river reach.

Major in Materials and Mechanics

Number Title Type ECTS Hours Lecturers

101-0617-00L Materials IV W+ 3 credits 2G H. J. Herrmann, I. Burgert, R. J. Flatt, F. Wittel

Abstract

This lecture is focused on current issues of materials research from various fields. It provides an overview on various directions of research on civil engineering materials and is intended to simplify the further choice of courses.
Based on the bachelor courses Materials I-III, current, fundamental, and important issues of specific building materials are addressed. Next to aspects of material production, usage and properties, their interaction with the environment e.g. by durability and environmental impact are addressed. This course is intended to simplify the further selection of courses.

**Objective**

The lecture is segmented into 13 important problems, namely:
1. Materials, Structures, and Sustainability
2. Granular matter: (DEM)
3. Fracture mechanics and size effects in concrete
4. Cyclic failure of asphalt (Fatigue)
5. Mechanics and failure of fiber reinforces materials
6. Wood: from the tree to the beam (multi scale approaches)
7. Transport and degradation in porous building materials
8. Rheology
9. Plasticity
10. Foam (e.g. polymers)
11. Gluing and coating (surfaces)
12. Asbestos, nano particles and hazardous substances
13. Biomimetics in Constructions

**Content**


**Prerequisites / notice**

The lecture will be given in english.

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**402-0809-01L Introduction to Computational Physics (for Civil Engineers) W 4 credits 2V+1U H. J. Herrmann**

**Abstract**

This course offers an introduction to computer simulation methods for physics problems and their implementation on PCs and super computers: classical equations of motion, partial differential equations (wave equation, diffusion equation, Maxwell’s equation), Monte Carlo simulations, percolation, phase transitions

**Content**


**Prerequisites / notice**

Lecture and exercice lessons in english

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**101-0637-01L Wood and Wood Composites W 3 credits 2G A. Frangi, I. Burgert, G. Fink, M. Fontana, R. Steiger**

**Abstract**

Knowledge of characteristic properties of wood as a anisotropic and porous material and their consideration in structural timber design. History, ecology, structure of timber, drying, material properties, influence of moisture and creep. Durability and grading.

**Objective**

Knowledge of characteristic properties of wood as a anisotropic and porous material and their consideration in structural timber design. Knowledge about history, ecology, structure of timber, drying, material properties, influence of moisture and creep, durability and grading.

**Content**


**Prerequisites / notice**

Lecture and case studies.

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**101-0677-00L Concrete Technology W 2 credits 2G G. Martinola, M. Bäuml**

**Abstract**

Opportunities and limitations of concrete technology. Commodities and leading edge specialties.

**Objective**

Advanced education in concrete technology for civil engineers who are designing, specifying and executing concrete structures.

**Content**

Based on the lecture ‘Werkstoffe I’ students receive deep concrete technology training. A comprehensive knowledge of the most important properties of conventional concrete and the current areas of research in concrete technology will be presented. The course covers various topics. The content of the course is:
1. concrete components
2. concrete properties
3. concrete mix design
4. production, transport, casting
5. demoulding, curing and additional protective measures
6. durability
7. standards
8. high performance concretes
   1. high strength and ultra high strength concrete
   2. fiber reinforced concrete
   3. self compacting concrete
   4. shotcrete
   5. light weight concrete
   6. low shrinkage concrete
   7. low heat concrete for mass structures
   8. frost and wear resistant concrete
9. concrete for low and high ambient temperatures

**Lecture notes**

Slides provided for download.

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**101-0177-00L Building Physics: Moisture and Durability W 3 credits 2G J. Carmeliet, T. Defraeye**

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 131 of 1434
Abstract
Moisture transport and related degradation processes in building and civil engineering materials and structures; concepts of poromechanics and multiscale analysis; analysis of damage cases.

Objective
- Basic knowledge of moisture transport and related degradation processes in building and civil engineering materials and structures
- Introduction to concepts of poromechanics and multiscale analysis
- Application of knowledge by the analysis of damage cases

Content
1. Introduction
Moisture damage: problem statement
Durability

2. Moisture Transport
Description of moisture transport
Determination of moisture transport properties
Hysteresis
Transport in cracked materials
Damage and moisture transport in cracked media

3. Poromechanics
Moisture and mechanics: poro-elasticity
Poro-elasticity and salt crystallisation
Poro-elasticity and damage
Case studies

4. Multiscale analysis
Problem statement
Multiscale transport model
Multiscale coupled transport - damage model

101-0648-00L Metallic Materials and Corrosion W+ 3 credits 2G B. Elsener
Abstract
Metals in civil engineering (steels, high strength steel, Al-alloys, stainless steels). Mechanisms to improve the mechanical properties, plastic deformation (dislocations), mechanical tests. Corrosion, stress corrosion. The goal is the understanding of the relation between chemical composition, microstructure and mechanical properties and durability (corrosion) of metallic materials. Case studies.

Objective
Knowledge and comprehension of the fundamentals of material science of metallic materials such as the relation between chemical composition, microstructure and properties of metallic materials. Ability to critically select the appropriate materials for application in civil engineering (fixation elements, reinforcement for concrete structures, high-strength steels).

Content
Fundamentals of metallic materials, crystal structure of metallic materials, defects, solidification.
Properties of metallic materials, physical (electrical, magnetic), mechanical (strength, deformation, fracture), chemical (corrosion resistance).
Most important alloys (steels, aluminium alloys, stainless steels)
Examples of application

Lecture notes
Lecture notes (in german) are distributed at the beginning of the course.
Reprints for selected topics.

Literature
Donald R. Askeland, Materialwissenschaften, Spektrum Akademischer Verlag, Heidelberg (1996)
ISBN 3-86025-357-3
Kapitel 1 - 13

3. Semester

Major Courses

Major in Construction and Maintenance Management

Number Title Type ECTS Hours Lecturers
101-0509-00L Infrastructure Management Systems W+ 3 credits 2G B. T. Adey
Abstract
The course will provide an introduction to the human and computerized systems used to manage infrastructure.

Objective
Upon completion of the course students will have the fundamental knowledge required
- to identify and model the processes used in organizations to manage infrastructure,
- to establish benchmarks that can be used to measure the performance of organizations that manage infrastructure, and
- to evaluate organizations that manage infrastructure

Content
- Introduction
- Organisation types used to manage infrastructure
- Processes used in organizations that manage infrastructure
- Methods used to evaluate organizations that manage infrastructure, including the establishment of appropriate benchmarks

Lecture notes
Appropriate reading / and study material will be handed out during the course.
Transparencies will be handed out at the beginning of each class.

Literature
Appropriate literature will be handed out when required.

101-0549-00L Selected Topics on Legal Aspects in Civil Engineering W+ 3 credits 2G H. Briner, D. Trümpy
Abstract
Basic knowledge in public and private law of civil engineering. Examples of the subjects treated: space management, protection of the environment, legal procedures, standards for building technology and contracts.

Objective
Part 1: The students shall acquire basic knowledge of the public law concerning civil engineering:
- space management, conception of buildings, protection of the environment, procedures
Part 2: The students shall acquire basic knowledge of the private law concerning civil engineering

Content
Teil 1: Jede Lektion behandelt für ein bestimmtes Stadium des Projekts ein Thema des öffentlichen Baurechts wie Bau- und Zonenordnungen, Quartierpläne, Umweltverträglichkeitsprüfungen, Baubewilligungsverfahren etc.
Teil 2: Grundzüge des privaten Baurechts wie Abnahme und Genehmigung von Bauwerken, Vollmacht des Architekten / Ingenieurs zu Rechtshandlungen namens des Bauherrn, Mängelrüge im Bauwesen, Mehrheit ersatzpflichtiger Baubeteiligter, Generalliegentümervertrag, Haftung des Baumaterialverkäufers, Bauhandwerkerpfandrecht, Grundzüge der SIA-Norm 118, Baukonsortium, technische Normen, internationale Bauverträge, Architekten / Ingenieure als Gerichtsexperten, Aspekte des Bauzivilprozesses

Lecture notes
D. Trümpy: Tafeln zu den Grundzügen des schweizerischen Bauvertragsrechts (Vorlesungsunterlage)
H. Briner: Tafeln zu den Grundzügen des öffentlichen Raumplanungs-, Bau- und Umweltrechts (Vorlesungsunterlage)

Literature
- Stöckli P./Siegenthaler Th. (Hrsg.) Die Planerverträge, Schulthess 2013
- Gauch Peter, Werkvertrag, 5. Auflage, Schulthess 2011
A list of the basic literature will be offered on a specific online platform, that could be used by all students attending the lectures.

Handouts

The course presents cost benefit analysis and related evaluation methods in transport and introduces the survey methods used to derive familiarity with the essential methods of project appraisal.

All documents for certification labels as well as detail plans of the buildings will be available for the students.

4 credits

After this course, the students are able to understand and use the different certification labels.

K. W. Axhausen

The following topics give an overview of the themes that are to be worked on during the lecture.

- Synthesis 4: Transition to sustainable development
- Synthesis 1: Climate Change mitigation and adaptation in cities
- Synthesis 2: Transition to sustainable development
- Method 3: Construction, flexibility, modularity
- Method 2: Economics for sustainable construction
- Method 1: Life cycle assessment (planning, construction, operation/ use, deconstruction)
- Case Study 4: Buildings, heating/cooling, consumers, prosumers and other stakeholder, cooperations
- Case Study 3: Material resources, scenarios, energy, construction materials, urban metabolism
- Case Study 2: Cities, forms of settlements
- Case Study 1: Sustainable construction, the role of construction industry (national/international)
- Case Study 6: Sustainable construction, the role of construction industry (national/international)
- Case Study 5: Material resources, scenarios, energy, construction materials, urban metabolism
- Case Study 4: Buildings, heating/cooling, consumers, prosumers and other stakeholder, cooperations
- Case Study 3: Material resources, scenarios, energy, construction materials, urban metabolism
- Case Study 2: Cities, forms of settlements
- Case Study 1: Sustainable construction, the role of construction industry (national/international)

All relevant information will be online available before the lectures. For each lecture slides of the lecture will be provided.

Lecture notes

A list of the basic literature will be offered on a specific online platform, that could be used by all students attending the lectures.

Lecture notes

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Lecture notes

A list of the basic literature will be offered on a specific online platform, that could be used by all students attending the lectures.

Lecture notes

Does not take place this semester.

Number of participants limited to 25

The slides from the presentations will be made available.

All documents for certification labels as well as detail plans of the buildings will be available for the students.

Handouts

Autumn Semester 2015
Deeper the knowledge on selected topics of underground construction as well as learning working out conceptual solutions of complex Track geometry including calculation and measuring as well as related data systems; interaction between track and vehicles, vehicle dynamics, stress; track construction including special features of railway bridges and tunnels; track diagnostics and forecast; track maintenance and related methods

The lecture gives a deeper insight into track geometry, the interaction between track and vehicles as well as in construction and dimensioning of the track. Methods for the diagnosis of the state of the track and its forecast are shown. State-of-the-art maintenance strategies and technologies are presented.

Track geometry including calculation and measuring as well as related data systems; interaction between track and vehicles, vehicle dynamics, stress; track construction including special features of railway bridges and tunnels; track diagnostics and forecast; track maintenance and related methods

The slides will be made available.

The lecture Railway Infrastructures (Transportation II) is recommended.

### Major in Geotechnical Engineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>101-0329-00L</td>
<td>Tunnelling III</td>
<td>W</td>
<td>4</td>
<td>2G</td>
<td>G. Anagnostou, E. Pimentel, M. Ramoni</td>
</tr>
<tr>
<td>101-0339-00L</td>
<td>Environmental Geotechnics</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>L. M. Plötze</td>
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<tr>
<td>101-0359-00L</td>
<td>Physical Modelling in Geotechnics</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>to be announced</td>
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</tbody>
</table>

**Abstract**

Deeper the knowledge on selected topics of underground construction as well as learning working out conceptual solutions of complex problems.

Lecture: Deepen the knowledge on selected topics of underground construction.

Exercises: Conceptual solutions of complex problems.

Caverns: Geometry, construction methods, support.

Shafts: Construction methods, support.

Urban tunnelling: Boundary conditions, system choice, alignment, design.

Field measurements: Principles, monitoring layout, applications, interpretation.

Cut and cover tunnels: Modelling, design.

Exercising conceptual solution of complex tunnelling problems based upon discussion of current tunnel cases with particularly demanding problems in small groups.

Autographieblätter

Empfehlungen

Prerequisite: BSc course "Tunnelling", MSc courses "Tunnelling I" and "Tunnelling II".

**Objective**

Introduction of basic knowledge about problems with contaminated sites, investigation of this sites, risk management, remediation and reclamation techniques as well as monitoring systems.

Introduction in landfill design and engineering with focus on barrier- and drainage systems and lining materials, evaluation of geotechnical problems, e.g. stability

Introduction of basic knowledge about problems with contaminated sites, investigation of this sites, risk management, remediation and reclamation techniques as well as monitoring systems.

Introduction in landfill design and engineering with focus on barrier- and drainage systems as well as lining materials, evaluation of geotechnical problems, e.g. stability.

Definition of contaminated sites, site investigation methods, historical research and technical investigation, risk assessment, contamination transport, remediation, clean-up and retaining techniques (e.g. bioremediation, incineration, retaining walls, pump-and-treat, permeable reactive barriers), monitoring, research projects and results.

Dr. R. Hermanns Stengele, Dr. M. Plötze: Environmental Geotechnics (german) digital excursion

### Literature

**Literature**


In this course selected famous geotechnical failures are investigated with the following purpose: (a) to deepen understanding of the geotechnical risks and possible solutions; (b) to practice design and analysis methods; (c) to learn the techniques for investigation of failures; (d) to learn the techniques for mitigation of the failure damage.

Abstract
In this course selected famous geotechnical failures are investigated with the following purpose: (a) to deepen understanding of the geotechnical risks and possible solutions; (b) to practice design and analysis methods; (c) to learn the techniques for investigation of failures; (d) to learn the techniques for mitigation of the failure damage.

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Content
Failure of shallow and deep foundations
Failure due to the creeping landslides
Failure due to excessive settlements
Failure due to the leaning instability
Failure due to tunneling
Excavation failure

Lecture notes
Lecture notes
Exercises

Literature

Prerequisites / notice
Prerequisite: Basic knowledge in Geotechnical Engineering (Course content of "Grundbau" or similar lecture)

101-0369-00L Geotechnical Engineering

W 3 credits 2G A. Puzrin

Abstract
In this course selected famous geotechnical failures are investigated with the following purpose: (a) to deepen understanding of the geotechnical risks and possible solutions; (b) to practice design and analysis methods; (c) to learn the techniques for investigation of failures; (d) to learn the techniques for mitigation of the failure damage.

Objective
In this course selected famous geotechnical failures are investigated with the following purpose: (a) to deepen understanding of the geotechnical risks and possible solutions; (b) to practice design and analysis methods; (c) to learn the techniques for investigation of failures; (d) to learn the techniques for mitigation of the failure damage.

Content
Failure of shallow and deep foundations
Failure due to the creeping landslides
Failure due to excessive settlements
Failure due to the leaning instability
Failure due to tunneling
Excavation failure

Lecture notes
Lecture notes
Exercises

Literature

Prerequisites / notice
Prerequisite: Basic knowledge in Geotechnical Engineering (Course content of "Grundbau" or similar lecture)

101-0119-00L Structural Masonry

W 3 credits 2G N. Mojsilovic

Abstract
Knowledge of the engineering properties of materials for masonry construction.
Technical understanding of the structural behaviour of load-bearing masonry structures subjected to in-plane forces and combined actions.
Develop a technical competence for design procedures for load-bearing masonry structures by means of exercises.

Objective
Knowledge of the engineering properties of materials for masonry construction.
Technical understanding of the structural behaviour of load-bearing masonry structures subjected to in-plane forces and combined actions.
Develop a technical competence for design procedures for load-bearing masonry structures by means of exercises.

Content
Historical Development of Masonry Construction
Detailing and Execution
Construction Materials
Structural Behaviour and Modelling
Structural Analysis and Dimensioning
Reinforced Masonry

Lecture notes
Lecture notes
Exercises

Literature
"Mauerwerk, Bemessungsbeispiele zur Norm SIA 266", SIA Dokumentation D0196, 2004
"Mauerwerk", Norm SIA 266, 2003

101-0129-00L Existing Structures

W 3 credits 2G T. Vogel

Abstract
Treatment of the topic primarily from the perspective of a consulting engineer dealing with a single object.
Elaboration of a systematic procedure for respective projects. Consolidation for concrete structures and extension to other construction methods.
Uncovering of interfaces between owners, architects, contractors and specialists.

Objective
Treatment of the topic primarily from the perspective of a consulting engineer dealing with a single object.
Elaboration of a systematic procedure for respective projects. Consolidation for concrete structures and extension to other construction methods.
Uncovering of interfaces between owners, architects, contractors and specialists.

Content
Systematics of existing structures, examination (condition survey, condition examination, recommendation of remedial measures), non-destructive testing methods, natural stone masonry, strengthening methods (esp. plate bonding)

Lecture notes
Lecture notes
Exercises

Literature
Normen SIA 269, 269/1 bis 269/6, SIA-Dokumentationen D 0239 und D 0240 der Einführungskurse

101-0149-00L Plate and Shell Structures

W 3 credits 2G T. Vogel, S. Fricker

Abstract
Basic load bearing behaviour of plate and shell structures
Comprehension of basic load bearing behaviour of plate and shell structures; knowledge of typical applications of different materials, ability to reasonably interpret and check results of numerical calculations, establish access to technical literature.

Objective
Basic load bearing behaviour of plate and shell structures
Comprehension of basic load bearing behaviour of plate and shell structures; knowledge of typical applications of different materials, ability to reasonably interpret and check results of numerical calculations, establish access to technical literature.

Content
In-plane loaded plates (cartesian and polar coordinates)
Kinematics of in-plane loaded plates
Folded plate structures
Thin plates with small deflections
Circular plates
Thin plates with large deflections
Geometry of curved surfaces
Shells (basics, membrane theory, bending theory, form finding)

Lecture notes
Autographie "Flächentragwerke"
2G After successfully completing this course the students will be able to:

- Basic knowledge of structural timber design including material behaviour especially anisotropy, moisture and long duration effects and their
- The course is complemented by Homework Sessions using computing tools and FE software such as MATLAB, ABAQUS & ANSYS.
- Nonlinear constitutive relations.
- Dynamic finite element analysis.
- Solution of eigen value problems.
- Practical application of the finite element nonlinear and/or dynamic analysis
- Problem solution using MATLAB, ABAQUS and ANSYS

Lecture notes
Handouts, Course Script available on http://www.ibk.ethz.ch/ibk/ch/education/femII/index_EN

Literature
Course Script available on http://www.ibk.ethz.ch/ibk/ch/education/femII/index_EN

Useful Reading:
"Nonlinear Finite Elements of Continua and Structures" by T. Belytschko, W.K. Liu, and R. Moran.


101-0169-00L Timber Structures II

Abstract
Basic knowledge of structural timber design including material behaviour especially anisotropy, moisture and long duration effects and their

Objective
Comprehension and application of basic knowledge of structural timber design including material behaviour especially anisotropy, moisture
and long duration effects and their consideration in structural analysis and detailing. Design, detailing and structural analysis of timber roof
structures, buildings and bridges.

Content
Field of application of timber structures; Timber as building material (wood structure, physical and mechanical properties of wood and
wood-based products); Durability; Principles of design and dimensioning; Connections (dowels, nails, screws, glued connections); Timber
components and assemblies (mechanically jointed beams, trusses); Design and detailing of timber roof structures, buildings and bridges.

Lecture notes
Autography Timber Structures
Copies of lecture slides

Literature
Timber design tables HBT 1, Lignum (2012)
Swiss Standard SIA 265 (2012)
Swiss Standard SIA 265/1 (2009)

Prerequisites / notice
Timber Structures I

101-0189-00L Seismic Design of Structures II

Abstract
The following advanced topics will be covered: 1) behavior and non-linear response of structural systems under earthquake excitation; 2)
seismic behavior and design of moment frame, braced frame, shear wall and masonry structures; 3) fundamentals of seismic isolation; and
4) assessment and retrofit of existing buildings. These topics are discussed in terms of performance-based seismic design.

Objective
After successfully completing this course the students will be able to:
1. Use the knowledge of nonlinear dynamic response of structures to interpret the design code provisions and apply them in seismic
design structural systems.
2. Explain the seismic behavior of moment frame, braced frame and shear wall structural systems and successfully design such systems
to achieve the performance objectives stipulated by the design codes.
3. Determine the performance of structures under earthquake loading using modern performance assessment methods and analysis
tools.

Content
This course completes the series of two courses on seismic design of structures at ETHZ. Building on the material covered in Seismic
Design of Structures I, the following advanced topics will be covered in this course: 1) behavior and non-linear response of structural
systems under earthquake excitation; 2) seismic behavior and design of moment frame, braced frame and shear wall structures; 3)
fundamentals of seismic isolation; and 4) assessment and retrofit of existing buildings. These topics will be discussed from the standpoint
of performance-based design.

Lecture notes
The electronic copies of the learning material will be uploaded to ILIAS and available through myStudies. The learning material includes the
lecture presentations, additional reading, and exercise problems and solutions.

Literature
Earthquake Engineering: From Engineering Seismology to Performance-Based Engineering, Yousef Borzognia and Vitelmo Bertero, Eds.,
CRC Press, 2004


Prerequisites / notice
ETH Seismic Design of Structures I course, or equivalent. Students are expected to understand the seismological nature of earthquakes, to
characterize the ground motion excitation, to analyze the response of elastic single- and multiple-degree-of-freedom systems to earthquake
excitation, to use the concept of response and design spectrum, to compute the equivalent seismic loads on simple structures, and to
perform code-based seismic design of simple structures. Familiarity with structural analysis software, such as SAP2000, and general-
purpose numerical analysis software, such as Matlab, is expected.

101-0439-00L Introduction to Economic Policy - A Case Study Approach with Cost Benefit Analysis in Transport

This course was offered as "Transport Systems Evaluation" until HS14.

Abstract
The course presents cost benefit analysis and related evaluation methods in transport and introduces the survey methods used to derive
the monetary values of non-market goods.
Cost-Benefit Analysis; multi-criteria analysis; European guidelines; stated response methods; travel cost approach and others; Valuation of Railway safety strategies, P. Güldenapfel, Road Safety

The collection and the methods of statistical and geographical analysis of road accidents are important fundamentals of this course. Safety Aspects in design of urban roads are discussed and measures for improving the safety situation are presented. Procedures of infrastructure safety management for administrations and police are another topic.

Objective

Importing knowledge about road safety and the event of accident, presenting possibilities to increase road safety

Content

Accident origin, collection of road accidents, statistical (descriptive and multivariate, accident prediction models) and geographical analysis of road accidents, risk analysis and rehabilitation measures, road safety instruments for infrastructure with focus on road safety audit, Swiss and international transport policy

Literature


Further literature: will be presented during the course

101-0469-00L Road Safety W 6 credits 4G H. Schüller, A. Simma, S. Skeledzic

Abstract

The collection and the methods of statistical and geographical analysis of road accidents are important fundamentals of this course. Safety Aspects in design of urban roads are discussed and measures for improving the safety situation are presented. Procedures of infrastructure safety management for administrations and police are another topic.

Objective

Importing knowledge about road safety and the event of accident, presenting possibilities to increase road safety

Content

Accident origin, collection of road accidents, statistical (descriptive and multivariate, accident prediction models) and geographical analysis of road accidents, risk analysis and rehabilitation measures, road safety instruments for infrastructure with focus on road safety audit, Swiss and international transport policy

Literature


Further literature: will be presented during the course

101-0419-00L Railway Construction and Maintenance W 4 credits 4G U. A. Weidmann, P. Güldenapfel, M. Kohler, M. J. Manhart, further speakers

Abstract

Track geometry including calculation and measuring as well as related data systems; interaction between track and vehicles, vehicle dynamics, stress; track construction including special features of railway bridges and tunnels; track diagnostics and forecast; track maintenance and related methods

Objective

The lecture gives a deeper insight into track geometry, the interaction between track and vehicles as well as in construction and dimensioning of the track. Methods for the diagnosis of the state of the track and its forecast are shown. State-of-the-art maintenance strategies and technologies are presented.

Content

Track geometry including calculation and measuring as well as related data systems; interaction between track and vehicles, vehicle dynamics, stress; track construction including special features of railway bridges and tunnels; track diagnostics and forecast; track maintenance and related methods

Prerequisites / notice

The lecture Railway Infrastructures (Transportation II) is recommended.

101-0479-00L Safety and Reliability of Railway Systems W 3 credits 3G U. A. Weidmann, O. Fink, M. Montigel

Abstract

Railway safety policies and safety concepts, command and control technologies for railways, optimization systems, European Train Control System, reliability availability maintainability safety (RAMS) of railway systems.

Objective

The students comprehend the main principles of safety, reliability and optimization for railway systems and understand the basic concepts of command and control technologies for railways.

Content

Railway safety strategies
- Safety in public transport
- Safety relevant characteristic of railway transport
- Safety requirements for railway transport
- Safety concepts

Command and control technologies for railways systems
- Protective functions
- Ensure the sequence/spacing of trains
- Ensure route protection
- Ensure level crossing protection
- Technical realization for protective functions
- European Train Control System

Operational command/control systems
- Dispatching
- Operational control systems
- Concepts of optimization

RAMS for railway systems
- Accident investigation methods
- RAMS standards for railways
- Risk analysis and hazard control
- RAMS methods
- Design principles for availability and safety
- Maintenance strategies
- Life Cycle Costs (LCC)
- Human Factor
- Safety in long railway tunnels

Lecture notes

The slides will be provided in German.

Literature

Further literature: will be presented during the course

Prerequisites / notice

The students must have completed the lecture “Railway Construction and Maintenance” and have a basic knowledge of track geometry and track construction.

101-0449-00L Management, Marketing, Quality W 6 credits 4G U. A. Weidmann

Abstract

Transport and administrative policy, international and national regulation, business management of public transport companies, marketing, advertising and pricing; quality management

Prerequisites / notice

The students must have completed the lecture “Railway Construction and Maintenance” and have a basic knowledge of track geometry and track construction.

References


Further literature: will be presented during the course.
Objective
Comprehension of the transport and administrative policy as well as of the regulation of public transport companies. To develop a full understanding of the three important public transport system operations management processes: (1) Business management; (2) Marketing; (3) Quality control. The course will teach essential working techniques in each of these processes.

Content
(1) Transport and administrative policy: Goals of the state related to public transports, governmental activities in public transport, regulation.
(2) Business management in public transport enterprises: goals of public transport companies, goals of the business management, management of public transport on the different management levels, business organization.
(3) Marketing, advertising and pricing: Fundamentals and goals; marketing strategies and concepts in public transports; marketing tools; putting marketing into action.
(4) Quality control: Quality in transport systems; goals of quality management; structuring quality control measures; collecting quality data in an operating service; use of quality control systems for service optimization.

Lecture notes
Course notes will be provided in German. Slides will be made available.

Literature
References to technical literature will be included in the course script. An additional list of literature will be given during the course.

Prerequisites / notice
Lectures System and Network Planning as well as Systems Dimensioning and Capacity recommended.

<table>
<thead>
<tr>
<th>101-0579-00L</th>
<th>Infrastructure Maintenance Processes</th>
<th>W</th>
<th>3 credits</th>
<th>2G</th>
<th>B. T. Adey</th>
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<tbody>
<tr>
<td>Abstract</td>
<td>This course provides an introduction to:</td>
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<td></td>
<td>- how to model the changes in infrastructure objects over time,</td>
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<td>- how to monitor these changes and assess the benefits of monitoring,</td>
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<td>- how to intervene to improve infrastructure performance and assess the benefits of interventions, and</td>
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<td>- how to model the changes in stakeholders interests over time.</td>
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<td>Objective</td>
<td>to provide the basic information and tools to be used to make decisions with respect to existing infrastructure</td>
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<tr>
<td>Content</td>
<td>Deterioration</td>
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<td></td>
<td>- manifest and latent processes,</td>
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<td></td>
<td>- modeling Monitoring</td>
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<td>- non-destructive and destructive techniques,</td>
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<td>- evaluation of benefits of monitoring Intervention</td>
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<td>- types of intervention,</td>
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<td>- evaluation of benefits of intervention Benefits</td>
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<td>- modeling of stakeholder benefits over time</td>
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<tr>
<td>Lecture notes</td>
<td>All necessary materials (e.g. transparencies and hand-outs) will be handed out at the beginning of each class.</td>
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<tr>
<td>Literature</td>
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<td>The course will provide an introduction to the human and computerized systems used to manage infrastructure.</td>
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<td>- to establish benchmarks that can be used to measure the performance of organizations that manage infrastructure, and</td>
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<td>- to evaluate organizations that manage infrastructure</td>
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<tr>
<td>Content</td>
<td>- Introduction</td>
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<tr>
<td></td>
<td>- Organisation types used to manage infrastructure</td>
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<td></td>
<td>- Processes used in organizations that manage infrastructure</td>
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<tr>
<td></td>
<td>- Methods used to evaluate organizations that manage infrastructure, including the establishment of appropriate benchmarks</td>
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<tr>
<td>Lecture notes</td>
<td>Appropriate reading / and study material will be handed out during the course.</td>
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<tr>
<td>Literature</td>
<td>Transparencies will be handed out at the beginning of each class.</td>
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<table>
<thead>
<tr>
<th>103-0417-02L</th>
<th>Theory and Methodology of Spatial Planning</th>
<th>W</th>
<th>3 credits</th>
<th>2G</th>
<th>R. Signer, M. Nollert</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Only for master students, otherwise a special permission by the lecturer is required.</td>
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<tr>
<td>Objective</td>
<td>In order to solve problems in spatial planning it is necessary to explore actions and to judge them; finally, one has to argue why a certain option should be preferred to others. Assessments of the situation are the basis for the problems to treat. Specific knowledge, represented in an adequate manner, is required.</td>
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<tr>
<td>Content</td>
<td>The participants know the interdependencies between the assessment of a situation, decision making, knowledge and language. They know the nature of a decision dilemma and maximes, how to deal with it. Especially they learn that the requirement of information for a decision depends upon the preferences of the deciding acteur. They are also familiar with difficulties and pitfalls within these contexts and know what can be done against it.</td>
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<tr>
<td>Literature</td>
<td>Appropriate literature will be handed out when required.</td>
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<tr>
<th>101-0491-00L</th>
<th>Agent Based Modeling in Transportation</th>
<th>W</th>
<th>3 credits</th>
<th>2G</th>
<th>F. Ciari, R. Waraich</th>
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<tbody>
<tr>
<td>Abstract</td>
<td>The main topics of the lecture are:</td>
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<tr>
<td></td>
<td>1) Introduction to the agent-based paradigm and overview on existing agent-based models in transportation, including MATSim</td>
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<tr>
<td></td>
<td>2) Learn how to setup MATSim for policy analysis</td>
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<td></td>
<td>3) Learn about the interfaces available to enhance the software (includes Java programming)</td>
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<td></td>
<td>4) Create, run and analyse a policy study</td>
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<tr>
<td>Objective</td>
<td>The objective of this course is to make the students familiar with agent-based models and in particular with the software MATSim. They will learn the pros and cons of this type of approach versus traditional transport models and will learn to use the simulation. They will design a policy study and run simulations to evaluate the impacts of the proposed policies.</td>
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<tr>
<td>Content</td>
<td>The main topics are:</td>
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<tr>
<td></td>
<td>1) Introduction to the agent-based paradigm and overview on existing agent-based models in transportation, including MATSim</td>
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<td></td>
<td>2) Introduction of basic building blocks of simulation approaches (random numbers generation, experimental design, variance control, response surface estimation)</td>
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<td>3) Revision of the key submodels and their parameters and concepts (value of time, Wardrop (Nash) equilibrium, etc.)</td>
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<td></td>
<td>4) Learn how to setup MATSim for policy analysis</td>
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<td></td>
<td>5) Learn about the interfaces available to enhance the software (includes Java programming)</td>
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<td></td>
<td>6) Create, run and analyse a policy study</td>
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</table>
Agent-based modeling in general

BDMBSim


Additional relevant readings, mostly scientific articles, will be recommended throughout the course.

There are no strict preconditions in terms of which lectures the students should have previously attended. However, it is expected that the students have some experience with some high level programming language (i.e. C, C++, Fortran or Java).

**Major in Hydraulic Engineering and Water Resources Management**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>101-0249-00L</td>
<td>Selected Topics on Hydraulic Engineering</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>R. Boes, I. Albayrak</td>
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<tr>
<td></td>
<td>Prerequisites: 101-0247-01L Hydraulic Engineering II or equivalent course.</td>
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<tr>
<td>Abstract</td>
<td>The lecture focuses on selected topics in hydraulic engineering, water management and aquatic ecology relating to hydropower and flood protection projects.</td>
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<tr>
<td>Objective</td>
<td>To deepen knowledge on special aspects in hydraulic engineering and to understand the procedures and the planning sequence of hydropower projects.</td>
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<tr>
<td>Content</td>
<td>Different selected topics in hydraulic engineering will be focused on, e.g. dam safety, possible problems at reservoirs like sedimentation or natural hazards by impulse waves, the hydraulics of river flows, spillways and intake structures at dams and weirs, hydropower and ecology like fish-ecological aspects at low-head hydropower plants and eco-hydraulics like flow-vegetation interaction. Another focus will be put on typical approaches and procedures in the planning process of hydropower projects.</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes/handouts will be available online.</td>
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<tr>
<td>Literature</td>
<td>Additional literature recommendations will be provided at the lectures.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>There are no pre-requisites for this course. The course Transport Simulation (101-0438-00 G) and previous experience with VISSIM is helpful but not mandatory. In addition, simultaneously taking the course Traffic Engineering (101-0437-00 G) is encouraged.</td>
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<tbody>
<tr>
<td>101-0269-00L</td>
<td>Numerical Modelling in Fluvial Hydraulics and River Engineering</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>D. F. Vetsch, A. Siviglia</td>
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<tr>
<td>Abstract</td>
<td>The basics of numerical modelling of fluvial hydraulics and river engineering problems are presented. The governing equations for flow and sediment transport in open channels and corresponding numerical solution strategies are introduced. The theoretical parts are discussed by examples.</td>
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<tr>
<td>Objective</td>
<td>Get to know possibilities and limitations of numerical modelling in fluvial hydraulics and river engineering.</td>
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<tr>
<td>Content</td>
<td>- Governing equations and modelling approaches</td>
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<td></td>
<td>- Initial and boundary conditions</td>
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<td></td>
<td>- Simulation process and grid generation</td>
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<td></td>
<td>- Numerical methods: basics, accuracy and stability</td>
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<tr>
<td></td>
<td>- Examples of numerical schemes, 1D and 2D models</td>
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<tr>
<td>Lecture notes</td>
<td>Slides of lecture are available for download as PDF. Supplementary material will be provided during lecture.</td>
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<tr>
<td>Literature</td>
<td>Relevant books and citations will be mentioned.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Exercises are based on the simulation software BASEMENT (<a href="http://www.basement.ethz.ch">www.basement.ethz.ch</a>), the open-source GIS Qgis (<a href="http://www.qgis.org">www.qgis.org</a>) and code examples written in MATLAB. The applications comprise one- and two-dimensional approaches for the modelling of flow and sediment transport.</td>
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<tbody>
<tr>
<td>101-0289-00L</td>
<td>Applied Glaciology</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>M. Funk, A. Bauder</td>
</tr>
<tr>
<td>Abstract</td>
<td>We will explain the fundamentals of physics of glaciers which are necessary for treating applied problems. We will go into climate-glacier interactions, flow of glaciers, lake ice and hydrology of glaciers.</td>
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<tr>
<td>Objective</td>
<td>To understand the fundamental physical processes in glaciology.</td>
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<td></td>
<td>To learn some basic numerical modelling techniques for glacier flow.</td>
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<td></td>
<td>To identify glaciological hazards and to learn some assessment and mitigation possibilities.</td>
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Basics in physical glaciology
Dynamics of glaciers: deformation of glacier ice, role of water in glacier motion, reaction of glaciers to climate changes, glacier calving, surges
Ice falls, ice avalanches
Glacier floods
Lake ice and bearing capacity

Lecture notes
Handouts are available

Literature
Relevante Literatur wird während der Vorlesung angegeben.

Prerequisites / notice
Für aktuelle Fallbeispiele werden risikobasierte Massnahmen bei glaziologischen Naturgefahren diskutiert.

Voraussetzungen: Es werden Grundkenntnisse in Mechanik und Physik vorausgesetzt.

101-1249-00L  Wastewater Hydraulics

Abstract
The basics of wastewater hydraulics are described from the environmental and the hydraulic points of views thereby presenting also examples from engineering practice. Typical case studies are further described during a laboratory visit of VAW.

Objective
The understanding and the computation of the essential hydraulic processes in wastewater hydraulics are presented. On the one hand, free-surface hydraulics is reviewed with particular reference to problems in wastewater hydraulics, whereas various special hydraulic structures such as manholes, separation structures and collector channels are analyzed with a hydraulic approach on the other hand. Particularities of wastewater schemes including depositions and the choking of a sewer as the abrupt transition from free-surface to pressurized high-speed flow are highlighted.

Content
Fundamentals
Hydraulic losses
Design of hydraulic elements
Uniform flow
Critical flow
Energy dissipation
Backwater curves
Culvert and inverted siphon
Overflows
Venturi flume
Mobile discharge measurement
Drop and vortex drop
Bend and junction manhole
Sidewir
Lateral overflow
Bottom opening
Side channel

Lecture notes
Text books

Literature
Exhaustive references are contained in the 'scripts'.

Prerequisites / notice
Visit of VAW hydraulic laboratories to add to applied resources. Description of a number of selected, at the time available hydraulic models.

102-0215-00L Urban Water Management II

Abstract

Objective
Consolidation of the basic procedures for design and operation of technical networks in water engineering.

Content
Demand Side Management versus Supply Side Management
Optimierung von Wasserverteilnetzen
Druckstösse
Kalkausfällung, Korrosion von Leitungen
Hygiene in Verteilsystemen
Siedlungshydrologie: Niederschlag, Abflussbildung
Instationäre Strömungen in Kanalisationen
Stofftransport in der Kanalisation
Einleitbedingungen bei Regenwetter
Versickerung von Regenwasser
Generelle Entwässerungsplanung (GEP)

Lecture notes
Written material and copies of the overheads will be available.

Prerequisites / notice
Prerequisite: Introduction to Urban Water Management

Major in Materials and Mechanics

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>101-0619-00L</td>
<td>Mechanics of Building Materials</td>
<td>W</td>
<td>3</td>
<td>2G</td>
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Abstract
Does not take place this semester.

Material models comprise our knowledge on the physical behavior of materials. Based on a short introduction to solid mechanics, 3D material laws for elastic, visco-elastic behavior, plasticity and damage mechanics are discussed. We focus on material laws for concrete, metals, wood and other composites, how to obtain parameters from mechanical tests and their application in FEM calculations.
**Objective**

This introductory course aims to bridge the gap between phenomenological, qualitative comprehension of processes in building materials, their characterization in mechanical testing and the ability to apply those for practical design purposes via constitutive models.

Upon completion of the course you should be able to:

- classify different material behavior (e.g., linear/non-linear elastic, elasto-plastic, creep) with respect to types of constitutive material models (total/incremental strain models, damage/plasticity models, linear visco-elasticity),

- review how incremental strain models (e.g., elasto-plastic) are algorithmically implemented in Finite Element software (UMat of Abaqus),

- formulate the main approach and assumptions to the most import models for building materials and discuss their limitations,

- propose experimental campaigns for obtaining relevant material parameters for non-linear material models.

**Content**

- Introduction to constitutive models for materials
- Fundaments of mechanics of materials
- Cauchy-, hyper- and hypoelastic material descriptions
- Constitutive Models for Concrete (non-linear elastic)
- Introduction to metall and concrete plasticity
- Introduction to ABAQUS UMAT Programming
- Damage continuum mechanics
- Linear visco-elastic materials

**Lecture notes**

Will be provided during the lecture.

**101-0639-01L Science and Engineering of Glass and Natural Stone in Construction**

The course offers an overview of relevant practical issues and present technological challenges for glass and natural stones in constructions. Students gain a good knowledge of the basics of glasses and natural stones, their potential as engineering materials and learn to apply them in the design of civil engineering constructions and to evaluate concepts.

Objective

Glas is increasingly used in constructions to ease the construction process, as functional insulation barrier, even for structural applications of impressive size. While everyone has experienced the innovation potential of glass in the last decade, products from natural stone suffer from an unjustified traditional image that often originates from a lack of understanding of the material and its combination with other materials. Culturally important structures often are made from natural stone and their conservation demands an understanding of their deterioration mechanisms, the concepts of which can be applied to other civil engineering materials. Designers and engineers need the knowledge to reconcile materials and system behavior with the entire processing, handling, integration and life time in mind. In this module students are provided with a broad fundamental as well as practice-oriented education on glass and natural stone in civil engineering applications. Present and future construction and building concepts demand for such materials with optimized properties. Based on the fundamentals from the Bachelor course in materials by the end of this module, you should be able to:

- recognize and choose specific applications from the broad overview you were provided with,
- relate processing technologies to typical products and building applications and recognize (and explain typical damage related to wrong material choice or application,
- explain the nature of glassy and crystalline materials and interpret their physical behavior against this background,
- explain the major deterioration mechanisms in natural stone and how this relates to durability,
- analyze material combinations and appraise their application in future products as well as integration in existing constructions,
- summarize with appropriate guidance publications on a related topic in an oral presentation and short report.

Content

Lecture 1: An introduction to science and engineering of glass and natural stone in construction (FW/TW)

Lecture 2: Glass chemistry including historical development of glass composition, use of raw materials, melts, chemical stability and corrosion. (FW)

Lecture 3: Geology and mineralogy of stones used in construction. Formation processes, chemistry, crystal structure. (TW)

Lecture 4: Microscopic models for glassy materials. Physics of glass transition. From microscopic physical models to thermodynamics, rheology and mechanics of glassy materials. (FW)

Lecture 5: Stone properties and behavior: microstructure, density, porosity, mechanical properties (TW)

Lecture 6: Glass physics: Optical properties (transmission, reflection, emission, refraction, polarization and birefringence, testing methods); Mechanical properties (density, thermal, mechanical, electric properties, glass testing) (FW)

Lecture 7: Stone properties and durability: transport, moisture and thermal cycling (TW)

Lecture 8: Forming and processing of glass: (plate and molded glass, drawing, slumping, profiling etc.; Processing: Cutting, mechanical processing, tempering, gluing, bending, laminating of glass Surface treatments: coating, sputtering, enameling, printing, etching, chemical pre-stressing.) (FW)

Lecture 9: Durability: Salt crystallization, freezing, biodeterioration (TW)

Lecture 10: Glass products for civil engineering applications: (Molded glasses, fiber glass, foam glass, plate glass); construction glass (insulation glass, structural glass, protective glass, intelligent glass, codes); (FW)

Lecture 11: Conservation: Consolidation, cleaning, and other treatments (TW). Practical aspects (guest lecturer)

Lecture 12: Glass in constructions. (modelling, application and regulation, typical damage in glass) (FW)

Lecture 13: Student presentations; exam questions (FW/TW)

**Lecture notes**

Will be handed out in the lectures

**Literature**

Werkstoffe II script (download via the IFB homepage). Rest will be handed out in the lectures

**Prerequisites / notice**

Werkstoffe I/II of the bachelor studies or equivalent introductory materials lecture.
The course focuses on durability of RC structures, in particular the corrosion of steel in concrete. The main emphasis lies on understanding the mechanisms, design and execution aspects related to durability of new and existing structures. New methods and materials for preventative measures, condition assessment and repair techniques are treated with lectures and practice related exercises.

**Objective**
Understand the mechanism of deterioration of RC structures, in particular reinforcement corrosion.

- Know the relevant parameters affecting durability of reinforced concrete, in particular cover depth, concrete quality, moisture, and the ways to control durability
- Understand the current approaches for design for durability (exposure classes, prescriptive) and be aware of their limitations
- Know the future performance-based models for durability design and the difficulties in defining input parameters (such as critical chloride content).
- Know and understand different ways to improve durability of RC structures (e.g. stainless steel reinforcement)
- Know the particular problems with post-tensioned structures and ways to overcome them (electrically isolated tendons).
- Know and understand the non-destructive methods for inspection and condition assessment (especially half-cell potential mapping) and be aware of the limitations
- Know and understand repair methods such as conventional repair, electrochemical methods (in particular cathodic protection)
- Be aware of differences in performance of the new blended cements (especially CEM II with limestone) respect to the traditional Portland cement and the possible future problems for durability.

**Abstract**

**Content**
Reinforced concrete combines the good compressive strength of concrete with the high tensile strength of steel and has proven to be successful in terms of structural performance and durability. However, there are instances of premature failure of reinforced concrete and prestressed concrete components due to corrosion of the reinforcing steel with very high economic implications of such damage. This course focuses on the chloride and carbonation induced corrosion of steel in concrete, presenting transport mechanisms and electrochemical concepts. The main emphasis lies on design and execution aspects related to durability of new and existing structures.

New methods and materials for preventative measures, condition assessment and repair techniques are discussed. The course is a point of reference for engineers and materials scientists involved in research and practice of corrosion protection, rehabilitation and maintenance of reinforced concrete structures and components.

Content of the course in detail:

**Lecture 1** Administrative issues, literature, what do students expect to learn? Introduction (economic relevance of durability, transition from building to maintenance). Fundamentals of corrosion and durability / Passivity and pitting corrosion

**Lecture 2** Reinforced concrete / Corrosion protection / Degradation mechanism corrosion (chlorides/carbonation) / electrochemical mechanism / controlling parameters / cracks and spalling on surface, danger of localized corrosion

**Lecture 3** Other degradation mechanisms: sulphate attack, ASR, frost attack
Various examples, frequency of occurrence of individual deterioration mechanisms

**Lecture 4** Service life: initiation stage & propagation stage. Durability design: prescriptive approach, constructive detailing, importance of moisture for almost all degradation mechanisms. Performance based approach, simple diffusion approach for chloride ingress, Critical chloride content (influencing parameters)

**Lecture 5** Stainless steel as reinforcing steel for concrete / different types of stainless steels / mechanical properties / corrosion resistance, passivity / coupling with black reinforcing steel / examples of application / life-cycle-costs

**Lecture 6** Inspection and condition assessment I: visual inspection / destructive testing (chloride profiles, carbonation depth, thin section analysis, etc.)

**Lectures 7** Inspection and condition assessment II: non-destructive testing (potential mapping, cover depth measurement, resistivity measurement). Potential mapping: measurement principle / effect of carbonated cover zone / effect of moisture / examples

**Lecture 8** Post-tensioned structures / problem with existing structures: no NDT method / approach for protection (multiple barrier) / new systems with polymer ducts / electrically isolated tendons / fib guidelines / Swiss guideline / Monitoring techniques / Applications

**Lecture 9** Repair methods I: conventional repair / coatings / inhibitors / limitations

**Lecture 10** Repair methods II: electrochemical repair methods (ECR, ER, CP) / principles / electrochemical chloride removal (theory and examples) / electrochemical realalkalization (theory and examples) / when can these methods be applied / cost aspects

**Lecture 11** Repair methods III: cathodic protection (theory, technical solutions, anode systems, etc examples). Monitoring of CP.

**Lecture 12** New cements, issue of CO2 reduction. Effects of fly ash, slag, limestone on workability, diffusion coefficient, resistivity, pH (including a discussion of the pozzolanic reaction and its consequences with respect to pH buffering Portlandite reserve). Discuss products on the Swiss market.

**Lecture 13** Summary of most important points of this course given by the students. Open discussion about durability design, use of new cements, new materials and repair methods. Expected consequences for practice / Course evaluation and time for asking questions.

**Literature**

101-0669-00L Bituminous Materials W 3 credits 2G M. Partl

Abstract
Introduction into special aspects of the mechanical and chemo-physical properties as well as the structure and application of bituminous materials for road and waterproofing application considering also new R&D trends

Objective
Introduction into special aspects of the mechanical and chemo-physical properties as well as the structure and application of bituminous materials for road and waterproofing application considering also new R&D trends

Content
Basics of mechanical behavior: Viscosity, rheological models, viscoelasticity, time-temperature superposition, fatigue, viscoplasticity.
Bituminous binders: Tar-related issues, bitumen, natural asphalt, polymer modified bitumen, technological tests, mechanical-physical properties, binder classification, bitumen emulsions, foam bitumen.
Asphalt pavements: material structure and concepts, production, mixture testing and characterization, mixture types, recycling.
Waterproofing membranes: tack- coats, structure of polymer modified waterproofing membranes, production, typical tests, system-related properties, conastruction and application

Lecture notes
Script, handed out during lecture

Prerequisites / notice
Copies of one to two research papers relevant to the topic of each lecture will be provided to the students as supportive information.

101-0689-00L Shrinkage and Cracking of Concrete: Mechanisms and Impact on Durability W 3 credits 2V P. Lura

Abstract
Concrete is generally viewed as a durable construction material. However, the long-term performance of a concrete structure can be greatly compromised by early-age cracking. This course will explain how shrinkage of concrete leads to cracking and how control of shrinkage allows increasing the expected durability of a concrete structure.

Objective
This course will begin with a brief introduction about hydration and microstructure development in cement paste and concrete. The students will learn the main causes of cracking at early ages, namely plastic, drying, thermal and autogenous shrinkage, with special emphasis on the driving mechanisms. The importance of concrete curing, especially in the first few days after casting, will be explained. Building on the knowledge of the driving forces of shrinkage, the way of action of shrinkage-reducing admixtures will be clarified and different applications illustrated. As an extension of external curing, the students will become familiar with internal water curing by means of saturated lightweight aggregate and superabsorbent polymer.

Content
Concrete is generally viewed as a durable construction material. However, the long-term performance of a concrete structure can be jeopardized by shrinkage-induced cracking. In addition to being unsightly, cracks have the potential to act as weak planes for further distress or as conduits for accelerated ingress of aggressive agents that may reduce durability.

Advances in concrete technology over the past decades have led to the practical use of concrete with a low water to binder ratio and with different types of mineral and organic admixtures. Another recent development is self-compacting concrete, which avoids concrete vibration and reduces labor during placing. Unfortunately, these concretes are especially prone to cracking at an early age, unless special precautions are taken. Proper curing becomes in this case the key to achieve better performance in various environmental and load conditions.

Specific topics covered by the course:
- Hydration and microstructure development
- Plastic shrinkage
- Development of mechanical properties
- Thermal deformation
- Autogenous deformation
- Drying shrinkage
- Curing
- Shrinkage-reducing admixtures
- Internal curing: saturated lightweight aggregate and superabsorbent polymer
- Fracture and microcracking
- Transport in cracked concrete
- Impact of cracking on concrete durability

Lecture notes
For each lecture, lecture notes will be provided. In addition, one or two research papers for each lecture will be indicated as supportive information.

Literature
The students will also be provided with a DVD containing the teaching material of a previous course on the same topic, including 16 hours of filmed lectures.

Prerequisites / notice
A basic knowledge of concrete technology is preferable.

151-0353-00L Mechanics of Composite Materials W 4 credits 2V+1U G. Kress

Abstract
The course Mechanics of Composite Materials is dedicated to modeling problems following from the complex mechanical behavior of these anisotropic material structures, and modeling of continuous fibre reinforced composites. Participants will be able to design parts for the mechanical, automotive and aerospace industry.

Objective
Understanding of the mechanical properties of fiber reinforced composites with regard to analysis and design of lightweight structures for mechanical, transportation and aerospace applications.

Content
1. Introduction and Elastic Anisotropy
2. Laminate Theory
3. Thick-Walled Laminates and Interlaminar Stresses
4. Edge Effects at Multidirectional Laminates
5. Micromechanics
6. Failure Hypotheses and Damage Prediction
7. Fatigue Response
8. Joining and Bonding Techniques
9. Sandwich Designs
Most problems in engineering are of nonlinear nature. The nonlinearities are caused basically due to the nonlinear material behavior, contact conditions and instability of structures. The principles of the nonlinear Finite-Element-Method (FEM) will be introduced in the scope of this lecture for treating such problems.

The goal of the lecture is to provide the students with the fundamentals of the non linear Finite Element Method (FEM). The lecture focuses on the principles of the nonlinear Finite-Element-Method based on explicit and implicit formulations. Typical applications of the nonlinear Finite-Element-Methods are simulations of:
- Crash
- Collapse of structures
- Materials in Biomechanics (soft materials)
- General forming processes

Special attention will be paid to the modeling of the nonlinear material behavior, thermo-mechanical processes and processes with large plastic deformations. The ability to independently create a virtual model which describes the complex non linear systems will be acquired through accompanying exercises. These will include the Matlab programming of important model components such as constitutive equations.

- Fundamentals of continuum mechanics to characterize large plastic deformations
- Elasto-plastic material models
- Updated-Lagrange (UL), Euler and combined Euler-Lagrange (ALE) approaches
- FEM implementation of constitutive equations
- Element formulations
- Implicit and explicit FEM methods
- FEM formulations of coupled thermo-mechanical problems
- Modeling of tool contact and the influence of friction
- Solvers and convergence
- Modeling of crack propagation
- Introduction of advanced FE-Methods

In an introduction to wood anatomy, the general structural features of softwoods and hardwoods will be explained and factors of diversity covered are mechanical stability and water transport, branches, reaction wood formation (compression wood, tension wood), spiral growth, growth stresses as well as adaptive growth of trees.

Learning target is a fundamental understanding of the anatomy of wood and the related impact of endogenous and exogenous factors. The students will learn how to distinguish common central European wood species at the macroscopic and microscopic level. A deeper insight will be given by wood identification exercises for softwood species. Further the students will gain insight into the relationships between tree growth and wood properties with a specific focus on the wood function in the living tree.

In an introduction to wood anatomy, the general structural features of softwoods and hardwoods will be explained and factors of diversity and variability will be discussed. A specific focus is laid on common central European tree species with relevance in the wood sector, which will be studied in macro-and microstructural investigations. For softwoods, exercises for the identification of species will be conducted. In the following, relationships between wood structure, properties and function in the living tree will be in the focus of the lecture. Topics covered are mechanical stability and water transport, branches, reaction wood formation (compression wood, tension wood), spiral growth, growth stresses as well as adaptive growth of trees.

Learning target is to provide the students with the fundamentals of the non linear Finite Element Method (FEM). The lecture focuses on the principles of the nonlinear Finite-Element-Method based on explicit and implicit formulations. Typical applications of the nonlinear Finite-Element-Methods are simulations of:
- Crash
- Collapse of structures
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- Fundamentals of continuum mechanics to characterize large plastic deformations
- Elasto-plastic material models
- Updated-Lagrange (UL), Euler and combined Euler-Lagrange (ALE) approaches
- FEM implementation of constitutive equations
- Element formulations
- Implicit and explicit FEM methods
- FEM formulations of coupled thermo-mechanical problems
- Modeling of tool contact and the influence of friction
- Solvers and convergence
- Modeling of crack propagation
- Introduction of advanced FE-Methods

The general introduction shows the economic relevance of the resource wood in a global, European and Swiss context and reflects aspects of sustainability in wood production and certification. In terms of bulk wood products a specific focus is laid on sawn timber production and drying processes. With regard to wood veneer production, steaming, veneer cutting and assembly to veneer lumber products are presented. Further the common technologies for the production of particle boards and fibre boards as well as paper will be discussed. In the following, the topics are related to wood gluing and wood proteins as well as the potentials and limitations in the application of wood and wood-based products. At the end of the lecture an excursion to a Swiss wood manufacturer is planned, in order to facilitate practical experience.

Topics include viscoelasticity, temperature and rate dependent plasticity, dynamic brittle and ductile fracture; impulse transfer, impact and wave propagation in solids; computational aspects of material model implementation into hydrocodes; simulation of dynamic failure of structures;

Various books will be recommended covering the topics discussed in class.
ECTS

Lecturers

Type

Lecturers

18A

The project work is supervised by a professor. Students can choose from different subjects and tasks.

The project work requires normally 250 to 300 hours of work.

101-0298-01L

Project on Hydraulic Engineering and Water Resources Management

W

9 credits

18A

Lecturers

Abstract

Working on a concrete task in Hydraulic Engineering

Objective

Promote independent, structured and scientific work; learn to apply engineering methods; deepen the knowledge in the field of the treated task.

Content

The project work is supervised by a professor. Students can choose from different subjects and tasks.

101-0398-01L

Project on Geotechnical Engineering

W

9 credits

18A

Lecturers

Abstract

Working on a concrete task in Geotechnical Engineering

Objective

Promote independent, structured and scientific work; learn to apply engineering methods; deepen the knowledge in the field of the treated task.

Content

The project work is supervised by a professor. Students can choose from different subjects and tasks.

101-0498-01L

Project on Transport Systems

W

9 credits

18A

Lecturers

Abstract

Working on a concrete task on Transport Systems

Objective

Promote independent, structured and scientific work; learn to apply engineering methods; deepen the knowledge in the field of the treated task.

Content

The project work is supervised by a professor. Students can choose from different subjects and tasks.

101-0598-01L

Project on Construction and Maintenance Management

W

9 credits

18A

Lecturers

Abstract

Working on a concrete task in Construction Engineering and Management

Objective

Promote independent, structured and scientific work; learn to apply engineering methods; deepen the knowledge in the field of the treated task.

Content

The project work is supervised by a professor. Students can choose from different subjects and tasks.

101-0698-01L

Project on Materials and Mechanics

W

9 credits

18A

Lecturers

Abstract

Working on a concrete task in Materials and Mechanics

Objective

Promote independent, structured and scientific work; learn to apply engineering methods; deepen the knowledge in the field of the treated task.

Content

The project work is supervised by a professor. Students can choose from different subjects and tasks.

Projects

The project work is supervised by a professor. Students can choose from different subjects and tasks.

The project work requires normally 250 to 300 hours of work.

Electives

The entire course programs of ETH Zurich and the University of Zurich are open to the students to individual selection.

Electives ETH Zurich

Recommended Electives of Master Programme

Number

051-0781-15L

051-0821-15L

Title

Costruire correttamente/Constructing Correctly: Curved Bearing and Folded Bearing Structures

Summer School: Markets in the Tropics - Barranquilla

ECTS

2 credits

4 credits

Content

In line with the approach of P.L. Nervi's book, our study is based on factors that, outlined by him, are still today all the more relevant as a lesson for architecturally and structurally justified buildings. We will observe selected buildings both of our time and of the past for their space, architecture and construction, understand them and interpret them according to universal values of design.

Lessons learned from this can enrich the design work of today’s and tomorrow's architects. All of these (see abstract) i.e. analyses, observances, hypotheses, groupings and cross-comparisons, will help the students in their careers to find their own strategies and approaches to design and to be aware of them. And so, according to the advice of Pier Luigi Nervi: "...At every stage of his training, the future architect should be constantly and methodically guided to search for essential elements in each problem, be it large or small. The study of the architectural works of the past should consist in the critical examination of their functional and structural solutions and of the relation between these and form, in order to show that form is a consequence and not a determinant of functional and structural needs." [P.L. Nervi: Costruire correttamente, Milano 1955; English version titled "Structures", 1956, p.28].

The main thread of this course, that runs over two semesters (*), are buildings of all ages that could be categorised under notions such as « most viewed », « most technically daring » , « most discussed » or « most worthy of discussion », and carry instructive aspects of the teachings of Pier Luigi Nervi ("costruire correttamente"). In the lecture, these buildings will be investigated on-the-spot, described from the designers’ point-of-view and will be commented on with reference to any redesign resulting from the interplay of architectural and structural concepts. Harmonies and discords should be discovered. Occasionally there will be guest lectures. These people, who were directly involved with a certain building, will portray the emergence and development of the project. In this sense, the course is also intended for civil / structural engineering students and presents a possible bridge between the two prospective project partners - architect and engineer.

Lecture notes

None for the time being

Number

051-0781-15L

051-0821-15L

Title

Costruire correttamente/Constructing Correctly: Curved Bearing and Folded Bearing Structures

Summer School: Markets in the Tropics - Barranquilla

ECTS

2 credits

4 credits

Content

- « most viewed »
- « most technically daring »
- « most discussed »
- « most worthy of discussion »
- Lessons learned from this can enrich the design work of today’s and tomorrow's architects.
- The main thread of this course, that runs over two semesters (*), are buildings of all ages that could be categorised under notions such as « most viewed », « most technically daring » , « most discussed » or « most worthy of discussion ».
- In the lecture, these buildings will be investigated on-the-spot, described from the designers’ point-of-view and will be commented on with reference to any redesign resulting from the interplay of architectural and structural concepts.
- Occasionally there will be guest lectures. These people, who were directly involved with a certain building, will portray the emergence and development of the project.

Lecture notes

None for the time being

Data: 06.02.2019 13:00
Autumn Semester 2015

Page 145 of 1434
This immersive summer school will function as an inter-disciplinary think-tank, exploring the requisites for sustainable urban development in Barranquilla through the lens of architecture, engineering, and environmental sciences. You will be challenged to work in an intensive cross-cultural setting and develop solutions in a complex, real-life context with local practitioners and stakeholders.

The program will combine site visits, expert lectures and workshops to allow you to develop the following skills:

- The capacity to work to address urban challenges in an inter-disciplinary team
- Cross cultural understanding and skills in an international collaboration
- Ability to use stakeholder participation to solve real world problems
- Understanding of integrated and sustainable urban development
- Mechanisms to collaborate and communicate with practitioners and stakeholders

Mid-sized cities in Latin America are growing at unprecedented rates. The next decade will be decisive in terms of demographic and economic growth, creating a time window to respond to unprecedented demands on resources, such as land, water and energy.

Are these boomtowns doomed to follow the fate of megacities or will they successfully avoid the pitfalls of rapid urban development? This program is part of a three-year ambitious collaboration with the Inter American Development Bank's Emerging and Sustainable Cities Initiative and the Swiss Ministry for Economic Cooperation (SECO). It will influence decision makers and engage with real issues.

ETH is teaming up with the leading Universidad del Norte in Colombia to focus on Barranquilla, a rapidly growing city of 1.2 million inhabitants on the Atlantic coast of Colombia. Following a period of decline, vast sums of foreign investment are now flowing into this port city, with the potential to reverse current inequalities and spark more sustainable development.

In a team, you will produce alternative urban scenarios for the redevelopment of Barranquillas Central Market. You will contribute your expertise and unpack the realities of sustainable development in a tropical climate. How can knowledge from the ETH be combined with leading Colombian research and translated to a Latin American context? Through debate, controversy and collaboration it is expected you produce scenarios that integrate your different disciplines and question the preconceptions of sustainable urban development.

This immersive summer school will be structured in three interlocking modules:

- **In the first module you will investigate the central market and gain a strong understanding of the social, environmental and built context in Barranquilla. You will employ and combine your varied disciplinary methodologies to gain insight into the sustainability challenges facing the city and the redevelopment of the avenue.**

- **In the second module, you will develop a series of scenarios for the central market in Barranquilla, proposing alternatives for its sustainable future. You will build on research from the first module, and explore the potential of your ideas with local stakeholders and professionals from your field. You will document these scenarios using creative and varied representational methods.**

- **In the final module you will pitch your scenarios to decision makers. During this high-level event you will measure their preferences, debate the associated trade-offs, and provide a series of orientations for those planning the future of Barranquilla.**

More information on our blog: www.marketsinthetropics.com

**Who should apply?**

Enthusiastic students currently enrolled in a masters program in ETH Zurich and Universidad del Norte, Barranquilla Colombia. A balanced group of 12 ETH master students from the D-ARCH, D-USYS and D-BAUG departments will be selected. They will be joined by 12 Colombian students from our partner university in Barranquilla, Universidad del Norte.

Applicants should have a strong interest in sustainable urban development and trans disciplinary collaborative research. They should be able to demonstrate their academic strength, motivation, interest and expertise. Knowledge of Spanish is welcomed but not obligatory.

ETH participants will be charged a fee of 300 CHF to cover local activities, travel and accommodation.

Students will be responsible for organising visa, health insurance, and transportation to and from Barranquilla. Flights to Barranquilla from Zurich cost approximately 1700 CHF. Additional travel grants are available for ETH students.

Applications can be submitted including curriculum vitae, portfolio where relevant and letter of motivation as portable document format (pdf) by May 30th, 17:00 CET to hertzog@usys.ethz.ch

Notification for admission June 1st.

**Compulsory Electives in Humanities, Social and Political Sciences**

*Recommended GESS compulsory elective courses (Type B) for D-BAUG.*

*see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability*

*see GESS Compulsory Electives: Language Courses ETH/UZH*

**Master Thesis**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0010-00L</td>
<td>Master’s Thesis</td>
<td>0</td>
<td>24 credits</td>
<td>47D</td>
<td>Supervisors</td>
</tr>
</tbody>
</table>

Only students who fulfill the following criteria are allowed to begin with their master thesis:

- a. successful completion of the bachelor programme;
- b. fulfilling of any additional requirements necessary to gain admission to the master programme.
Abstract
The Master Programme concludes with the Master Thesis, which has to be done in one of the chosen Majors and has to be completed within 16 weeks. The Master Thesis is supervised by a professor and shall attest the students ability to work independently and to produce scientifically structured work.

Objective
To work independently and to produce a scientifically structured work.

Content
The topics of the Master Thesis are published by the professors. The Topic can be set also in consultation between the student and the professor.

Civil Engineering Master - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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</table>

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Compulsory Subjects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-1008-00L</td>
<td>Seminar</td>
<td>O</td>
<td>3 credits</td>
<td>2S</td>
<td>E. de Bruijn</td>
</tr>
</tbody>
</table>

**Abstract**
The master thesis accompaniment seminar with ethical discussions, obtaining research plans, literature searches, critical discussion of original publications, and obtaining possible solutions when confronted with experimental problems.

**Objective**
The seminar helps during the master thesis in order to enable a successful completion of the thesis.

#### Electives

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0385-10L</td>
<td>Biomedical Imaging</td>
<td>W</td>
<td>6 credits</td>
<td>5G</td>
<td>S. Kozerke, U. Moser, K. P. Prüssmann, M. Rudin</td>
</tr>
<tr>
<td></td>
<td>New course. Not to be confused with 227-0385-00L of fall 2014.</td>
<td></td>
<td></td>
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</tbody>
</table>

**Abstract**
Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.

**Objective**
To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

**Content**
- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

**Lecture notes**
Lecture notes and handouts

**Literature**
Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011

**Prerequisites / notice**
Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

<table>
<thead>
<tr>
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<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0386-00L</td>
<td>Biomedical Engineering</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>J. Váróš, S. J. Ferguson, S. Kozerke, U. Moser, M. Rudin, M. P. Wolf, M. Zenobi-Wong</td>
</tr>
</tbody>
</table>

**Abstract**
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.

**Objective**
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

**Content**

**Lecture notes**
Practical and theoretical exercises in small groups in the laboratory.

**Lecture notes**
Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino

**Literature**
Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino

AND

https://www1.ethz.ch/lbb/Education/BME

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<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1051-00L</td>
<td>Introduction to Systems Neuroscience</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>D. Kiper</td>
</tr>
</tbody>
</table>

**Abstract**
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: INI415

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

**Objective**
This course focuses on basic aspects of central nervous system physiology, including perception, motor control and cognitive functions.

**Content**
Main emphasis sensory systems, with complements on motor and cognitive functions.

**Lecture notes**
None

**Literature**
"Principles of Neural Science", Kandel, Schwartz, and Jessel

**Prerequisites / notice**
none

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0301-00L</td>
<td>Work Design and Organizational Change</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>G. Grote</td>
</tr>
</tbody>
</table>

**Abstract**
Good work design is crucial for individual and company effectiveness and a core element to be considered in organizational change. Meaning of work, organization-technology interaction, and uncertainty management are discussed with respect to work design and sustainable organizational change. As course project, students learn and apply a method for analyzing and designing work in business settings.
Objective - Know effects of work design on competence, motivation, and well-being
- Understand links between design of individual jobs and work processes
- Know basic processes involved in systematic organizational change
- Understand the interaction between organization and technology and its impact on organizational change
- Understand relevance of work design for company performance and strategy
- Know and apply methods for analyzing and designing work

Content - Work design: From Adam Smith to job crafting
- Effects of work design on performance and well-being
- Approaches to analyzing and designing work
- Modes of organizational change and change methods
- Balancing stability and flexibility in organizations as design criterion
- The organization-technology interaction and its impact on work design and organizational change
- Example Flexible working arrangements
- Strategic choices for work design

Literature A list of required readings will be provided at the beginning of the course.

Prerequisites / notice The course includes the completion of a course project to be conducted in groups of four students. The project entails applying a particular method for analyzing and designing work processes and is carried out by means of interviews and observations in companies chosen by the students.

363-0790-00L Technology Entrepreneurship W 2 credits 2V U. Claesson, P. Baschera, F. Hacklin

Abstract Technology ventures are significantly changing the global economic picture. Technological skills increasingly need to be complemented by entrepreneurial understanding.

This course offers the fundamentals in theory and practice of entrepreneurship in new technology ventures. Main topics covered are success factors in the creation of new firms, including founding, financing and growing a venture.

Objective This course provides theory-grounded knowledge and practice-driven skills for founding, financing, and growing new technology ventures. A critical understanding of dos and don'ts is provided through highlighting and discussing real life examples and cases.

Content See course website

Lecture notes See slides and case material

376-0221-00L Contemporary Problems of Neural Control of Movement n For MSc Major "Human Movement Science and Sport" only.

W 2 credits 2S N. Wenderoth

Abstract Students read, present and discuss seminal papers in the field of Neural Control of Movement and Motor Learning.

This course is designed to nurture and develop independent thinking which is a vital component of personal and professional development. Students will critically evaluate academic papers, present logical arguments, source reliable information and design thought experiments to solve problems relevant to the neural control of behavior.

Objective Students are required to have successfully completed the course "Neural control of movement and motor learning" and to have basic knowledge of applied statistics. Self-study material will be available at the beginning of the course and statistical knowledge will be tested (central element) in the second course week (open book). Passing this test is a requirement for continuing the course. Students will be required to write essays, give presentations and participate in discussions on a regular basis. Assessment will be made on the basis of the complete aforementioned practical work.

376-0225-00L Physical Activities and Health W 3 credits 2V E. de Bruin

Abstract This course introduces/exploring the complex relationship between physical activity, sedentary behavior and health. It will discuss the evolution of current physical activity recommendations. It will examine the current evidence base that has informed physical activity recommendations and that identified physical activity as a key modifiable lifestyle behavior contributing to disease and mortality.

Objective On completion of this course students will be able to demonstrate:
1. knowledge of and critical awareness of the role of physical activity and sedentary behavior in the maintenance of health and the aetiology, prevention and treatment of disease.
2. thorough knowledge and critical awareness of current recommendations for physical activity, and current prevalence and trends of physical activity and associated diseases
3. awareness of current national and international physical activity policies and how these impact on global challenges

Content Introduction to Physical Activity for Health, including sedentary behavior
Physical activity epidemiology: concepts principles and approaches
Physical activity and all cause morbidity and mortality
Physical activity and chronic disease; Coronary heart disease, diabetes, bone health, cancer and obesity
Physical activity and brain health
Physical activity and sedentary behavior recommendations
Population prevalence of physical activity and sedentary behavior
Physical activity policies
Physical activity assessment

Literature Core texts for this course are:

Prerequisites / notice Selective journal articles from relevant journals such as Journal of Physical Activity and Health and Journal of Aging and Physical Activity

376-1033-00L History of Sports W 2 credits 2V M. Gisler

Abstract Comprehension for development and changes of sports from the ancient world to the present. Description of sports in services of national idea, from education and health promotion from the middle of the 18th century till this day.

Objective Understanding for the development and adaptation of sports from the ancient world to present times.


Lecture notes Ein Skript für die aktuelle Veranstaltung wird abgegeben.


376-1107-00L Sport Pedagogy W 2 credits 2V D. Seiler Hubler
Abstract

Central aspects of Sport related pedagogy will be handled in these lectures. These aspects cover, amongst others, the subject and tasks of Sport related pedagogy. Furthermore, the general and sports relevant foundations of Sport related pedagogy will be covered.

Objective

To gain basic knowledge of sports pedagogy and to recognize starting points for applied sports pedagogical intervention in schools.

Content

Inhaltliche Schwerpunkte der Vorlesung sind:
- Einführung in die Sportpädagogik
- Bedeutung des Sports im Kindes- und Jugendalter
- Leistungssport im Kindes- und Jugendalter
- Pädagogische Perspektiven des Sportunterrichts in der Schule
- Ein zeitgemäßer Schulsport
- Bewegungskulturelle Bildung: Bewegungserziehung, Spielerziehung

Lecture notes

Unterrichtsmaterialien zu den einzelnen Veranstaltungen werden den Studierenden zur Verfügung gestellt.
Abstract
Consolidated findings of movement sciences concerning deterioration, overload and regeneration of the musculoskeletal system are an important basis for an ergonomic working environment. The following topics are covered: Muscle fatigue during the 8-hour day, use of the computer mouse, backaches, Tendinitis, nerve compression, epidemiology, prevention, rehabilitation, laws, measuring procedures.

Objective
Goal of the course is the activation of physiological and patho-physiological insights for the understanding of loads of the musculoskeletal system during work. Prevention and rehabilitation of work related musculoskeletal disease will be discussed with the help of a bio-psycho-social model. Furthermore, evidence based methods for a healthy work design will be presented.

Content
Insights of human movement sciences concerning wear, overstraining and regeneration of the musculoskeletal system form an important base for an ergonomic work design. The following topics will be covered: Muscle fatigue in an 8-hours-day, mouse appliance, back pain, insertion tendinitis, nerve compression, epidemiology, prevention, rehabilitation, laws, and measurement methods.

Lecture notes
Skript und Folien auf NETZ als PDF-Datei zur Verfügung

Prerequisites / notice

376-1305-00L Development of the Nervous System W 3 credits 2V E. Stoeckli, further lecturers

Abstract
The course covers the development of the nervous system (NS) with a focus on neurogenesis and migration, axon growth, synapse formation, mol. & cell. mechanisms, and diseases of the developing NS.

Objective
The aim is to give a deepened insight on the normal development, of the nervous system based on molecular, cellular and biochemical approaches.

Content
The main focus is on the development of the NS: Early development of the NS, cellular processes, nerve fiber growth, building of synapses and neuronal networks.

Lecture notes
Must be downloaded from OLAT: https://www.olat.uzh.ch/olat/dmz/
as BIC344

Literature
The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on OLAT.

Prerequisites / notice
Auxiliary tools: None. Bring something to write and your student ID

376-1305-01L Structure, Plasticity and Repair of the Nervous System W 3 credits 2V M. E. Schwab, L. Filli, K. A. Martin, further lecturers

Abstract
The course covers the structure, plasticity and regeneration of the adult nervous system (NS) with focus on: sensory systems, cognitive functions, learning and memory, molecular and cellular mechanisms, animal models, and diseases of the NS.

Objective
The aim is to give a deepened insight into the structure, plasticity and regeneration of the nervous system based on molecular, cellular and biochemical approaches.

Content
The main focus is on the structure, plasticity and regeneration of the NS: biology of the adult nervous system; structural plasticity of the adult nervous system, regeneration and repair: networks and nerve fibers, regeneration, pathological loss of cells.

Lecture notes
ETH students: Lecture notes will be provided on Moodle https://moodle-app2.let.ethz.ch/course/view.php?id=694
Password will be provided at the beginning of the lecture.

UZH students: Lecture notes will be provided on OLAT: https://www.olat.uzh.ch/olat/dmz/

Literature
The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on Moodle / OLAT.

Prerequisites / notice
Repetitionsprüfung 15. Juni 2016, HG E 26.1, 9-10.30h

376-1665-00L Training and Coaching I W 3 credits 2G O. Buholzer

Abstract
The combining of training and coaching as an example of sport analysis, which has an effect on youth training and athlete development

Objective
- To develop basics for a differentiate analyses of sports (model)
- To develop a profile of requirements for specific sports
- To develop competencies of training with youth and talents
- To develop the basics of talent training in theory and practice
- To observe athletes in case studies, make judgments and conclusion

Content
Das Modell der Sportartenanalyse
Die Relevanz der einzelnen Leistungsfaktoren
Das Modell der Wettkampfanalyse
Folgerungen für das Training und Coaching in der Sportart
Folgerungen für das Nachwuchstraining
Praxisbeispiele erarbeiten und planen
Konkrete Athletenbeobachtung

Lecture notes
Die Skript- (Lektionsunterlagen) werden im Rahmen des Semesters abgeben und auf Homepage veröffentlicht.

Literature
Struktur sportlicher Leistung (Modellsansatz von Gundlach; (Trainingswissenschaften S. 45 - 49; Stiehler/Konzag/Döbler)
Leistungsdiagnostische Verfahren, Stiehler(Konzag/Döbler)
Training fundiert erklärt, Handbuch der Trainingslehre, Ingold Verlag 2006
Das sportliche Talent, W. Joch, Meyer&Meyer Verlag, 2002
Das neue Konditionstraining, Grosser/Starischka/Zimmermann, blv 2002
The following issues will be discussed: Epidemiology and etiology of spinal cord injury; complications and consequences of spinal cord injury.

General literature:
- Communication/conversation with patients

Students will acquire the ability to independently load, plot, and process kinematic, kinetic and electromyographical data using the MATLAB computing environment.

376-1717-00L  Practical Basics in Sports and Exercise Therapy  W  2 credits  2V  B. Spörri Kälin, B. S. Wirth Gasser

Objective
- The members are able to transform the knowledge from the previous courses in practical situations of Sports and Exercise Therapy.

Content
- communication/conversation with patients
- psychoregulation: relaxation
- anatomy in vivo

Lecture notes
- skript will be on lern-platform

Prerequisites / notice
- The courses "Introduction in Sports and Exercise Therapy" and "Introduction to Exercise Therapy" have been completed successfully.

376-1720-00L  Application of MATLAB in the Human Movement Sciences  W  2 credits  2G  R. van de Langenberg

Objective
- Students will acquire the ability to independently load, plot, and process kinematic, kinetic and electromyographical data using the MATLAB computing environment.

Content
- Drawbacks of Excel; Possibilities in MATLAB; Import of several data formats; Plot of one and more signals; Removing of an offset and filtering of data based on self-written functions; Normalisation and parametrisation of data; Reliability; Interpolation; Differentiation and Integration in MATLAB.

Literature
- During the lecture, several electronically available MATLAB introductions are indicated. Course-specific scripts will be provided by the lecturer.

Prerequisites / notice
- A Laptop with MATLAB installed (v2009 or higher) and wireless internet access is mandatory. Two students can share a laptop if necessary. A MATLAB student version can be obtained at Stud-IDES for free.

376-1722-00L  Spinal Cord Injury and Exercise  W  2 credits  2V  C. Perret

Objective
- Knowledge of the pathophysiology and the concomitant complications of a spinal cord injury and the consequences for physical exercise and trainability during rehabilitation as well as in recreational and elite sport.

Content
- The following issues will be discussed: Epidemiology and etiology of spinal cord injury; complications and consequences of spinal cord injury; trainability/exercise physiology and spinal cord injury; history and organisation of wheelchair sports; elite sport and spinal cord injury

Literature
- General literature:
  - G.A. Zäch, H. G. Koch
  - Paraplegie - ganzheitliche Rehabilitation
  - Karger-Verlag, 2006
  - ISBN 3-8055-7980-2
  - V. Goosey-Tolfrey
  - Wheelchair sport: A complete guide for athletes, coaches and teachers
  - Human Kinetics, 2010
  - Y.C. Vanlandewijck, W.R. Thompson
  - The Paralympic Athlete
  - Liz Broad
  - Sports Nutrition for Paralympic Athletes
  - CRC Press 2014

Prerequisites / notice
- Voraussetzung: Vorlesung Anatomie/Physiologie besucht!
Content
- Physiological, physical, and cognitive factors in sensation and perception
- Body spaces and functional anthropometry
- Experimental techniques in assessing human performance and well-being
- Human factors and ergonomics in system designs, product development and innovation
- Human information processing and biological cybernetics
- Interaction among consumers, environments, behavior, and tasks

Literature

376-1179-00L Applications of Cybernetics in Ergonomics
Objective
To learn and practice cybernetics principles in interface designs and product development.
Content
- FIT's law applied in manipulation tasks
- Hick-Hyman law applied in design of the driver assistance systems - Vigilance applied in quality inspection
- Accommodation/vergence crosslink function
- Cross-link models in neurobiology- the ocular motor control system
- Human performance in optimization of production lines

Literature

376-1716-00L Basics of Exercise Therapy
Objective
Students learn the assessments to plan an exercise-therapy-treatment.
They are able to use them. They're able to integrate biological and medical basics.
They are able to prepare a therapy-session

Content
Grundlagen der Diagnostik, Anamnese, Bewegungsdiagnostik, Funktionsdiagnostik
Sport- und Bewegungstherapeutische Testverfahren
Motorische Basidiagnostik
Diagnostik bewegungsbezogenen Erlebens und Verhaltens
Biologisch-medicinische Grundlagen
Biomechanik (v.a. Gelenke), Pathophysiologische Grundlagen, Modelle der Methodik und Didaktik, Lektionsplanung

Literature
- Deimel et al.: Neue aktive Wege in Prävention und Rehabilitation, Deutscher Ärzteverlag, Köln 2007
- Schülke / Huber: Grundlagen der Sporttherapie, Deutscher Ärzteverlag, Köln 2012
- Schmidt K-U, Niederer P, M. Muser, Walz F: "Trauma Biomechanics - Accidental Injury in traffic and sports", Springer Verlag
- Deimel et al.: Neue aktive Wege in Prävention und Rehabilitation, Deutscher Ärzteverlag, Köln 2007

Prerequisites / notice
90% of the lections students must be present.

376-2017-00L Biomechanics of Sports Injuries and Rehabilitation
Objective
Within the scope of this lecture you will learn the basic principles of trauma biomechanics. Based on examples from sports, you will get to know different mechanisms that can possibly result in injury. Investigating the background and the injury risk for sports activities. Furthermore you should be able to develop measures to prevent such injury.

Content
This lecture deals with the basic principles of injury mechanics and rehabilitation. Mechanisms that can result in injury are presented. Furthermore possibilities to prevent injuries are discussed. Theryby the lecture focuses on sports injuries.

Literature
Schmit K-U, Niederer P, M. Muser, Walz F: "Trauma Biomechanics - Accidental Injury in traffic and sports", Springer Verlag

Prerequisites / notice
A course work is required. The mark of this course work contributes to the final credits for this lecture. Details will be given during the first lecture.

752-6001-00L Introduction to Nutritional Science
Objective
This course introduces basic concepts of micro- and macronutrient nutrition. Micronutrients studied include fat-soluble and water-soluble vitamins, minerals and trace elements. Macronutrients include proteins, fat and carbohydrates. Special attention is given to nutrient digestion, bioavailability, metabolism and excretion with some focus on energy metabolism.

Content
The course is devided into two parts. The lectures on micronutrients are given by Prof. Zimmermann and the lectures on macronutrients are given by Prof. Wolfrum. Prof. Zimmermann discusses the micronutrients, including fat-soluble vitamins, water-soluble vitamins, minerals and trace elements. Prof. Wolfrum introduces basic nutritional aspects of proteins, fats, carbohydrates and energy metabolism. The nutrients are described in relation to digestion, absorption and metabolism. Special aspects of homeostasis and homeorhesis are emphasized.

Literature
Elmadfa I & Leitzmann C: Ernährung des Menschen UTB Ulmer, Stuttgart, 4, überarb. Ausgabe 2004
Garrow JS and James WPT: Human Nutrition and Dietetics Churchill Livingstone, Edinburgh, 11th rev. ed. 2005

752-6101-00L Nutrition and Chronic Disease (HS)
Objective
To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.
To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.

The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

There is no script. Powerpoint presentations will be made available on-line to students.

To be provided by the individual lecturers, at their discretion.

No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.

The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented.

Students are able:
- to evaluate the scientific evidence on the effects of diet on human health
- to describe the role of nutritional factors in the prevention of chronic diseases
- to assess the nutritional status of a population (Switzerland taken as an example)
- to put forward preventive measures addressing individuals but also our society in relation to the obesity epidemic

The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented. Switzerland taken as an example, the health risks associated with our nutritional habits will be evaluated. Finally, examples of preventive measures addressing individuals but also the society in relation to the obesity epidemic and other threats to health are discussed.

The module "public health concepts" offers an introduction to key principles of public health. Students get acquainted with the concepts and methods of epidemiology. Students also learn to use epidemiological data for prevention and health promotion purposes. Public health concepts and intervention strategies are presented, using examples from infectious and chronic diseases.

At the end of this module students are able:
- to interpret the results of epidemiological studies
- to critically assess scientific literature
- to know the definition, dimensions and determinants of health
- to plan public health interventions and health promotion projects

Concepts of descriptive and analytical epidemiology, study designs, measures of effect, confounding and bias, screening, surveillance, definition of health and health promotion, health dimensions and health determinants, prevention strategies, public health interventions, public health action cycle, epidemiology and prevention of infectious and chronic diseases (HIV, Tuberculosis, Obesity, Public health nutrition).

Handouts are provided to students in the classroom.

Language of the course is English

The course introduces basic concepts of the interaction between nutrition and exercise and cognitive performance.

To understand the potential effects of nutrition on exercise performance, with a focus on concepts and principles of nutrition before, during and after exercise.

The course will cover elementary aspects of sports nutrition physiology, including carbohydrate, glycogen, fat, protein and energy metabolism. A main focus will be to understand nutritional aspects before exercise to be prepared for intensive exercise bouts, how exercise performance can be supported by nutrition during exercise and how recovery can be assisted by nutrition after exercise.

Although this is a scientific course, it is a goal of the course to translate basic sports nutrition science into practical sports nutrition examples.

Lecture slides and required handouts will be available on the ETH website.

Information on further reading will be announced during the lecture. There will be some mandatory as well as voluntary readings.

General knowledge about nutrition, human biology, physiology and biochemistry is a prerequisite for this course. The course builds on basic nutrition and biochemistry knowledge to address exercise and performance related aspects of nutrition.

The course is designed for 3rd year Bachelor students, Master students and postgraduate students (MAS/CAS).

Language: English

It is strongly recommended to attend the lectures. The lecture (including the handouts) is not designed for distance education.

The lectures "Leadership I" (WS) and "Leadership II" (SS) have been designed as a two-semester lecture series, but may also be followed independently of one another or in reverse order. "Leadership I" covers the following fields: leadership basics, leadership theories and leadership styles, the concept of leadership responsibility and the role of communication in practical leadership.

The aim of this lecture is to give students an introductory overview of relevant topics regarding leadership research and practice, thus enabling them to gain a deeper understanding of the leadership phenomenon. Students should understand different concepts of leadership in the complex interaction between individuals, groups, organisation, context and situation. They should be informed about the evolution of the understanding of mankind in relation to working processes and its impact on organizations and the understanding of leadership theory in the past 100 years. They should grasp the concept of leadership responsibility (leadership ethics) and be able to derive consequences for leadership in practical situations. They should recognize the fundamental importance of communication in leadership situations and receive input which enables them to communicate adequately in specific situations.

The 1-hour written exam will take place during the last lecture in the semester.

The students should obtain practical experience of 3 month length in possible job environments. The selected places (internal or external) should be as close as possible by the major exercise in movement and training doctrines.

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The students should obtain practical experience of 3 month length in possible job environments. The selected places (internal or external) should be as close as possible by the major exercise in movement and training doctrines.

### Master Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-1100-00L</td>
<td>Master’s Thesis</td>
<td>O</td>
<td>30</td>
<td>30D</td>
<td>E. de Bruin</td>
</tr>
</tbody>
</table>

Objective
- The master thesis can only be started after the Bachelor Degree was obtained and the Vertiefungsleiter has approved the study.

### Major in Biomechanics

### Compulsory Subjects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1651-00L</td>
<td>Clinical and Movement Biomechanics</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>S. Lorenzetti, R. List, N. Singh</td>
</tr>
</tbody>
</table>

Objective
- The students are able to analyse the human movement from a technical point of view, to process the data and perform modeling with a focus towards clinical application.

Content
- This course includes ethical considerations, measurement techniques, clinical testing, accessing movement data and anysis as well as modeling with regards to human movement.

### Electives

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0501-00L</td>
<td>Kinematics and Statics</td>
<td>W</td>
<td>5</td>
<td>3V+2U</td>
<td>E. Mazza</td>
</tr>
</tbody>
</table>

Objective
- The understanding of the fundamentals of statics for engineers and their application in simple settings.

Content
- Grundlagen: Lage eines materiellen Punktes; Geschwindigkeit; Kinematik starrer Körper, Translation, Rotation, Kreiselung, ebene Bewegung; Kräfte, Reaktionsprinzip, innere und äussere Kräfte, verteilte Flächen- und Raumkräfte; Leistung

Lecture notes
- Übungsläfter

Literature
- Sahr, M.B., Dual J., Kaufmann S., Ingenieurmechanik 1: Grundlagen und Statik, Teubner

Prerequisites / notice
- Written session examination in "Kinematics and Statics" and "Mechanics of Materials" for D-MAVT Students, Students in Human Movement Sciences and Sport and all other Students, who take "Kinematics and Statics" and "Mechanics of Materials":
  - Part 1: 20 minutes: Neither notes nor calculators allowed right afterwards.


151-0503-00L | Dynamics                     | W    | 6    | 4V+2U | G. Haller         |

Objective
- This course provides Bachelor students of mechanical engineering with fundamental knowledge of kinematics and dynamics of mechanical systems. By studying motion of a single particle, systems of particles and rigid bodies, we introduce essential concepts such as work and energy, equations of motion, and forces and torques. Further topics include stability of equilibria and vibrations. Examples presented in the lectures and weekly exercise lessons help students learn basic techniques that are necessary for advanced courses and work on engineering applications.

Content
- 1. Motion of a single particle || Kinematics: trajectory, velocity, acceleration, inertial frame, moving frames - Forces and torques. Active- and reaction forces. - Linear momentum principle, angular momentum principle, work-energy principle - Equations of motion;
- 2. Motion of systems of particles || Internal and external forces - Linear momentum principle, angular momentum principle, work-energy principle - Rigid body systems of particles; conservative systems
- 3. 3D motion of rigid bodies || Kinematics: angular velocity, velocity transport formula, instantaneous center of rotation - Linear momentum principle, angular momentum principle, work-energy principle - Parallel axis theorem. Angular momentum transport formula

Lecture notes
- Hand-written slides will be downloadable after each lecture.

Literature
- Typed course notes from the previous year

Prerequisites / notice
- Please log in to moodle (https://moodle-app2.let.ethz.ch/auth/shibboleth/login.php), search for "Dynamics", and join the course there. All exercises sheets, lecture materials etc. will be uploaded there.
227-0385-10L Biomedical Imaging

W 6 credits 5G S. Kozerke, U. Moser, K. P. Prüssmann, M. Rudin

Abstract
Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.

Objective
To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

Content
- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

Lecture notes
Lecture notes and handouts

Literature
Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011

Prerequisites / notice
Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

227-0386-00L Biomedical Engineering


Abstract
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.

Objective
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

Content

Practical and theoretical exercises in small groups in the laboratory.

Lecture notes
Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino

https://www1.ethz.ch/lbb/Education/BME

227-0447-00L Image Analysis and Computer Vision

W 6 credits 3V+1U G. Székely, O. Göksel, L. Van Gool

Abstract

Objective
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

Content
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

Lecture notes
Course material Script, computer demonstrations, exercises and problem solutions

Prerequisites / notice
Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C. The course language is English.

227-1051-00L Introduction to Systems Neuroscience

W 6 credits 2V+1U D. Kiper

Abstract
This course focuses on basic aspects of central nervous system physiology, including perception, motor control and cognitive functions.

Objective
To understand the basic concepts underlying perceptual, motor and cognitive functions.

Content
Main emphasis sensory systems, with complements on motor and cognitive functions.

Lecture notes
None

Literature
"Principles of Neural Science", Kandel, Schwartz, and Jessel

Prerequisites / notice

363-0790-00L Technology Entrepreneurship

W 2 credits 2V U. Claesson, P. Baschera, F. Haaklin

Abstract
Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

Objective
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

Content
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

Lecture notes
Course material Script, computer demonstrations, exercises and problem solutions

Prerequisites / notice
Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C. The course language is English.

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 156 of 1434
Technology ventures are significantly changing the global economic picture. Technological skills increasingly need to be complemented by entrepreneurial understanding. This course offers the fundamentals in theory and practice of entrepreneurship in new technology ventures. Main topics covered are success factors in the creation of new firms, including founding, financing and growing a venture.

This course provides theory-grounded knowledge and practice-driven skills for founding, financing, and growing new technology ventures. A critical understanding of dos and don'ts is provided through highlighting and discussing real life examples and cases.

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Rehab. Engineering is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.

Provide knowledge on the anatomy and physiology of the human sensory system, related dysfunctions and pathologies, and how rehabilitation engineering can provide sensory restoration and substitution.

Rehabilitation of visual function
- Anatomy and physiology of the visual sense
- Technical aids (glasses, sensor substitution)
- Retina and cortex implants

Rehabilitation of hearing function
- Anatomy and physiology of the auditory sense
- Hearing aids
- Cochlea Implants

Rehabilitation and use of kinesthetic and tactile function
- Anatomy and physiology of the kinesthetic and tactile sense
- Tactile/haptic displays for motor therapy (incl. electrical stimulation)
- Role of displays in motor learning

Rehabilitation of vestibular function
- Anatomy and physiology of the vestibular sense
- Rehabilitation strategies and devices (e.g. BrainPort)

Rehabilitation of vegetative Functions
- Cardiac Pacemaker
- Phrenic stimulation, artificial breathing aids
- Bladder stimulation, artificial sphincter

Brain stimulation and recording
- Deep brain stimulation for patients with Parkinson, epilepsy, depression
- Brain-Computer Interfaces
**Literature**

**Introductory Books:**


**Selected Journal Articles and Web Links:**

- VideoTact, ForeThought Development, LLC. http://my.execcpc.com/?dwysocki/videotac.html

**Prerequisites / notice**

**Target Group:**
- Students of higher semesters and PhD students of
- D-MAVT, D-ITET, D-INFK, D-HEST
- Biomedical Engineering, Robotics, Systems and Control
- Medical Faculty, University of Zurich
- Students of other departments, faculties, courses are also welcome

**376-1714-00L Biocompatible Materials**

| W | 4 credits | 3G | K. Maniura, J. Möller, M. Zenobi-Wong |

**Abstract**

Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

**Objective**

The class consists of three parts:

1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

**Content**

Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

**Lecture notes**

Handouts can be accessed online.
This lecture deals with the basic principles of injury mechanics and rehabilitation. Mechanisms that can result in injury are presented. Prevention measures, Topics include: accident statistics and accident reconstruction, biomechanical response of the human to impact loading, injury mechanisms and injury criteria, test methods (including crash tests), computer simulations using multi-body and finite element modeling techniques, aspects of passive safety of vehicles (focusing on restraint systems and vehicle compatibility). Real world examples mainly from automobile safety are used to augment lecture material.

Literature
W. Niederer, P. Schmitt, M. Muser, F. Walz: "Trauma Biomechanics - An Introduction to Injury Biomechanics", Springer-Verlag

Prerequisites / notice
A course work is required. The mark of this course work contributes to the final credits for this lecture. Details will be given during the first lecture.

401-0625-01L Applied Analysis of Variance and Experimental Design

Abstract
Key concepts of experimental design. Planning and analysis of single factor experiments, block designs, full factorial and fractional designs, split-plot and strip-plot designs. Random effects and mixed effects models.

Objective
Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R.

Content

Literature

551-1295-00L Introduction to Bioinformatics: Concepts and Applications

Abstract
Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.

Objective
Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.
The thesis is the final work of the Master program. It promotes the students' abilities to develop and solve a research problem.

**Practical Training**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-2010-00L</td>
<td>Practical Training I</td>
<td>O</td>
<td>15 credits</td>
<td>15P</td>
<td>S. Lorenzetti</td>
</tr>
<tr>
<td>Abstract</td>
<td>3-months practical work with topics from the major exercise biomechanics.</td>
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<tr>
<td>Objective</td>
<td>3-months practical work with topics from the major exercise biomechanics.</td>
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</tr>
<tr>
<td>557-2011-00L</td>
<td>Practical Training II</td>
<td>O</td>
<td>15 credits</td>
<td>15P</td>
<td>S. Lorenzetti</td>
</tr>
<tr>
<td>Abstract</td>
<td>3-months practical work with topics from the major exercise biomechanics.</td>
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<tr>
<td>Objective</td>
<td>3-months practical work with topics from the major exercise biomechanics.</td>
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**Master Thesis**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-2100-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30 credits</td>
<td>30D</td>
<td>B. Taylor</td>
</tr>
<tr>
<td>Abstract</td>
<td>The thesis is the final work of the Master program. It promotes the students' abilities to develop and solve a research problem independently, structured under methodological considerations. The thesis is based on the studies of the Bachelor program and the lectures of the Master Program.</td>
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</tr>
<tr>
<td>Objective</td>
<td>The thesis is the final work of the Master program. It promotes the students' abilities to develop and solve a research problem independently, structured under methodological considerations. The thesis is based on the studies of the Bachelor program and the lectures of the Master Program.</td>
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</table>

**Major in Sport Physiology**

**Compulsory Subjects**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-3007-00L</td>
<td>Seminar I</td>
<td>O</td>
<td>3 credits</td>
<td>2S</td>
<td>C. Spengler</td>
</tr>
<tr>
<td>Abstract</td>
<td>The master thesis accompanying seminar including discussion of legal and ethical issues, as well as scientific integrity, most important study designs and related statistics. Writing and presenting a research plan, performing literature searches, critical discussion of original publications, and discussion of possible solutions when confronted with experimental problems.</td>
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<tr>
<td>Objective</td>
<td>The seminar prepares for the successful completion of a master thesis through critical review of legal, ethical, technical and scientific aspects.</td>
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<tr>
<td>Content</td>
<td>Ethical and legal issues will be discussed including scientific integrity. An individual ethics application will be written and the personal research plan for the master thesis will be written out and presented to the group within 30 min. The group critically discusses formal issues and scientific content of the presentation. The literature searches will be optimised and at least one original publication will be orally presented and critically commented. During the master thesis, progress reports will be presented. Should experimental problems occur, the group will discuss possible solutions. When the data of the thesis is analysed, results will be presented (max. 30min). The group will again critically discuss formal and scientific aspects.</td>
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</table>

| Lecture notes   | -                            |
| Literature      | Unterlagen werden auf moodle zur Verfügung gestellt. |
| Prerequisites / notice | Exercise Physiology Lecture and Practical Course successfully completed. Bachelor completed. |

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-3008-00L</td>
<td>Seminar II</td>
<td>O</td>
<td>3 credits</td>
<td>2S</td>
<td>C. Spengler, J. M. Kroepfl</td>
</tr>
<tr>
<td>Abstract</td>
<td>The master thesis accompanying seminar. Participants present new scientific publications and landmark-papers in form of a short oral presentation and a poster. Furthermore, results of the Master Thesis are presented in a 30-min oral presentation. Critical discussion of scientific and conceptual aspects are trained intensively.</td>
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<tr>
<td>Objective</td>
<td>Critical analysis and discussion, as well as presentation of scientific literature and own results.</td>
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<tr>
<td>Content</td>
<td>Furthermore, results of the Master Thesis are presented in a 30-min oral presentation. Thus, the most common types of scientific presentations as well as critical discussion of scientific and conceptual aspects are trained intensively.</td>
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</table>

| Literature      | -                            |
| Prerequisites / notice | Unterlagen werden in moodle zur Verfügung gestellt. |

**Electives**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0385-10L</td>
<td>Biomedical Imaging</td>
<td>W</td>
<td>6 credits</td>
<td>5G</td>
<td>S. Kozerke, U. Moser, K. P. Prüssmann, M. Rudin</td>
</tr>
<tr>
<td>Note</td>
<td>New course. Not to be confounded with 227-0385-00L of fall 2014.</td>
<td></td>
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</tbody>
</table>
Abstract
Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.

Objective
To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

Content
- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

Lecture notes
Lecture notes and handouts

Literature
Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011

Prerequisites / notice
Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming
376-0130-00L Laboratory Course in Exercise Physiology

Number of participants limited to 36.

BWS: Mandatory for "Exercise physiology". HST: Possible from the 5th semester on.

Objective
Conduct physical performance tests and measurements that are typically used to assess performance of athletes and/or patients and that deepen the understanding of physiological processes in response to physical exertion.

Content
Gain hands-on experience in exercise physiology and consolidate knowledge on physiological adaptations to different types and degrees of physical activity and climatic influences. Learn fundamental assessment techniques of the muscular system, the cardio-respiratory system and of whole-body performance, learn scientifically correct data analysis and interpretation of results. Insight into today's Sports Medicine.

Literature
Schmidt/Lang/Heckmann: Physiologie des Menschen, Springer-Verlag, Heidelberg

376-0221-00L Contemporary Problems of Neural Control of Movement

For MSc Major "Human Movement Science and Sport" only.

Number of participants limited to 20.

Objective
Students read, present and discuss seminal papers in the field of Neural Control of Movement and Motor Learning.

Content
The goal of this course is to nurture and develop independent thinking which is a vital component of personal and professional development. Students will critically evaluate academic papers, present logical arguments, source reliable information and design thoughtful experiments to solve problems relevant to the neural control of behavior.

Literature
Edeleman, N. Wenderoth, Kenney/Wilmore/Costill: Physiology of Sport and Exercise, Human Kinetics

376-0225-00L Physical Activities and Health

Objective
This course introduces/explores the complex relationship between physical activity, sedentary behavior and health. It will discuss the evolution of current physical activity recommendations. It will examine the current evidence base that has informed physical activity recommendations and that identified physical activity as a key modifiable lifestyle behavior contributing to disease and mortality.

Content
On completion of this course students will be able to demonstrate:
1. knowledge of and critical awareness of the role of physical activity and sedentary behavior in the maintenance of health and the aetiology, prevention and treatment of disease.
2. thorough knowledge and critical awareness of current recommendations for physical activity, and current prevalence and trends of physical activity and associated diseases
3. awareness of current national and international physical activity policies and how these impact on global challenges

Literature

376-1033-00L History of Sports

Objective
Comprehension for development and changes of sports from the ancient world to the present. Description of sports in services of national idea, from education and health promotion from the middle of the 18th century till this day.

Content

Literature
Ein Skript für die aktuelle Veranstaltung wird abgegeben.

376-1107-00L Sport Pedagogy

Objective
See course website

Content
Lecture notes
Lecture slides and case material

Literature

376-1035-00L Laboratory course: Exercise Physiology Lab

Number of participants limited to 20.

Objective
Perform physical performance tests and measurements that are typically used to assess performance of athletes and/or patients and that deepen the understanding of physiological processes in response to physical exertion.

Content
Various exercises assessing human performance and assessments of physiological responses to activity (examples are VO2max-test, Conconi-Tests, Determination of anaerobic threshold, Cooper-Test, 1-repetition maximum test, lactate minimum test, dynamometry, mechanography, body composition etc.) Insight into measurements in Sports Medicine.

Literature
Conconi-Tests, Determination of anaerobic threshold, Cooper-Test, 1-repetition maximum test, lactate minimum test, dynamometry, mechanography, body composition etc.) Insight into measurements in Sports Medicine.
### Abstract
Central aspects of Sport related pedagogy will be handled in these lectures. These aspects cover, amongst others, the subject and tasks of Sport related pedagogy. Furthermore, the general and sports relevant foundations of Sport related pedagogy will be covered.

### Objective
To gain basic knowledge of sports pedagogy and to recognize starting points for applied sports pedagogical intervention in schools.

### Content
Inhaltliche Schwerpunkte der Vorlesung sind:
- Einführung in die Sportpädagogik
- Bedeutung des Sports im Kindes- und Jugendalter
- Leistungssport im Kindes- und Jugendalter
- Pädagogische Perspektiven des Sportunterrichts in der Schule
- Ein zeitgemäsßer Schulsport
- Bewegungskulturelle Bildung: Bewegungserziehung, Spielerziehung

### Lecture notes
Unterrichtsmaterialien zu den einzelnen Veranstaltungen werden den Studierenden zur Verfügung gestellt.

### 376-1117-00L Sport Psychology

<table>
<thead>
<tr>
<th>W</th>
<th>2 credits</th>
<th>2V</th>
</tr>
</thead>
</table>

#### Abstract
This lecture is intended as an introduction to sport psychology and imparts knowledge on selected areas of the subject. Students are given insight into different work areas of sport psychology. In order to understand what «sport psychology» is, it is necessary to explain the essence and tasks of sport psychology and what it relates to, and to work out an underlying basis for key topics, such as cognition and emotions. Students’ expertise is furthered by presenting and providing more in-depth treatment of additional topics of sport psychology. Selected intervention forms are intended to provide insight into applied sport psychology and ensure that mental processes and their impact in sport can be recognised. Case studies and practical exercises (e.g. objective training) are intended to prompt students to reflect to a greater extent on the forms in which sport psychology can be applied in their practice of sports and to integrate these in their teaching.

#### Content
- Introduction to sport psychology
- Cognitions in sports: mental rehearsal and mental training
- Emotions and stress
- Motivation: goal-setting in sports
- Career and career transition in elite sport
- Coach-Athlete-Interaction
- Psychological aspects of sport-injury rehabilitation
- Group dynamics in sport

### Literature

### 376-1155-00L The Musculoskeletal System and Work

<table>
<thead>
<tr>
<th>W</th>
<th>3 credits</th>
<th>2V</th>
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</table>

#### Abstract
Consolidated findings of movement sciences concerning deterioration, overload and regeneration of the musculoskeletal system are an important basis for an ergonomic working environment. The following topics are covered: Muscle fatigue during the 8-hour day, use of the computer mouse, backaches, Tendinitis, nerve compression, epidemiology, prevention, rehabilitation, laws, measuring procedures.

#### Objective
Goal of the course is the activation of physiological and patho-physiological insights for the understanding of loads of the musculoskeletal system during work. Prevention and rehabilitation of work related musculoskeletal disease will be discussed with the help of a bio-psycho-social model. Furthermore, evidence based methods for a healthy work design will be presented.

#### Content
- Insights of human movement sciences concerning wear, overstraining and regeneration of the musculoskeletal system form an important base for an ergonomic work design. The following topics will be covered: Muscle fatigue in an 8-hours-day, mouse appliance, back pain, insertion tendinitis, nerve compression, epidemiology, prevention, rehabilitation, laws, and measurement methods.

### Lecture notes
Skript und Folien auf NETZ als PDF-Datei zur Verfügung

### Prerequisites / notice

### 376-1177-00L Human Factors I

<table>
<thead>
<tr>
<th>W</th>
<th>2 credits</th>
<th>2V</th>
</tr>
</thead>
</table>

#### Abstract
Every day humans interact with various systems. Strategies of interaction, individual needs, physical & mental abilities, and system properties are important factors in controlling the quality and performance in interaction processes. In the lecture, factors are investigated by basic scientific approaches. Discussed topics are important for optimizing people's satisfaction & overall performance.

#### Objective
The goal of the lecture is to empower students in better understanding the applied theories, principles, and methods in various applications. Students are expected to learn about how to enable an efficient and qualitatively high standing interaction between human and the environment, considering costs, benefits, health, and safety as well. Thus, an ergonomic design and evaluation process of products, tasks, and environments may be promoted in different disciplines. The goal is achieved in addressing a broad variety of topics and embedding the discussion in macroscopic factors such as the behavior of consumers and objectives of economy.
### Applications of Cybernetics in Ergonomics

**W 1 credit 1U**  
M. Menozzi Jäckli, Y.Y. Hedinger Huang, R. Huang

**Abstract**  
Cybernetics systems have been studied and applied in various research fields, such as applications in the ergonomics domain. Research interests include the man-machine interaction (MMI) topic which involving the performance in multi-model interactions, quantification in gestalt principles in product development; or the information processing matter.

**Objective**  
- Fitt's law applied in manipulation tasks  
- Hick-Hyman law applied in design of the driver assistance systems - Vigilance applied in quality inspection  
- Accommodationvergence crosslink function  
- Cross-link models in neurobiology-the ocular motor control system  
- Human performance in optimization of production lines

**Content**  
- To learn and practice cybernetics principles in interface designs and product development.

**Literature**  

### Development of the Nervous System

**W 3 credits 2V**  
E. Stoeckli, further lecturers

**Abstract**  
The course covers the development of the nervous system (NS) with focus on neurogenesis and migration, axon growth, synapse formation, mol. & cell. mechanisms, and diseases of the developing NS.

**Objective**  
The aim is to give a deepened insight into the structure, plasticity and regeneration of the nervous system based on molecular, cellular and biochemical approaches.

**Content**  
The main focus is on the development of the NS: Early development of the NS, cellular processes, nerve fiber growth, building of synapses and neuronal networks.

**Lecture notes**  
Must be downloaded from OLAT: https://www.olat.uzh.ch/olat/dmz/ as BIO444

**Literature**  
The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on OLAT.

**Prerequisites / notice**  
Auxiliary tools: None. Bring something to write and your student ID.

### Structure, Plasticity and Repair of the Nervous System

**W 3 credits 2V**  
M. E. Schwab, L. Filli, K. A. Martin, further lecturers

**Abstract**  
The course covers the structure, plasticity and regeneration of the adult nervous system (NS) with focus on: sensory systems, cognitive functions, learning and memory, molecular and cellular mechanisms, animal models, and diseases of the NS.

**Objective**  
The aim is to give a deepened insight into the structure, plasticity and regeneration of the nervous system based on molecular, cellular and biochemical approaches.

**Content**  
The main focus is on the structure, plasticity and regeneration of the NS: biology of the adult nervous system; structural plasticity of the adult nervous system, regeneration and repair: networks and nerve fibers, regeneration, pathological loss of cells.

**Lecture notes**  
ETH students: Lecture notes will be provided on Moodle https://moodle-app2.let.ethz.ch/course/view.php?id=694  
Password will be provided at the beginning of the lecture.

**Literature**  
UZH students: Lecture notes will be provided on OLAT: https://www.olat.uzh.ch/olat/dmz/  
The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on Moodle / OLAT.

**Prerequisites / notice**  
Repetitionsprüfung 15. Juni 2016, HG E 26.1, 9-10.30h

### Training and Coaching I

**W 3 credits 2G**  
O. Buholzer

**Abstract**  
The combining of training and coaching as in the example of sport analysis, which has an effect on youth training and athlete development

- To develop basics for a different analyses of sports (model)  
- To develop a profile of requirements for specific sports  
- To develop competencies of training with youth and talents  
- To develop the basics of talent training in theory and practice  
- To observe athletes in case studies, make judgments and conclusion

**Content**  
Das Modell der Sportartenanalyse  
Die Relevanz der einzelnen Leistungsfaktoren  
Das Modell der Wettkampfanalyse  
Folgerungen für das Training und Coaching in der Sportart  
Folgerungen für das Nachwuchstraining  
Folgerungen für die Athletenauswahl, Athletenbeobachtung und -betreuung  
Das Nachwuchs- und Talentraining (Sichtung, Selektion, Förderung)  
Projekte aus der Praxis (Talent- und Nachwuchs training)  
Praxisinput zum Thema Koordination, motorische Grundbedürfnisse, Kraft und Gesundheit  
Praxisbeispiele erarbeiten und planen  
Konkrete Athletenbeobachtung

**Lecture notes**  
Die Skript- (Lektionsunterlagen) werden im Rahmen des Semesters abgeben und auf Homepage veröffentlicht.

**Literature**  
Struktur sportlicher Leistung (Modellsansatz von Gundlach; (Trainingswissenschaften S. 45 - 49; Stiehler(Konzag/Döbler)

- Leistungsdiagnostische Verfahren, Stiehler(Konzag/Döbler)
- Training fundiert erklärt, Handbuch der Trainingslehre, Ingold Verlag 2006}

Data: 06.02.2019 13:00  
Autumn Semester 2015  
Page 164 of 1434
Prerequisites / notice
Für die Kreditvergabe sind die vorgeschriebenen Semesterrarbeiten und die Präsenz zwingend. Die Benotung erfolgt durch eine schriftliche Arbeit.

Planung
Die Planungsunterlagen werden zu Semesterbeginn abgegeben, sind provisorisch und können vom Dozenten geändert werden. Die Praxislektionen werden jeweils am Mittwoch von 13.00 - 15.00 abgehalten. Die Termine werden in Absprache festgelegt.

Die Semesterarbeit ist 4 Wochen nach Semesterende abzugeben.


376-1716-00L Basics of Exercise Therapy W 2 credits 2V K. Marschall
Number of participants limited to 30.
Possible from the 5th semester on.
Requirement:"Introduction of Exercise Therapy" passed.
Abstract Basics of Exercise Therapy:
A: diagnostic, anamnesis, diagnostic of movement and function, assessments in exercise therapy, diagnostic of experience and behavior in relation to movement
B: biological-medical basics biomechanic (joints), pathophysiological Basics (internal, orthopedic and psychological deseases).
C: didactic knowledge, Reha-didactic
Objective Students learn the assessments to plan an exercise-therapy-treatment. They are able to use them. They're able to integrate biological and medical basics. They are able to prepare a therapy-session
Content Grundlagen der Diagnostik, Anamnese, Bewegungsdagnostik, Funktionsdiagnostik Sport- und Bewegungstherapeutische Testverfahren Motorische Basisdiagnostik Diagnostik bewegungsbezogenen Erlebens und Verhaltens Biologisch-medizinische Grundlagen Biomechanik (v.a. Gelenke), Pathophysiologische Grundlagen, Modelle der Methodik und Didaktik, Lektionsplanung
Lecture notes wird vor Semesterbeginn elektronisch zur Verfügung gestellt
Literature - Schüle / Huber: Grundlagen der Sporttherapie, Deutscher Ärzteverlag, Köln 2012
- Deimel et al.: Neue aktive Wege in Prävention und Rehabilitation, Deutscher Ärzteverlag, Köln 2007
Prerequisites / notice
90% of the lections students must be present.

376-1717-00L Practical Basics in Sports and Exercise Therapy W 2 credits 2V B. Spörri Kälin, B. S. Wirth Gasser
Number of participants limited to 30.
Possible from the 5th semester on.
Requirement:"Introduction of Exercise Therapy" passed.
Abstract Impart knowledge of practical basics of Sports and Exercise Therapy
Objective The members are able to transform the knowledge from the previous courses in practical situations of Sports and Exercise Therapy. They learn basic aspects to design therapy lessons.
Content communication/conversation with patients psychoregulation: relaxation anatomy in vivo
Lecture notes skript will be on lern-platform
Prerequisites / notice
The courses "Introduction in Sports and Exercise Therapie" and has been successfully completed.

376-1720-00L Application of MATLAB in the Human Movement Sciences W 2 credits 2G R. van de Langenberg
Prerequisite: Anatomy and Physiology
Abstract Students will learn to import, process and graphically present experimental data using the MATLAB computing environment. Both the data and the methods of analysis will be typical for experiments in Human Movement Science (i.e. kinematics, kinetics and electromyography).
Objective Students will acquire the ability to independently load, plot, and process kinematic, kinetic and electromyographical data using the MATLAB computing environment.
Content Drawbacks of Excel; Possibilities in MATLAB; Import of several data formats; Plot of one and more signals; Removing of an offset and filtering of data based on self-written functions; Normalisation and parametrisation of data; Reliability; Interpolation, Differentiation and Integration in MATLAB.
Literature During the lecture, several electronically available MATLAB introductions are indicated. Course-specific scripts will be provided by the lecturer.
Prerequisites / notice
A Laptop with MATLAB installed (v2009 or higher) and wireless internet access is mandatory. Two students can share a laptop if necessary. A MATLAB student version can be obtained at Stud-IDES for free.

376-1722-00L Spinal Cord Injury and Exercise W 2 credits 2V C. Perret
Abstract Intensive discussion concerning complications of a spinal cord injury and their consequences on trainability and exercise performance of persons sitting in a wheelchair. Overview on the clinical application of exercise testing as well as on the implementation of sport scientific findings to optimise performance of spinal cord injured subjects in rehabilitation and elite sports.
Objective Knowledge of the pathophysiology and the concomitant complications of a spinal cord injury and the consequences for physical exercise and trainability during rehabilitation as well as in recreational and elite sport.
Content The following issues will be discussed: Epidemiology and etiology of spinal cord injury; complications and consequences of spinal cord injury; trainability/exercise physiology and spinal cord injury; history and organisation of wheelchair sports; elite sport and spinal cord injury
Prerequisites / notice

Voraussetzung/Vorlesung Anatomie/Physiologie besucht!

752-6001-00L Introduction to Nutritional Science W 3 credits 2V M. B. Zimmermann, C. Wolfrum

Abstract
This course introduces basic concepts of micro- and macronutrient nutrition. Micronutrients studied include fat-soluble and water-soluble vitamins, minerals and trace elements. Macronutrients include proteins, fats and carbohydrates. Special attention is given to nutrient digestion, bioavailability, metabolism and excretion with some focus on energy metabolism.

Objective
To introduce the students to both macro- and micronutrients in relation to food and metabolism.

Content
The course is divided into two parts. The lectures on micronutrients are given by Prof. Zimmermann and the lectures on macronutrients are given by Prof. Wolfrum. Prof. Zimmermann discusses the micronutrients, including fat-soluble vitamins, water-soluble vitamins, minerals and trace elements. Prof. Wolfrum introduces basic nutritional aspects of proteins, fats, carbohydrates and energy metabolism. The nutrients are described in relation to digestion, absorption and metabolism. Special aspects of homeostasis and homeorhesis are emphasized.

Lecture notes
Handouts can be downloaded.

Literature
Elmadfa I & Leitzmann C: Ernährung des Menschen UTB Ulmer, Stuttgart, 4. überarb. Ausgabe 2004

Garrow JS and James WPT: Human Nutrition and Dietetics Churchill Livingstone, Edinburgh, 11th rev. ed. 2005

752-6105-00L Epidemiology and Prevention W 3 credits 2V M. Eichholzer

Abstract
The module Epidemiology and Prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented.

Objective
Students are able to:
- evaluate the scientific evidence on the effects of diet on human health,
- describe the role of nutritional factors in the prevention of chronic diseases
- assess the nutritional status of a population (Switzerland taken as an example)
- put forward preventive measures addressing individuals but also our society in relation to the obesity epidemic

Content
The module Epidemiology and Prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented. Switzerland taken as an example, the health risks associated with our nutritional habits will be evaluated. Finally, examples of preventive measures addressing individuals but also the society in relation to the obesity epidemic and other threats to health are discussed.

752-6151-00L Public Health Concepts W 3 credits 2V R. Heusser

Abstract
The module "public health concepts" offers an introduction to key principles of public health. Students get acquainted with the concepts and methods of epidemiology. Students also learn to use epidemiological data for prevention and health promotion purposes. Public health concepts and intervention strategies are presented, using examples from infectious and chronic diseases.
The course introduces basic concepts of the interaction between nutrition and exercise and cognitive performance.

### Leadership I

**557-6403-00L**

**Objective**

At the end of this module students are able:
- to interpret the results of epidemiological studies
- to critically assess scientific literature
- to know the definition, dimensions and determinants of health
- to plan public health interventions and health promotion projects

### Nutrition and Performance

**Abstract**

The course introduces basic concepts of the interaction between nutrition and exercise and cognitive performance.

**Objective**

- To understand the potential effects of nutrition on exercise performance, with a focus on concepts and principles of nutrition before, during and after exercise.

**Content**

The course will cover elementary aspects of sports nutrition physiology, including carbohydrate, glycogen, fat, protein and energy metabolism. A main focus will be to understand nutritional aspects before exercise to be prepared for intensive exercise bouts, how exercise performance can be supported by nutrition during exercise and how recovery can be assisted by nutrition after exercise.

Although this is a scientific course, it is a goal of the course to translate basic sports nutrition science into practical sports nutrition examples.

**Prerequisites / notice**

General knowledge about nutrition, human biology, physiology and biochemistry is a prerequisite for this course. The course builds on basic nutrition and biochemistry knowledge to address exercise and performance related aspects of nutrition.

**Language**

The course is designed for 3rd year Bachelor students, Master students and postgraduate students (MAS/CAS).

Language: English

It is strongly recommended to attend the lectures. The lecture (including the handouts) is not designed for distance education.

### Uncertainty Quantification for Engineering & Life Sciences

**Abstract**

The lectures "Leadership I" (WS) and "Leadership II" (SS) have been designed as a two-semester lecture series, but may also be followed independently of one another or in reverse order. "Leadership I" covers the following fields: leadership basics, leadership theories and leadership styles, the concept of leadership responsibility and the role of communication in practical leadership.

**Objective**

The aim of this lecture is to give students an introductory overview of relevant topics regarding leadership research and practice, thus enabling them to gain a deeper understanding of the leadership phenomenon. Students should understand different concepts of leadership in the complex interaction between individuals, groups, organisation, context and situation. They should be informed about the evolution of the understanding of mankind in relation to working processes and its impact on organizations and the understanding of leadership theory in the past 100 years. They should grasp the concept of leadership responsibility (leadership ethics) and be able to derive consequences for leadership in practical situations. They should recognize the fundamental importance of communication in leadership situations and receive input which enables them to communicate adequately in specific situations.

**Prerequisites / notice**

The 1-hour written exam will take place during the last lecture in the semester.

### Practical Training

**Number**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-3010-00L</td>
<td>Practical Training I</td>
<td>O</td>
<td>15</td>
<td>15P</td>
<td>C. Spengler</td>
</tr>
<tr>
<td>557-3011-00L</td>
<td>Practical Training II</td>
<td>O</td>
<td>15</td>
<td>15P</td>
<td>C. Spengler</td>
</tr>
</tbody>
</table>
Prerequisites / notice

Practical work can be combined with the master thesis. In such a case, it can only be started after the Bachelor Degree was obtained and the Vertiefungsleiter has approved the study.

Master Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-3100-00L</td>
<td>Master's Thesis  ■</td>
<td>O</td>
<td>30 credits</td>
<td>30D</td>
<td>C. Spengler</td>
</tr>
</tbody>
</table>

Only students who fulfill the following criteria are allowed to begin with their master thesis:

a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to gain admission to the master programme.

Abstract

6-months research study with topics from the major exercise physiology.

Objective

The student shall apply his basic knowledge in a practical scientific study. He/she will be confronted with the requirements of scientific working. He/she must master this requirements.

Content

The content of the master thesis is determined by the supervisor together with the student. The thesis can begin only after the approval Vertiefungsleiter.

Prerequisites / notice

The master thesis can only be started after the Bachelor Degree was obtained and the Vertiefungsleiter has approved the study.

Sport Practical

For the entire offering see Sport Teaching Diploma.

see Sport Teaching Diploma, Sport Practical: Basic Education

see Sport Teaching Diploma, Sport Practical: Major Education

see Sport Teaching Diploma, Sport Practical: Education acquired outside ETH

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-HEST.

see GESS Compulsory Electives: Type A. Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Human Movement Sciences Master - Key for Type

| W+       | Eligible for credits and recommended |
| Dr       | Suitable for doctorate               |
| O        | Compulsory                           |

| W        | Eligible for credits                 |
| E-       | Recommended, not eligible for credits |
| Z        | Courses outside the curriculum       |

Key for Hours

| V       | lecture                             |
| G       | lecture with exercise               |
| U       | exercise                            |
| S       | seminar                             |
| K       | colloquium                          |

| P       | practical/laboratory course        |
| A       | independent project                |
| D       | diploma thesis                     |
| R       | revision course / private study    |

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Biology (General Courses)

Complementary Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0255-00L</td>
<td>Energy Conversion and Transport in Biosystems</td>
<td>Z Dr</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>D. Poulidakos, A. Ferrari</td>
</tr>
<tr>
<td>Abstract</td>
<td>Theory and application of thermodynamics and energy conversion in biological systems and biomedicine at the macro scale and the cellular level.</td>
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<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>Theory and application of energy conversion at the macro scale and the cellular level. Understanding of the basic features governing fluid transport in the principal systems of the human cell. Connection of characteristics and patterns from other fields of engineering to biofluidics. Heat and mass transport processes within the human body and relation to biomedical technologies.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>Mass transfer models for the transport of chemical species in the human cell. Organization and function of the cell membrane and of the cell cytoskeleton. The role of molecular motors in cellular force generation and their function in cell migration. Description of the functionality of these systems and of analytical experimental and computational techniques for understanding of their operation. Introduction to bioengineering approaches for the treatment of common pathogenic conditions of these systems. Introduction to cell metabolism, cellular energy transport and cellular thermodynamics.</td>
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</tr>
<tr>
<td>Literature</td>
<td>Script as well as additional material in the form of hand-outs will be distributed.</td>
<td></td>
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</tbody>
</table>

| 376-1791-00L | Introductory Course in Neuroscience I             | Z Dr | 2 credits | 2V   | J.M. Fritschy, W. Knecht    |
| Abstract     | The course gives an introduction to the development and anatomical structure of nervous systems. Furthermore, it discusses the basics of cellular neurophysiology and neuropharmacology. Finally, the nervous system is described on a system level with a particular emphasis on the visual system. |
| Content      | 1) Neuroanatomy I  
2) Neuroanatomy II  
3) Neurogenesis  
4) Axon guidance  
5) Action and language development  
6) Circadian rhythms  
7) Synaptic plasticity  
8) Synaptic transmission  
9) Neural circuits in vivo  
10) Visual pathways and visual processing  
11) Somatosensory system  
12) Vestibular system  
13) Sleep  
14) Learning and Memory, mice and human |
| Prerequisites / notice | For doctoral students of the Neuroscience Center Zurich (ZNZ). |

| 376-1795-00L | Advanced Course in Neurobiology I (Functional Anatomy of the Rodent Brain) | Z Dr | 2 credits | 2V   | J.M. Fritschy, H. U. Zeilhofer |
| Abstract     | The goal of this Advanced Course in Neurobiology is to provide students with a broader knowledge in several important areas of neurobiology. The course consists of four parts: Part I deals with various topics in developmental neurobiology; Part II is devoted to aspects of signal transduction. Part III focuses on synaptic transmission. Part IV gives deeper insights into systems neuroscience. |
| Objective    | The course gives an introduction to the development and anatomical structure of nervous systems. Furthermore, it discusses the basics of cellular neurophysiology and neuropharmacology. Finally, the nervous system is described on a system level with a particular emphasis on the visual system. |
| Content      | 1) Neuroanatomy I  
2) Neuroanatomy II  
3) Neurogenesis  
4) Axon guidance  
5) Action and language development  
6) Circadian rhythms  
7) Synaptic plasticity  
8) Synaptic transmission  
9) Neural circuits in vivo  
10) Visual pathways and visual processing  
11) Somatosensory system  
12) Vestibular system  
13) Sleep  
14) Learning and Memory, mice and human |
| Prerequisites / notice | Für Doktorierende des Zentrums für Neurowissenschaften Zürich. Nicht für Master-Studierende geeignet. |

| 551-1159-00L | Molecular Systems Biology               | Z Dr | 0 credits | 1K   | U. Sauer, R. Aebersold   |
| Objective    | Seminar series on current research topics in systems biology |
| Content      | An overview of systems biology research |
| Literature   | Seminar series on current research topics in systems biology |

| 701-0265-00L | Ecology and Evolution                  | Z Dr | 2 credits | 2S   | E. Postma, J. Jokela |
| Abstract     | A course dedicated to the reading and discussion of the relevant literature. The actual list of theme papers will be proposed anew for every year. Students then choose a topic and prepare themselves for a general discussion with their colleagues and peers. In the process, current and controversial topics will be discussed and studied. |
| Objective    | To become proficient in reading scientific literature, to understand how to look at publications, to understand them and to be able to put them in context. The course also trains the skills needed for the presentation of scientific contributions and the ability to put things into a broader context. Training in how to participate in a scientific discussion, how to make an argument and how to listen to arguments of others. |
| Content      | All topics focus on themes from ecology and evolution, notably so on studies on adaptation of organisms, their evolutionary history, or on questions of current methodology. |
| Lecture notes | The actual content, i.e. the theme papers, will be determined and allocated to the participants at the start of the course each year. Takes place at Uni Irchel. Please refer to notes on board or ask secretary Mrs. Rita Jenny (Rita.Jenny@env.etzh.ch). |
| Prerequisites / notice | Requirements: Knowledge of ecology and evolution, e.g., lectures during basic and advanced study period. The course is meant for advanced and PhD students. |

| 760-2211-00L | Colloquium Agricultural Science   | Z Dr | 0 credits | 2K   | E. Frossard, N. Buchmann, W. Grüttem, M. Kreuzer, O. Voinnet, A. Walter, S. C. Zeeman |
| Abstract     | Does not take place this semester. |

| 151-0927-00L | Rate-Controlled Separations in Fine Chemistry | Z Dr | 4 credits | 3G   | M. Mazzotti |
| Abstract     | The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology. |
This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning “good practice” that can be applied in every student's own projects and daily work life.

The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

The course starts with the basics of linear regression modeling, and then proceeds to parameter estimation, tests and confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, categorical input variables, shrinkage and general modeling strategies.

The last third of the course is dedicated to an introduction into generalized linear regression models: this includes logistic regression for binary response variables, Poisson regression for count data, cumulative logit models for ordered, and multinomial regression for categorical response variables.

The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

Prerequisites / notice
Requirements: Thermal separation Processes I (151-0926-00) and Modelling and mathematical methods in process and chemical engineering (151-0940-00)

Applied Statistical Regression

Z Dr 5 credits 2V+1U M. Dettling

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Content</td>
<td>The class covers separation techniques that are central in the purification and downstream processing of chemicals and biopharmaceuticals. Examples from both areas illustrate the utility of the methods: 1) Liquid-liquid extraction; 2) Adsorption and chromatography; 3) Membrane processes; 4) Crystallization and precipitation.</td>
</tr>
<tr>
<td>Lecture notes</td>
<td>Handouts during the class</td>
</tr>
<tr>
<td>Literature</td>
<td>Recommendations for text books will be covered in the class</td>
</tr>
</tbody>
</table>

Faraway (2005): Linear Models with R
Faraway (2006): Extending the Linear Model with R
Draper & Smith (1998): Applied Regression Analysis
Fox (2008): Applied Regression Analysis and GLMs
Montgomery et al. (2006): Introduction to Linear Regression Analysis

<table>
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<th>401-0649-00L Applied Statistical Regression</th>
<th>2 credits</th>
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<tbody>
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<th>Objective</th>
<th>The goal of this course is to provide doctoral and postdoctoral students with a broad overview on the most recent developments in biochemistry, structural biology and biophysics.</th>
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<tr>
<td>Content</td>
<td>The course consists of a series of research seminars on Structural Biology, Biochemistry and Biophysics, given by both scientists of the National Center of Competence in Research (NCCR) in Structural Biology and external speakers. Information on the individual seminars is provided on the following websites: <a href="http://www.STRUCTURALBIOLOGY.ETHZ.CH/EDUC002.ASP">http://www.STRUCTURALBIOLOGY.ETHZ.CH/EDUC002.ASP</a> <a href="http://WWW.BIOL.ETHZ.CH/DBIOL-CAL/INDEX">http://WWW.BIOL.ETHZ.CH/DBIOL-CAL/INDEX</a></td>
</tr>
<tr>
<td>Literature</td>
<td>Particularly suitable for students of D-BIOL, D-CHAB, D-HEST</td>
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<td>Prerequisites / notice</td>
<td>This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.</td>
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Faraday (2005): Linear Models with R
Faraday (2006): Extending the Linear Model with R
Draper & Smith (1998): Applied Regression Analysis
Montgomery et al. (2006): Introduction to Linear Regression Analysis

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<td>- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.</td>
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<td>The goal of this course is to provide doctoral and postdoctoral students with a broad overview on the most recent developments in biochemistry, structural biology and biophysics.</td>
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</table>

1K 2V+1U 551-1615-00L NMR Methods for Studies of Biological Macromolecules
551-1619-00L Structural Biology
851-0180-00L Research Ethics
551-1615-00L NMR Methods for Studies of Biological Macromolecules
551-1619-00L Structural Biology
851-0180-00L Research Ethics

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<tr>
<td>Content</td>
<td>This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.</td>
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<td>The goal of this course is to provide doctoral and postdoctoral students with a broad overview on the most recent developments in biochemistry, structural biology and biophysics.</td>
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1K 2V+1U 551-1615-00L NMR Methods for Studies of Biological Macromolecules
551-1619-00L Structural Biology
851-0180-00L Research Ethics
551-1615-00L NMR Methods for Studies of Biological Macromolecules
551-1619-00L Structural Biology
851-0180-00L Research Ethics
I. Ethics & the Process of Ethical Inquiry

Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)

Integrity in Research & Research Misconduct
- What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 R's (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks;
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Literature
Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.

Cancer: Fundamentals, Origin and Therapy

376-1581-00L  Z  2 credits  2G  H. Nägeli

Abstract
Discussion of selected microbiology themes presented by invited speakers.

Advice for analyzing data by statistical methods. There will be about 5 talks on how statistical methods are applied in practice.

S. Bonhoeffer

Statistical Consulting

See how statistical methods are applied in practice. Presentations will be made available after the seminars.

Seminars in Microbiology

Interaction seminar. Student-mediated presentations, guests and discussions on current themes in ecology, evolutionary and population science.

Handouts with reproductions of all presented transparencies will be distributed.

551-0530-00L

Repair, Recombination, Replication

Z 0 credits 1K

J. Jiriczky

Several research groups from University, ETH, Basel, Bern and Konstanz meet once per month and present their work related to DNA-repair, recombination, replication, and cancer.

Discussion of current topics in DNA-repair, recombination, replication, and cancer.

Discussion of current topics in DNA-repair, recombination, replication, and cancer.

no script

551-0540-00L

ZüKoS!: Seminar on Applied Statistics

Z Dr 0 credits 1K


About 5 talks on applied statistics.

See how statistical methods are applied in practice.

There will be about 5 talks on how statistical methods are applied in practice. This is no lecture. There is no exam and no credit points will be awarded. The current program can be found on the web: http://stat.ethz.ch/events/zukoester

Course language is English or German and may depend on the speaker.

551-1109-00L

Seminars in Microbiology

Z Dr 0 credits 2K

M. Aebi, H.M. Fischer, W.D. Hardt, J. Piel, J. Vorholt-Zambelli

Seminars by invited speakers covering selected microbiology themes.

Discussion of selected microbiology themes presented by invited speakers.

401-0620-00L

Statistical Consulting

Z Dr 0 credits 0.1K

M. Kalisch, L. Meier

The Statistical Consulting service is open for all members of ETH, including students, and partly also to other persons.

Advice for analyzing data by statistical methods.

We highly recommend to contact the consulting service when planning a project, not only towards the end of analyzing the resulting data!

This is not a course, but a consulting service. There are no exams nor credits.

Contact: beratung@stat.math.ethz.ch . Tel. 044 632 2223. See also http://stat.ethz.ch/consulting

Requirements: Knowledge of the basic concepts of statistics is desirable.

551-0512-00L

Current Topics in Molecular and Cellular Neurobiology

Z Dr 2 credits 1S

U. Suter

Number of participants limited to 8.

The course is a literature seminar or "journal club". Each Friday a student, or a member of the Suter Lab in the Institute of Molecular Health Sciences, will present a paper from the recent literature.

Students and researchers can get advice for analyzing scientific data, often for a thesis.

You will present one paper yourself. Give an introduction to the field of the paper, then show and comment on the main results (all the papers we present are available online, so you can show original figures with a beamer). Finish with a summary of the main points and a discussion of their significance.

You are expected to take part in the discussion and to ask questions. To prepare for this you should read all the papers beforehand (they will be announced a week in advance of the presentation).

Presentations will be made available after the seminars. We cover a range of themes related to development and neurobiology. Before starting your preparations, check with Jorge Pereira (jorge.pereira@biol.ethz.ch), who helps you with finding an appropriate paper.

You must attend at least 80% of the journal clubs, and give a presentation of your own. At the end of the semester there will be a 30 minute oral exam on the material presented during the semester. The grade will be based on the exam (45%), your presentation (45%), and a contribution based on your active participation in discussion of other presentations (10%).

551-0737-00L

Experimental Ecology: Evolution and Ecology

Z Dr 2 credits 2K

S. Bonhoeffer

Interaction seminar. Student-mediated presentations, guests and discussions on current themes in ecology, evolutionary and population biology.

Getting familiar with scientific arguments and discussions. Overview of current research topics. Making contacts with fellow students in other groups.

Scientific talks and discussions on changing subjects.

None

None
Current Immunological Research in Zürich

**Prerequisites / notice**
For information and details: http://www.eco.ethz.ch/news/zis
or contact: Lehre-eve@env.ethz.ch

**Abstract**
This monthly meeting is a platform for Zurich-based immunology research groups to present and discuss their ongoing research projects. At each meeting three PhD students or Postdocs from the participating research groups present an ongoing research project in a 30 min seminar followed by a plenary discussion.

**Objective**
The aim of this monthly meeting is to provide further education for master and doctoral students as well as Postdocs in diverse topics of immunology and to give an insight in the related research. Furthermore, this platform fosters the establishment of science- and technology-based interactions between the participating research groups.

**Content**
Presentation and discussion of current research projects carried out by various immunology-oriented research groups in Zurich.

**Electron Cryomicroscopy Seminar**

**Prerequisites / notice**
Presented project data are confidential. Sign-up for seminar announcements by emailing pilhofer@biol.ethz.ch.

**Biology (General Courses) - Key for Type**

<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>W+</th>
<th>W</th>
<th>Dr</th>
<th>E-</th>
<th>O</th>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eligible for credits and recommended</td>
<td>Suitable for doctorate</td>
<td>Eligible for credits</td>
<td>Recommended, not eligible for credits</td>
<td>Compulsory</td>
<td>Courses outside the curriculum</td>
<td></td>
</tr>
</tbody>
</table>

**Key for Hours**

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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</table>

<table>
<thead>
<tr>
<th>P</th>
<th>practical/laboratory course</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**
European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 173 of 1434
### Compulsory Subjects First Year Examinations

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
401-0291-00L | Mathematics I | O | 6 credits | 4V+2U | A. Caspar

**Abstract**
Mathematics I/II is an introduction to one- and multidimensional calculus and linear algebra emphasizing on applications.

**Objective**
Students understand mathematics as a language for modeling and as a tool for solving practical problems in natural sciences. Students can analyze models, describe solutions qualitatively or calculate them explicitly if need be. They can solve examples as well as their practical applications manually and using computer algebra systems.

**Content**
- Linear, exponential, bounded, logistic
- Fixed points, discrete rate of change
- Sequences and limits

## Eindimensionale diskrete Entwicklungen ##
- Reproduction, fixed points,
- Periodicity,
- Continuity

## Funktionen in einer Variablen ##
- Reproduction, fixed points,
- Periodicity,
- Continuity

## Differentialrechnung (I) ##
- Rate of change/velocity
- Differential quotient and derivative function
- Applications of the derivative function

## Integralrechnung (I) ##
- Primitive function
- Integration techniques

## Gewöhnliche Differentialgleichungen (I) ##
- Qualitative description using examples:
  - Bounded, logistic, Gompertz
- Stationary solutions
- Linear ODE 1st order
- Separation of variables

## Lineare Algebra ##
- First arithmetic aspects
- Matrix calculation
- Eigenvalues / -vectors
- Quadratic LGS and determinant

**Lecture notes**
In addition to the lecture chapters of the lecture courses, we compile important facts, formulas and further explanations in a Vademecum. The pdfs are available under Learning Material > Documents.

Dabei gilt:

* The lecture notes do not replace the lecture and/or the exercises!
* Without attending the lectures or exercises, the explanations lose their value.
* Details will develop in the lectures and exercises, to fill the gaps here.
* Relevant for examination is what we cover in the lecture and exercises.

**Literature**

**T. Wihler**
Mathematik für Naturwissenschaften, 2 Bände: Einführung in die Analysis, Einführung in die Lineare Algebra; Haupt-Verlag Bern, UTB.

**H. H. Storrer**
Einführung in die mathematische Behandlung der Naturwissenschaften I; Birkhäuser. Via ETHZ-Bibliothek: http://link.springer.com/book/10.1007/978-3-0348-8598-0/page/1

**Ch. Blatter**
Lineare Algebra; VDF sowie [pdf](http://www.math.ethz.ch/~blatter/dlp.html)
## 252-0852-00L Foundations of Computer Science

**Abstract**

Students learn to apply selected concepts and tools from computer science for working on interdisciplinary projects.

The following topics are covered: modeling and simulations, introduction to programming, visualizing multi-dimensional data, introduction matrices, managing data with lists and tables and with relational databases, universal methods for algorithm design.

**Objective**

The students learn to:
- understand the role of computer science in science,
- to control computer and automate processes of problem solving by programming,
- choose and apply appropriate tools from computer science,
- process and analyze real-world data from their subject of study,
- handle the complexity of real-world data,
- know universal methods for algorithm design.

**Content**

1. The role of computer science in science
2. Introduction to Programming with Python
3. Modeling and simulations
4. Introduction to Matrices with Matlab
5. Visualizing multidimensional data
6. Data management with lists and tables
7. Data management with a relational database
8. Universal methods for algorithm design

**Lecture notes**

All materials for the lecture are available at www.gdi.ethz.ch

**Prerequisites / notice**

This course is based on application-oriented learning. The students spend most of their time working through projects with data from natural science and discussing their results with teaching assistants. To learn the computer science basics there are electronic tutorials available.

## 551-0105-00L Fundamentals of Biology IA

**Abstract**

The course provides an introduction to the basics of molecular- and cell biology and genetics.

**Objective**

Introduction to modern biology and to principal biological concepts.

**Content**

The course is divided into several chapters:
1. Basic principles of Evolution.
2. Chemistry of Life: Water; Carbon and molecular diversity; biomolecules
3. The cell; structure; membrane structure and function, cell cycle
4. Metabolism: Respiration; Photosynthesis; Fermentation
5. Inheritance: meiosis and sexual reproduction; Mendelian genetics, chromosomal basis of inheritance, molecular basis of inheritance, from gene to protein, regulation of gene expression; genomes and their evolution

**Lecture notes**

None.

**Literature**

The text-book "Biology" (Campbell, Reece) (10th edition) is the basis of the course.

The structure of the course is largely identical with that of the text-book.

**Prerequisites / notice**

Certain sections of the text-book must be studied by self-instruction.

## 529-1001-01L General Chemistry (for Biology/Pharmacy/HST)

**Abstract**

The lecture deals with a number of basic chemistry concepts. These include (amongst others) chemical reactions, energy transfer during chemical reactions, properties of ionic and covalent bonds, Lewis structures, properties of solutions, kinetics, thermodynamics, acid-base equilibria, electrochemistry and properties of metal complexes.

**Objective**

The course is designed to provide an understanding of the basic principles and concepts of general and inorganic chemistry.

**Content**

The lecture deals with a number of basic chemistry concepts. These include (amongst others) chemical reactions, energy transfer during chemical reactions, properties of ionic and covalent bonds, Lewis structures, properties of solutions, kinetics, thermodynamics, acid-base equilibria, electrochemistry and properties of metal complexes.

**Literature**


Weiterführende Literatur:
Brown, LeMay, Bursten CHEMIE (deutsch)
Housecroft and Constable, CHEMISTRY (englisch)
Oxtoby, Gillis, Nachtrieb, MODERN CHEMISTRY (englisch)

## 529-1011-00L Organic Chemistry I (for students of Biology, Pharmaceutical Sci., and Health Sci. & Tech.)

**Abstract**

Fundamentals of Organic Chemistry: molecular structure. Bonding and functional groups; nomenclature; resonance and aromaticity; stereochemistry; conformation; bond strength; organic acids and bases; basic reaction thermodynamics and kinetics; reactive intermediates: carbanions, carbenium ions and radicals.
| Objective | Understanding the basic concepts and definitions of organic chemistry. Knowledge of the functional groups and classes of compounds that are important in biological systems. Understanding the relationship between structure and reactivity. |
| Lecture notes | Printed lecture notes are available. Exercises, answer keys and other handouts can be downloaded from the Moodle course "Organic Chemistry I" of the current semester (https://moodle-app2.let.ethz.ch). |
| Literature | Lecture notes are available. |
| Prerequisites / notice | The course consists of plenary lectures (2 h per week) and problem-solving lessons (2 h per week, groups of ca. 25 people). In addition, online exercises are available in the e-learning environment Moodle (Course OC I). |

### First Year Laboratory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-1001-00L</td>
<td>Laboratory Course General Chemistry (for Biology and Pharmacy)</td>
<td>O</td>
<td>6 credits</td>
<td>8P</td>
<td>R. O. Kissner, K.H. Altmann, J. Hall, D. Neri, G. Schneider, M. D. Wörle</td>
</tr>
</tbody>
</table>

**Abstract**: Introduction to the practical work in a chemistry laboratory. The most important manipulations and techniques are treated, as well as the most fundamental chemical reaction types.

**Objective**
- Knowledge of the basic chemical laboratory methods.
- Basic knowledge of the scientific approach in experimenting.
- Observation and interpretation of real-world chemical processes.
- Keeping of a reliable laboratory journal.

**Content**
- Simple chemical methods and calculations.
- Separation techniques.
- Simple physical measurements.
- Ionic solids (salts).
- Acid/Base chemistry, buffers.
- Redox reactions.
- Metal complexes.
- Titration methods.
- Introduction to qualitative analysis.

**Lecture notes**
Course manual (is handed out to the students at the begin of the lessons).
Language: German. English upon request.

**Literature**

**Prerequisites / notice**
This practical course causes costs for materials and chemicals. The costs are charged to the students at the end of semester.

### Second Year Courses

#### Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-1023-00L</td>
<td>Physical Chemistry I (for Biology and Pharmacy)</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>R. Riek, H. P. Lüthi</td>
</tr>
</tbody>
</table>


**Objective**
Understanding the fundamental thermodynamical properties of chemical and biological systems.

**Content**

**Lecture notes**
In process, will be distributed at the beginning of the first lecture

**Literature**

**Prerequisites / notice**
Prerequisites: mathematics I-II, functions of multiple variables, partial derivatives.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0103-00L</td>
<td>Fundamentals of Biology II: Cell Biology</td>
<td>O</td>
<td>5 credits</td>
<td>5V</td>
<td>E. Hafen, U. Kutay, J. Matos, G. Schertler, U. Suter, S. Werner</td>
</tr>
</tbody>
</table>

**Abstract**: The goal of this course is to provide students with a wide general understanding in cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

**Objective**
The goal of this course is to provide students with a wide general understanding cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

**Content**
The focus is animal cells and the development of multicellular organisms with a clear emphasis on the molecular basis of cellular structures and phenomena. The topics include biological membranes, the cytoskeleton, protein sorting, energy metabolism, cell cycle and division, viruses, extracellular matrix, cell signaling, embryonic development and cancer research.

**Lecture notes**
The lectures are presented in the Powerpoint format. These are available on the WEB for ETH students over the nethz (Moodle). Some lectures are available on the ETH WEB site in a live format (Livestream) at the above WEB site.

Data: 06.02.2019 13:00
Autumn Semester 2015
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This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolution science investigates these questions. The topics covered range from different forms of selection, phylogenetic analysis, population genetics, life history theory, the evolution of sex, social evolution to human evolution. These topics are important for the understanding of a number of evolutionary problems in the basic and applied sciences.

Elective Blocks

Biodiversity

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0245-00L</td>
<td>Introduction to Evolutionary Biology</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>G. Velicer, S. Wiegoss</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions. The topics covered range from different forms of selection, phylogenetic analysis, population genetics, life history theory, the evolution of sex, social evolution to human evolution. These topics are important for the understanding of a number of evolutionary problems in the basic and applied sciences.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions. The topics covered range from different forms of selection, phylogenetic analysis, population genetics, life history theory, the evolution of sex, social evolution to human evolution. These topics are important for the understanding of a number of evolutionary problems in the basic and applied sciences.</td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>Topics likely to be covered in this course include research methods in evolutionary biology, adaptation, evolution of sex, evolutionary transitions, human evolution, infectious disease evolution, life history evolution, macroevolution, mechanisms of evolution, phylogenetic analysis, population dynamics, population genetics, social evolution, speciation and types of selection.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literature</td>
<td>Textbook: Evolutionary Analysis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Scott Freeman and Jon Herron</td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>The exam is based on lecture and textbook.</td>
<td></td>
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</tbody>
</table>

551-0435-00L Systematic Biology: Zoology

Abstract: The lecture provides an overview of animal diversity. Using key selected groups, phylogenetic, morphological and ecological aspects are addressed. Two priority topics are the arthropods and the vertebrates (including vertebrate fauna of Switzerland).

Practical: Knowledge of selected animal groups and their characteristics (supplementing the lecture) and of the basic methods.
Objective
Lecture: The systematic classification of animals and the characteristics of the most important animal groups, basic animal body plans.
Practical: Examples of selected animal groups and their characteristics; acquire the relevant skills: simple preparations, dissection, microscopy, drawing, protocols.

Content
Lecture: Body plans, characteristics, diversity and phylogenetic position of the main groups of Protozoa, Invertebrates, and Vertebrates, with a special focus on Arthropods and Vertebrates (including vertebrate fauna of Switzerland).
Practical: Macroscopic and microscopic study of selected Protozoa, Invertebrates (especially insects) and Vertebrates: morphology and anatomy; behaviour, mainly locomotion, feeding, and reproduction.

Lecture notes
A script for the course will be sold in the lecture, and additional material will be handed out (particularly in the practical).

Literature
No further literature required, the script contains suggestions for further reading.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0227-00L</td>
<td>Mycology</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>M. Aebi</td>
</tr>
</tbody>
</table>

Abstract
The lecture gives an introduction into the field of Mycology. It provides an overview of the fungal lifestyle (hyphal growth/mycelium; reproductive cycles; ecology of the fungi; use of fungi)

Objective
Understanding the fungal life form.
Knowledge of the specific properties of the fungal cell
Knowledge of the different reproductive cycles in all fungal phyla
Knowledge of the different nutritional modes of the fungi; correlation with habitat and ecology
Knowledge of the application of fungi in food production and biotechnology

Content
The lecture focuses on the following topics within Mycology:
1. The fungal lifestyle
2. Differentiation processes of the Mycelium
3. Reproductive cycles and systematic grouping of fungi
4. Ecology of the fungi
5. Use of fungi

Lecture notes
none; hand-outs will be prepared before the lectures

Literature
none

Prerequisites / notice

Cellular and Molecular Biology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0245-00L</td>
<td>Introduction to Evolutionary Biology</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>G. Velicer, S. Wielgoss</td>
</tr>
</tbody>
</table>

Abstract
This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions.

Objective
This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions. The topics covered range from different forms of selection, phylogenetic analysis, population genetics, life history theory, the evolution of sex, social evolution to human evolution. These topics are important for the understanding of a number of evolutionary problems in the basic and applied sciences.

Content
Topics likely to be covered in this course include research methods in evolutionary biology, adaptation, evolution of sex, evolutionary transitions, human evolution, infectious disease evolution, life history evolution, macroevolution, mechanisms of evolution, phylogenetic analysis, population dynamics, population genetics, social evolution, speciation and types of selection.

Literature
Textbook; Evolutionary Analysis
Scott Freeman and Jon Herron

Prerequisites / notice
The exam is based on lecture and textbook.

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0229-00L</td>
<td>Practical Course Organic Chemistry (for Students of Biology and Pharmaceutical Sciences)</td>
<td>O</td>
<td>8</td>
<td>12P</td>
<td>C. Thilgen, F. Diederich, Y. Yamakoshi</td>
</tr>
</tbody>
</table>

Abstract
Analytical part: basic operations for the separation of mixtures of organic compounds (recrystallization, distillation, extraction, chromatography)
Synthetic part (main part): at least 8 synthetic steps (one- or two-step syntheses).

Objective
Learn the basic techniques for the preparation and purification of organic compounds.
Learn to take accurate notes of the experiments.
Deepen the understanding of reaction mechanisms.

Content
Analytical part: basic operations for the separation of mixtures of organic compounds (recrystallization, distillation, extraction, chromatography).
Synthetic part (main part): at least 8 synthetic steps (one- or two-step syntheses).
Introduction to database searches (Reaxys, SciFinder).

Lecture notes
None. Detailed laboratory protocol will be handed out at the beginning of the course.

Literature
1) P. Wörfel, M. Bitzer, U. Claus, H. Felber, M. Hübel, B. Vollenweider, Laborpraxis (Bd. 1: Einführung, allgemeine Methoden; Bd. 2: Messmethoden; Bd. 3: Trennungsmethoden; Bd. 4: Analytische Methoden), Birkhäuser Verlag.

Prerequisites / notice
The basic reactions of Organic Chemistry and their mechanisms should be known (cf. course 529-1012-00L Organic Chemistry II for Students of Biology, Pharmaceutical Sciences, and Health Sci. and Tech.).

As a prerequisite, all participants need to pass the "Safety Test HCI Chemie_V2 English" (see https://moodle-app2.let.ethz.ch). A printout of the certificate generated by the system needs to be presented to the teaching assistants prior to starting lab work.

Biological Chemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tbody>
<tr>
<td>529-0229-00L</td>
<td>Practical Course Organic Chemistry (for Students of Biology and Pharmaceutical Sciences)</td>
<td>O</td>
<td>8</td>
<td>12P</td>
<td>C. Thilgen, F. Diederich, Y. Yamakoshi</td>
</tr>
</tbody>
</table>

Abstract
Latest online enrolment is one week before the beginning of the semester.

Objective
Learn the basic techniques for the preparation and purification of organic compounds.

Lecture notes
Documentation will be handed out at the beginning of the course.

Literature
1) P. Wörfel, M. Bitzer, U. Claus, H. Felber, M. Hübel, B. Vollenweider, Laborpraxis (Bd. 1: Einführung, allgemeine Methoden; Bd. 2: Messmethoden; Bd. 3: Trennungsmethoden; Bd. 4: Analytische Methoden), Birkhäuser Verlag.

Prerequisites / notice
The basic reactions of Organic Chemistry and their mechanisms should be known (cf. course 529-1012-00L Organic Chemistry II for Students of Biology, Pharmaceutical Sciences, and Health Sci. and Tech.).

As a prerequisite, all participants need to pass the "Safety Test HCI Chemie_V2 English" (see https://moodle-app2.let.ethz.ch). A printout of the certificate generated by the system needs to be presented to the teaching assistants prior to starting lab work.
### 3. Year, 5. Semester

#### Concept Courses, 5. Semester

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-2413-00L</td>
<td>Evolutionary Genetics</td>
<td>W</td>
<td>6</td>
<td>4</td>
<td>T. Städler, A. Widmer, P. C. Brunner, M. C. Fischer, A. Guggisberg</td>
</tr>
<tr>
<td>551-0307-00L</td>
<td>Biomolecular Structure and Mechanism I: Protein Structure and Function</td>
<td>W</td>
<td>3</td>
<td>2</td>
<td>R. Glockshuber, K. Locher, E. Weber-Ban</td>
</tr>
<tr>
<td>551-0309-00L</td>
<td>Concepts in Modern Genetics</td>
<td>W</td>
<td>6</td>
<td>4</td>
<td>Y. Barral, D. Bopp, A. Hajnal, O. Vainnet</td>
</tr>
</tbody>
</table>

#### Abstract

**Analytical part:** basic operations for the separation of mixtures of organic compounds (recrystallization, distillation, extraction, chromatography). Synthetic part (main part): at least 8 synthetic steps (one- or two-step syntheses).

**Objective**

- Learn the basic techniques for the preparation and purification of organic compounds.
- Learn to take accurate notes of the experiments.
- Deepen the understanding of reaction mechanisms.

**Content**

- Analytical part: basic operations for the separation of mixtures of organic compounds (recrystallization, distillation, extraction, chromatography).
- Synthetic part (main part): at least 8 synthetic steps (one- or two-step syntheses).

- Introduction to database searches (Reaxys, SciFinder).

**Lecture notes**

Documentation will be handed out at the beginning of the course.

**Literature**

1) P. Wörfel, M. Bitzer, U. Claus, H. Felber, M. Hübel, B. Vollenweider, Laborpraxis (Bd. 1: Einführung, allgemeine Methoden; Bd. 2: Messmethoden; Bd. 3: Trennungsmethoden; Bd. 4: Analytische Methoden), Birkhäuser Verlag.

**Prerequisites / notice**

The basic reactions of Organic Chemistry and their mechanisms should be known (cf. course 529-1012-00L Organic Chemistry II for Students of Biology, Pharmaceutical Sciences, and Health Sci. and Tech.)

As a prerequisite, all participants need to pass the "Safety Test HCI Chemie_V2 English" (see https://moodle-app2.let.ethz.ch). A printout of the certificate generated by the system needs to be presented to the teaching assistants prior to starting lab work.

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**Number**

529-1121-00L

**Inorganic Chemistry (for Biology)**

**Abstract**

Orbitals and chemical bonding in main-group elements and transition metals.

**Objective**

Introduction to the orbital concept and to the bonding theory in complexes of the transition metals.

**Content**


**Lecture notes**

Documentation will be handed out at the beginning of the course.

**Literature**

The new course "Molecular Life of Plants" reflects the rapid advances that are occurring in the field of experimental plant biology as well as the changing interests of students being trained in this discipline. Contemporary plant biology courses emphasize a traditional approach to experimental plant biology by discussing discrete topics that are removed from the context of the plant life cycle. The course will take an integrative approach that focuses on developmental concepts. Whereas traditional plant physiology courses were based on research carried out on intact plants or plant organs and were often based on phenomenological observations, current research in plant biology emphasizes work at the cellular, subcellular and molecular levels.

The goal of "Molecular Life of Plants" is to train students in integrative approaches to understand the function of plants in a developmental context. While the course focuses on plants, the training integrative approaches will also be useful for other organisms.

Content
The course "Molecular Life of Plants" will cover the following topics in a developmental context:

- Plant genome organization
- Seed anatomy
- Food reserves and mobilization
- Seeding emergence
- Heterotrophic to autotrophic growth
- Chlorophyll biosynthesis, photoreceptors
- Integration of metabolism
- Hormones
- Cell cycle
- Cell differentiation and expansion
- Environmental interactions
- Environmental interactions
- Flower development and fertilization
- Embryo and seed development
- Fruit development
- Senescence

"Molecular Life of Plants" is taught in English.
For students of the study programme Biology BSc the course can only be selected as 4th concept course.

Abstract
This lecture is the first part of a one-year course. It offers insights into the fundamentals and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts and molds present in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms.

Objective
The lecture offers insights into the basics, practical consequences and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts, molds and protozoa in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms.

Content
1. History of Food Microbiology
   1.1. Short synopsis of foodborne microorganisms
   1.2. Spoilage of Foods
   1.3. Foodborne Disease
   1.4. Food Preservation
   1.5. VIP's of Food Microbiology
2. Overview of Microorganisms in Foods
   2.1 Origin of foodborne Microorganisms
   2.2. Bacteria
   2.3. Yeasts
   2.4. Molds
3. Microbial Spoilage of Foods
   3.1. Intrinsic and Extrinsic Parameters
   3.2. Meats, Seafoods, Eggs
   3.3. Milk and Milk Products
   3.4. Vegetable and Fruit Products
   3.5. Miscellaneous (baked goods, nuts, spices, ready-to-eat products)
   3.6. Drinks and Canned Foods
4. Foodborne Disease
   4.1. Significance and Transmission of Foodborne pathogens
   4.2. Staphylococcus aureus
   4.3. Gram-positive Sporeformers (Bacillus & Clostridium)
   4.4. Listeria monocytogenes
   4.5. Salmonella, Shigella, Escherichia coli
   4.6. Vibrio, Yersinia, Campylobacter
   4.7. Brucella, Mycobacterium, Aeromonas, Plesiomonas
   4.8. Parasites
   4.9. Viruses and Bacteriophages
   4.10. Mycotoxins
   4.11. Bioactive Amines
   4.12. Miscellaneous (Antibiotic-resistant Bacteria, Biofilms)

Lecture notes
Electronic copies of the presentation slides (PDF) will be made available for download.

Literature
Recommendations will be given in the first lecture.

Immunology I
Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response.

Objective
Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response.

Content
- Introduction and historical background
- Innate and adaptive immunity, Cells and organs of the immune system
- B cells and antibodies
- Generation of diversity
- Antigen presentation and Major Histoincompatibility (MHC) antigens
- Thymus and T cell selection
- Autoimmunity
- Cytotoxic T cells and NK cells
- Th1 and Th2 cells, regulatory T cells
- Allergies
- Hypersensitivities
- Vaccines, immune-therapeutic interventions

Lecture notes
Electronic access to the documentation will be provided. The link can be found at "Lernmaterialien"

Literature

Prerequisites / notice
Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a "Sessionsprüfung".

Introduction to Bioinformatics: Concepts and Applications
Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.
**Objective**

Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

**Content**

Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Subject</th>
<th>Credits</th>
<th>Block</th>
<th>Lecturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1305-10L</td>
<td>Neurobiology</td>
<td>6 credits</td>
<td>W</td>
<td>M. E. Schwab, E. Stoeckli, L. Filli, K. A. Martin, further lecturers</td>
</tr>
<tr>
<td>701-1415-00L</td>
<td>Population Biology</td>
<td>3 credits</td>
<td>W</td>
<td>Does not take place this semester</td>
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<tr>
<td>376-0205-00L</td>
<td>Molecular Disease Mechanisms I</td>
<td>6 credits</td>
<td>W</td>
<td>C. Wolfrum, C. Ciaudo, M. Ristow, M. Stoffel, A. Wutz, M. Zenobi-Wong</td>
</tr>
<tr>
<td>701-0323-00L</td>
<td>Plant Ecology</td>
<td>3 credits</td>
<td>W</td>
<td>S. Güsewell, J. Levine</td>
</tr>
</tbody>
</table>

**Abstract**

**376-1305-10L Neurobiology**

Development of the nervous system (NS): the adult NS, plasticity and regeneration, sensory systems, cognitive functions, learning and memory, molecular and cellular mechanisms, animal models, diseases of the NS.

**Objective**

Overview of normal development, plasticity and regeneration of the nervous system based on molecular, cellular and biochemical approaches.

**Content**

Development: Early development of the nervous system, cellular level, nerve fiber growth, building of neuronal networks; biology of the adult nervous system; structural plasticity of the adult nervous system, regeneration and repair: networks and nerve fibers, regeneration, pathological loss of cells.

**Lecture notes**

Structure, Plasticity and Repair of the Nervous System (376-1305-01L); Lecture notes will be provided on Moodle https://moodle-app2.let.ethz.ch/course/view.php?id=694

Password will be provided at the beginning of the lecture.

Development of the Nervous System (376-1305-00L): Lecture notes will be provided on OLAT https://www.olat.uzh.ch/olat/dmz/

**Literature**

The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures.

**701-1415-00L Population Biology**

This course provides an understanding of the basic concepts of population biology. It presents models regarding the dynamics and evolution of populations, and experimental designs for investigating population biology hypotheses (e.g., population growth, species interactions, epidemiology, metapopulations, life history evolution, local adaptation, evolution of sex, and coevolution).

**Objective**

Students are able to describe and apply population biology models (e.g., growth, species interactions) to describe and apply epidemiological models to substantiate evolutionary concepts (e.g., life history evolution, coevolution, evolution of sex) using population biology arguments and provide examples.

**Content**

Population growth, population regulation, predator-prey interactions, host-pathogen interactions, competition, metapopulations, life history evolution, local adaptation, mating systems, sexual selection, coevolution.

**Lecture notes**

Handouts of lectures

**Literature**


**736-0205-00L Molecular Disease Mechanisms I**

The mechanisms of disease development will be studied. Main topics will be: Genetic regulation of disease development with a focus on monogenic and polygenic forms. In addition the methods used in elucidating genetic components in disease progression will be discussed.

**Objective**

To understand the mechanisms governing disease development with a special emphasis on genetic and ageing associated components to understand the mechanisms governing disease development with a special emphasis on genetic and ageing associated components.

**701-0323-00L Plant Ecology**

This class focuses on ecological processes involved with plant life, mechanisms of plant adaptation, plant-animal and plant-soil interactions, plant strategies and implications for the structure and function of plant communities. The discussion of original research examples familiarizes students with research questions and methods; they learn to evaluate results and interpretations.

**Objective**

Students will be able to: propose methods to study ecological processes involved with plant life, and how these processes depend on internal and external factors; analyse benefits and costs of plant adaptations; explain plant strategies with relevant traits and trade-offs; explain and predict the assembly of plant communities; explain implications of plant strategies for animals, microbes and ecosystem functions; evaluate studies in plant ecology regarding research questions, assumptions, methods, as well as the reliability and relevance of results.
Lectures will particularly focus on the contribution of biotechnology towards crop improvement, with examples from our own work on crops.

In this block course, students will gain conceptual and practical introduction to crop biotechnology research. In addition to the theoretical

Lecturers
A. Leuchtmann

Hours
Relevant literature information will be provided within the course.

Introduction to the biology, systematics and ecology of the important fungal groups. The participants will study primarily fungal materials


Type
Handouts and further reading will be available electronically at the beginning of the semester.

Plants represent the matrix of natural communities. The structure and dynamics of plant populations drives the function of ecosystems.

Biodiversity and Ecological Significance of Fungi

Knowledge of characteristics, life style and ecological significance of major fungal and fungal-like groups. Become acquainted with

Übersichten und Skriptunterlagen zum Kursstoff werden abgegeben.

K. Bärenfaller

W
551-0333-00L
Biodiversity and Ecological Significance of Fungi

Number of participants limited to 8.

Number
551-0333-00L

Type
W

ECTS
6 credits

Lecturers
A. Leuchtmann, R. Berndt, B. Senn-Irlet

Abstract
Introduction to the biology, systematics and ecology of the important fungal groups. The participants will study primarily fungal materials that they collect during field excursions or that they isolate in the laboratory.

Objective
Knowledge of characteristics, life style and ecological significance of major fungal and fungal-like groups. Become acquainted with methods for collecting, microscopic examination and identification of fungi.

Content

Auf mehreren Auskursionen werden wir die Vielfalt und Ökologie der Pilze am natürlichen Standort studieren. Die Auskursionen dienen auch dem Sammeln von Material, an dem wir im Kurs die Mikroskopie und Präparation der Pilze üben werden.

Lecture notes
Übersichten und Skriptunterlagen zum Kursstoff werden abgegeben.

Literature


Practical Aspects of Plant Biotechnology

The course covers multidisciplinary aspects of plant molecular biology and green biotechnology. The participants will acquire theoretical and practical introduction on diverse topics, including, generation and molecular characterization of transgenic plants; allelic mining from genetic resources and on strategies to improve plants against biotic & abiotic stresses and for their nutritional value.

Abstract
The course covers multidisciplinary aspects of plant molecular biology and green biotechnology. The participants will acquire theoretical and practical introduction on diverse topics, including, generation and molecular characterization of transgenic plants; allelic mining from genetic resources and on strategies to improve plants against biotic & abiotic stresses and for their nutritional value.

Objective
In this block course, students will gain conceptual and practical introduction to crop biotechnology research. In addition to the theoretical overview of current trends in plant biotechnology, students will envision the practical application of the knowledge gained through hands-on training on the plant molecular biology laboratory techniques. The course will introduce the potential of plant molecular biology and genetic transformation as a tool for gene identification, gene function, crop improvement and commercial application. The course will also allow the students to understand and critically evaluate the literature in this research field.

Content
Lectures will particularly focus on the contribution of biotechnology towards crop improvement, with examples from our own work on crops including rice and wheat.

Following topics will be covered:
- Green biotechnology: status and prospects
- Plant genetic transformation (methods)
- Molecular characterization of transformed plants
- Selection of marker systems (examples, antibiotic and herbicide resistance, phosphomannose-isomerase, marker-free systems, visible markers)
- Introduction to promoter types (example tissue specific promoters)
- Plant tissue culture techniques
- Crop improvement through biotechnology (examples from our work on rice, wheat and cassava)
- Gene/allele mining from plant genetic resource collections

A visit to the ETH greenhouse facilities at Eschikon will provide an opportunity to visualize and discuss different rice, wheat and cassava projects performed at the ETH Plant Biotechnology Lab.

Lecture notes
For the practical part, protocols will be distributed within the course and Lecture material will be made available.

Literature
Relevant literature information will be provided within the course.

Biological Information Mining

Number of participants limited to 8.

Number
551-0193-00L

Type
W

ECTS
6 credits

K. Bärenfaller, J. Fütterer
Many new biological analysis methods result in lists of genes or proteins related to biological structures, functions, or processes. The information available about the genes or proteins is often scattered in multiple databases and publications, making it difficult to extract and uncover common features or relationships among the biological molecules.

In the course students will use lists of genes or proteins from ongoing experiments in the laboratory and learn how to find and assemble gene-centered information in the literature, different databases and with analysis tools. The training and research will lead to a better and more meaningful annotation of co-detected genes and generate a hypothesis about their functional relationship. The work will be done exclusively using a computer. Students will work independently but with close supervision by experienced scientists. Daily discussions of the work will ensure progress. The computer work will be accompanied by lectures on theoretical and practical aspects of databases, gene networks and the project context of the gene lists that will be analyzed. Students will present their results and hypotheses at the end of the block course.

### 551-0347-00L Molecular Mechanisms of Cell Growth and Polarity

**Objective**

Introduction to the principles and molecular mechanisms of cell polarity, using animal cells and fungi as model systems.

**Content**

During this Block-Course, the students will learn to:

1. describe and compare the principles and molecular mechanisms of cell polarity in fungi and animal cells,
2. apply, evaluate and compare experimental strategies in the different model systems, and
3. select the best model system to answer a particular question.

Students - in groups of 2 or max 3- will be integrated into a research project connected to the subject of the course, within one of the participating research groups.

**Lecture notes**

Lectures and technical notes will be given and informal discussions held to provide you with the theoretical background.

**Literature**

Documentation and recommended literature (review articles) will be provided during the course.

### 551-0916-00L Learning and Teaching Biology

**Objective**

The course aims at introducing principles of synthetic biology related to metabolic engineering. The main focus is on practical work and will familiarize with complementary approaches, in particular genetic, biochemical and analytical approaches. Scientific presentation of results.

**Content**

The projects will involve the selection of enzymes and pathways for integration into foreign host metabolism and testing of their activity. Experimental work applied during the course will comprise e.g. creation of synthetic operons, cloning work, transformation, enzyme activity tests, dynamic 13C labeling experiments. The course will be linked to ongoing research projects in the laboratory.

**Lecture notes**

None

**Literature**

Will be provided at the beginning of the course.

### 551-0345-00L Mechanisms of Bacterial Pathogenesis

**Objective**

Research laboratory class in small groups. Research projects on current topics in cellular microbiology and bacterial pathogenesis are assigned to each student.

**Content**

Research projects on the model pathogen Salmonella.

**Lecture notes**

none.

**Literature**

Literature will be selected with reference to the assigned research project.
Lab course. In small groups projects of relevance to current research questions in the field of bacterial natural product biosynthesis are introduced.

Membrane Biology

The course will introduce the students to the key concepts in membrane biology and will allow them to be involved in laboratory projects related to that broad field. The course will consist of lectures, literature discussions, and practical laboratory work in small groups. Results of the practical projects will be presented during the poster session at the end of the course.

Phytopathology

The course will be taught in English. All general lectures will be held at ETH Hoenggerberg; special lectures will be organized by individual participating groups. Students will be divided into small groups to carry out experiments at ETH or at the Paul Scherrer Institute. Travel to the Paul Scherrer Institute will be organized by car rental or public transportation.

Block Courses in 3rd Quarter of the Semester

From 3.11.2015 13:00 hr to 25.11.2015, 17:00 hr
### Introduction to the physiological and biochemical action of insulin signaling and its role in the fasted/feeding response and in obesity and diabetes

The course will focus on the physiological and biochemical action of insulin signaling and its role in the fasted/feeding response and in obesity and diabetes. Students will learn about the open questions of insulin signaling research and discuss approaches to address these questions experimentally.

All technologies used for the experiments will be explained to the students in theory and in practice with the goal that they will be able to independently apply them for the course project and in future research endeavors. After the course, an individual report about the results obtained has to be prepared.

### Lecture notes

A script will be distributed at the beginning of the course.

### Literature

General literature to "Directed Evolution" and chorismate mutases, e.g.:


Further literature will be indicated in the distributed script.

### Prerequisites / notice

This laboratory course will involve experiments that require a tight schedule and (sometimes) long (!) working days. The maximum number of participants for the laboratory class is limited, but surplus applicants may contact P. Kast directly to have their names added to a waiting list. A valid registration is considered a commitment for attendance of the entire course, as involved material orders and experimental preparations are necessary and, once the class has started, the flow of the experiments must not be interrupted by individual absences. In case of an emergency, please immediately notify P. Kast. For more information, see also http://www.protein.ethz.ch/kast/praktikum.html

### Methods in Cellular Biochemistry

**Objective**

Students will learn about biochemical approaches to analyze cellular functions. The course consists of practical projects in small groups, lectures and literature discussions. The course concludes with the presentation of results at a poster session.

**Abstract**

Students will learn to design, carry out and assess experiments using current biochemical and cellular biological strategies to analyze cellular functions in a wide range of model systems. In particular they will learn novel imaging techniques along with biochemical approaches to understand fundamental cellular pathways. Furthermore, they will learn to assess strengths and limitations of the different approaches and be able to discuss their validity for the analysis of cellular functions.

**Content**

The course will be taught in English.

**Literature**

Documentation and recommended literature (review articles and selected primary literature) will be provided during the course.

### Insulin Signaling

**Objective**

The students will obtain an overview about the current topics of research in insulin signaling and how it impacts on growth, metabolism and cell differentiation. They will learn to design experiments and use techniques necessary to analyze different aspects of insulin signaling, including physiological actions in whole animals as well as in tissue culture. Through lectures and literature seminars, they will learn about the open questions of insulin signaling research and discuss approaches to address these questions experimentally.

In practical lab projects the students will perform physiological in vivo studies as well as biochemical experiments. Finally, they will learn how to present and discuss their data. Student assessment is a graded semester performance based on individual performance in the laboratory, a written exam and the lab data presentation.

### Experimental Food Microbiology for Biologists

**Objective**

Introduction of methods and techniques of food microbiology.
Bryophytes: Basic knowledge on the morphology, ecology, biogeography and endangerment of bryophytes; knowledge of common

In vitro & in vivo experiments will introduce current research on the biosynthesis, structure & function of protein-bound glycans in different

Teaching of basic experimental knowledge for detection and identification of foodborne pathogens by applying state-of-the-art techniques

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551-0363-00L Complex Carbohydrates - the Fourth Pillar of Life  W 6 credits 7G  R. Gauss

Number of participants limited to minimum 2 and maximum 8.

Abstract In vitro & in vivo experiments will introduce current research on the biosynthesis, structure & function of protein-bound glycans in different pro- and eukaryotic microorganisms.

Objective Participants are familiar with the biosynthesis, structure and function of N-glycans in microorganisms and with the methods for their analysis.

Content * Topics: biosynthesis of asparagin-linked glycans in pro- and eukaryotes; structure of glycans in different organisms; methods to analyse the structure of glycans; function of glycans in protein quality control

- Introductory lectures
- Seminar with presentation and discussion of recent publications
- Experiments that exemplify the current research done in the group

551-0117-00L Plant Volatiles in Plant Insect Interactions  W 6 credits 7G  A. L. Clavijo McCormick, S. Halloran, K. Mauck

Number of participants limited to 16.

Abstract During the course students will become familiar with methods for the collection and analysis of plant-derived volatile organic compounds and explore the role of these compounds in mediating plant-insect interactions.

Objective The course will cover six main topics that will be connected throughout the experimental phase:

1) Plant volatile biosynthesis and classification
2) Insect olfactory physiology
3) Volatile-mediated plant-herbivore interactions
4) Volatile-mediated multitrophic interactions
5) Manipulation of plant volatile emission by vector- borne disease agents
6) Methods for volatile collection and analysis

The lab practical will be performed in a system consisting of the cabbage butterfly Pieris brassicae (Brussels sprouts), and the parasitoid wasp Cotesia glomerata (natural enemy of P. brassicae).

During the course we will work with the food-borne pathogen Listeria monocytogenes. Listeria monocytogenes represents a particular threat to pregnant women. Due to biosafety reasons participation is not allowed in case of pregnancy.

551-0361-00L Biology of Bryophytes and Ferns  W 6 credits 7G  R. Holderegger, A. L. Bergamini

Number of participants limited to 20.

Abstract Bryophytes: Basic knowledge on the morphology, ecology, biogeography and endangerment of bryophytes; knowledge of common species; skills in the determination of bryophytes; field trip.

Ferns: basic knowledge on the life cycle, evolution and ecology of ferns; identification of Swiss ferns; field trips.

Objective Bryophytes: Basic knowledge on the morphology, ecology, biogeography and endangerment of bryophytes; knowledge of common species; skills in the determination of bryophytes.

Ferns: basic knowledge on the life cycle, evolution and ecology of ferns; identification of Swiss ferns.

Content Bryophytes: Systematics and morphology of hornworts, liverworts and mosses and special themes such as ecology, biogeography, diversity and endangerment of bryophytes; one full-day field trip.

Ferns: Life cycle; evolutionary groups of ferns and fern allies; breeding systems, micro- and macroevolution; ecology; full-day and half-day field trips.

Lecture notes Hand-outs are available.


Prerequisites / notice Students have to present a poster on a special theme.

Grade according to poster presentation and contributions during the course.

Requirements: First and second year courses in Botany and Evolution.

551-1309-00L RNA-Biology  W 6 credits 7G  C. Claudio, F. Allain, J. Hall, H. L. Lightfoot, B. Mateescu, O. Voinnet, K. Weis, A. Wutz

Number of participants limited to 24.

Abstract Introduction to the diversity of current RNA-research at all levels from structural biology to systems biology using mainly model systems like S. cerevisiae (yeast), mammalian cells.

Objective The students will obtain an overview about the diversity of current RNA-research and will learn to design experiments and use techniques necessary to analyze different aspects of RNA biology. Through lectures and literature seminars, they will learn about the burning questions of RNA research and discuss approaches to address these questions experimentally. In practical lab projects the students will work in one of the participating laboratories. Finally, they will learn how to present and discuss their data in an appropriate manner. Student assessment is a graded semester performance based on individual performance in the laboratory, the written exam and the poster presentation.

Literature Documentation and recommended literature will be provided at the beginning and during the course.

Prerequisites / notice The course will be taught in English.

551-1511-00L Parallels Between Tissue Repair and Cancer  W 6 credits 7G  S. Werner, U. Auf dem Keller, M. Schäfer

Number of participants limited to 15.
This course aims at the understanding of the cellular and molecular mechanisms underlying tissue repair processes in response to different insults. The focus will be on repair of the skin and the liver. In addition, we will highlight the parallels and differences between tissue repair and cancer.

Objective
To learn the cellular and molecular principles underlying tissue repair processes, in particular in the skin and in the liver, and the parallels and differences to cancer. To learn modern technologies in Molecular and Cellular Biology as well as Histology and to use these technologies to study questions related to mechanisms underlying tissue repair and cancer.

Content
This course aims at the understanding of the cellular and molecular mechanisms underlying tissue repair processes in response to different insults. The focus will be on repair of the skin and the liver. In addition, we will highlight the parallels and differences between tissue repair and cancer. Experimental approaches include biochemical studies, molecular and cellular studies using cultured cell lines and primary cells, as well as analysis of murine and human tissues. 

The course combines practical work with lectures, discussions, project preparations and presentations.

Lecture notes
siehe Lernmaterialien

551-0371-00L Growth Control: Insights from Yeast and Flies W 6 credits 7G H. Stocker, R. C. Dechant, E. Hafen, M. Peter

Abstract
All organisms have to control their growth in accordance with environmental conditions. This course focuses on the analysis of growth regulation in the model organisms yeast and Drosophila. The participants will perform experiments in small teams to study insulin/TOR signaling as a key regulator of cellular growth. A particular focus will be the discussion of current research.

Objective
The aims of the block course are that students

(I) understand the function and evolution of insulin/TOR signaling

(II) learn how genetic approaches in different organisms contribute to the understanding of human diseases such as cancer

(III) get a first exposure to current research

(IV) get a first exposure to current research.

551-1403-00L Imaging Bacterial Cells in a Native State by Electron Cryotomography W 6 credits 7G M. Pilhofer

Abstract
The goal is to acquire the techniques to image bacteria by electron cryotomography, resolving their structure in a native state, in 3D, and to macromolecular resolution. In a small group, students will perform wet lab experiments, data collection with atal-of-the-art equipment, data processing and analyses. The key method and its application in bacterial cell biology will be introduced by lectures.

Objective
Students will acquire the skills to cultivate bacteria, plunge-freeze samples for cryotomography, collect data using an electron cryomicroscope, process raw data, analyze tomograms, perform subtomogram averaging, model structures of interest, and generate movies for visualization.

https://www.mol.biol.ethz.ch/groups/pilhofer_group/

Block Courses during the 1st Half of the Semester

From 15.9.2015, 13:00 hr to 30.10.2015, 17:00 Uhr.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<tr>
<td>551-1143-00L</td>
<td>Analysis of Human T and B Cell Responses to Infectious Agents</td>
<td>W</td>
<td>6 credits</td>
<td>7G</td>
<td>A. Lanzavecchia</td>
</tr>
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</table>

Abstract
This course combines Limnology (the study of inland waters in its broad sense) with Ecological and Evolutionary concepts. It deals with rivers, groundwater, wetlands and lakes.

Objective
During this course you will get an overview of the world's typical continental aquatic ecosystems. After this course you will be able to understand how aquatic organisms have adapted to their habitat, and how the interactions (e.g. food web) between organisms work. During the experimental part of this course you will learn the principles of doing research to observe interrelations in aquatic ecosystems. You will measure and interpret biological and physical data (e.g. during experiments, field work) and present the collected knowledge. After this course you will know the most important aquatic species groups (macroinvertebrates, microinvertebrates and cryptogames) in Switzerland and the most important identification traits.

Content
The course contains a lecture part, an experimental part, two determination courses (aquatic invertebrates and algae) and field excursions.

Lecture: The lecture part covers ecology and evolution of aquatic organisms in lentic and lotic waters. Topics include: Adaptations, distribution patterns, biotic interactions, and conceptual paradigms in freshwater ecosystems. Important aspects regarding ecosystem metabolism and habitat properties of freshwaters. Applied case studies and experiments testing ecological and evolutionary processes in freshwaters.

Practical part: The practical part includes an Excursion to the river Sense (Saturday 26th of September 2015): On this excursion you will get to know and experience a natural river system. Further you will conduct in a team your own field research project. Further the practical part contains two excursions to a lake (Greifensee) and a river (Töss). Additional you will perform in small groups an independent experiment in a research group at Eawag.

The taxonomic part will cover macroinvertebrates (e.g. Crustacean, aquatic insects), microinvertebrates and algae. The goal is to get to know the most common aquatic taxa in Switzerland, to identify them with commonly used identification literature, and to get an idea how these organisms are used in research and practice. (Language: German, translation of the most important things during the course possible)

Lecture notes
Course notes and power point presentations provided during the course.

Block Courses during Semester Break

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Students actively participate in ongoing research projects on the analysis of human T and B cell response to pathogens and vaccines. They will be tutored in small groups by doctoral students and postdocs. In a lecture series, the theoretical background for the projects will be provided and the students will have the opportunity to present their projects and discuss recent publications.

To learn current methodologies in human immunology through experimental work in the lab. To learn current concepts through lectures and discussion of original papers. Requirement for obtaining the credit points: oral presentation of the research project in a ppt format.

Abstract

Students will carry out defined research projects related to the current research topics of the groups of Prof. Glockshuber and Prof. Weber-Ban. The topics include mechanistic studies on the assembly of adhesive pili from pathogenic bacteria, disulfide bond formation in the bacterial periplasm, ATP-dependent chaperone-protease complexes and formation of amyloid deposits in Alzheimer's disease.

Objective

The course should enable the students to understand and apply biophysical methods, in particular kinetic and spectroscopic methods, to unravel the mechanism of complex reactions of biological macromolecules and assemblies in a quantitative manner.

Content

The students will be tutored in small groups by doctoral or postdoctoral students from the Glockshuber or Weber-Ban group. In addition, the course includes specific lectures that provide the theoretical background for the experimental work, as well as exercises on the numeric evaluation of biophysical data, and literature work.

Participation in one of the following projects will be possible:

Projects of the Glockshuber group:
- Purification, biophysical characterization and structure determination of enzymes required for disulfide bond formation in the periplasm of Gram-negative bacteria.
- Mechanistic studies on the assembly of type 1 pili from pathogenic Escherichia coli strains. In vitro reconstitution of pili assembly from all purified components. Characterization of folding, stability and assembly behavior of individual pili subunits.
- Identification of intermediates in the aggregation of the human Abeta peptide

Experimental work on these projects involves
- Molecular cloning, recombinant protein production in E. coli and protein purification
- Protein crystallization
- Thermodynamic and kinetic characterization of conformational changes in proteins and protein-ligand interactions by fluorescence and circular dichroism spectroscopy
- Analysis of rapid reactions by stopped-flow fluorescence
- Negative-stain electron microscopy
- Light scattering

Projects of the Weber-Ban group:
- Generation and purification of site-directed variants of the E. coli ClpA/P protease and chaperone-proteasome complexes from other organisms, their biophysical characterization, including rapid kinetics by stopped-flow methods, ATPase activity measurements, negative-stain electron microscopy and light scattering

Lecture notes

No script

Literature

Literature related to the individual projects will be provided on the first day of the course.

Prerequisites / notice

Attendance of the concept course “Biomolecular Structure and Mechanism I: Protein Structure and Function” (551-0307-00L) in the autumn semester is highly recommended for acquiring the theoretical background to this block course.

Compulsory Electives in Humanities, Social and Political Sciences

► Recommended GESS compulsory elective courses (Type B) for D-BIOL.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Biology Bachelor - Key for Type

| Dr | Suitable for doctorate | W | Eligible for credits |
| O | Compulsory | E- | Recommended, not eligible for credits |
| W+ | Eligible for credits and recommended | Z | Courses outside the curriculum |

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Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
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<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<td>independent project</td>
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<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
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<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
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<td>K</td>
<td>colloquium</td>
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ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Biology Teaching Diploma

The programme "Teaching Diploma, Two Subjects in One-Step Procedure" will not be offered anymore since Autumn Semester 2010. Therefore new matriculations are no longer possible. The courses offered below are valid only for students who have registered before.

Detailed information on the programme at: www.didaktischeausbildung.ethz.ch

► Biology as First Subject

►► Educational Science

Course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>851-0242-06L</td>
<td>Cognitively Activating Instructions in MINT Subjects  ❋ W 🏷️</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>R. Schumacher</td>
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<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<td><strong>Number of participants limited to 30.</strong></td>
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<td><strong>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</strong></td>
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</table>

Abstract
This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.

Objective
- Get to know cognitively activating instructions in MINT subjects
- Get information about recent literature on learning and instruction

Prerequisites / notice
Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

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<th>Number</th>
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<tbody>
<tr>
<td>851-0242-07L</td>
<td>Human Intelligence ❋ W 🏷️</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner, B. Rütsche</td>
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<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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Abstract
The focus will be on the book "Intelligenz: Grosse Unterschiede und ihre Folgen" by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.

Objective
- Understanding of research methods used in the empirical human sciences
- Getting to know intelligence tests
- Understanding findings relevant for education

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<tbody>
<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science ❋ W 🏷️</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler</td>
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<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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Abstract
Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and two further meetings will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.

Objective
- Understand research methods used in the empirical educational sciences
- Understand and critically examine information from scientific journals and media
- Understand pedagogically relevant findings from the empirical educational sciences

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<td><strong>The successful completion of both course no. 851-0240-00L &quot;Menschliches Lernen (EW 1)&quot; and course no. 851-0238-01L &quot;Unterstützung und Diagnose von Wissenserwerbsprozessen (EW 3)&quot; is a necessary prerequisite for this course.</strong></td>
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Abstract
In teams of two, participants in this seminar conduct their own research project. Each team is advised by one of the researchers serving as lecturers in this course. Basic conceptual and methodological issues are the topic of a series of plenary meetings; however, the major part of the work is done in small-group meetings with the advising researcher, and in self-directed research projects.

Objective
The course is targeted at advanced students who have taken an interest in gathering practical research experience in the field of Learning & Instruction. In teams of two, students conduct their own research projects (planning, conducting, analyzing, interpreting, and presenting research); thus, the course requires a high amount of self-directed working. Students are personally advised, and supported in their research project, by one of the researchers serving as lecturers in this course. During the first half of the semester, relevant methodological knowledge and skills are practiced during plenary meetings and in students’ independent reading (e.g. generating and testing research questions, designing experiments, and analyzing data in the field of Learning and Instruction)

Learning goals include:
- Participants can illustrate and explain basic methods and concepts for research in the fields of Learning and Instruction, e.g. with the help of practical examples.
- Participants can generate testable research questions for a topic relevant in the fields of Learning and Instruction.
- Participants can design and conduct a study that is relevant for answering their research question.
- Participants can summarize and evaluate the main results from a study in the field of learning and Instruction, with regard to the research question being asked.
Mentored Work Subject Didactics Biology A

Objective
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

Prerequisites / notice
- Allfällige fachwissenschaftliche Auflagen müssen alle erfüllt sein, bevor mit der Mentorierten Arbeit begonnen werden kann.

Abstract
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

Content
Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

Lecture notes
Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt.

Literature
Die Literatur ist themenübersichtlich.

Prerequisites / notice
- Beginn nach Absprache jederzeit möglich, jedoch erst nach Abschluss der Fachdidaktik I und II und nach der Absolvierung allfälliger fachwissenschaftlicher Voraussetzungen.

Lecture notes
Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt.

Literature
Die Literatur ist themenspezifisch.

Prerequisites / notice
- Beginn nach Absprache jederzeit möglich, jedoch erst nach Abschluss der Fachdidaktik I und II und nach der Absolvierung allfälliger fachwissenschaftlicher Voraussetzungen.

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<tr>
<td>551-0961-00L</td>
<td>Mentored Work Subject Didactics Biology A</td>
<td>O</td>
<td>2</td>
<td>4A</td>
<td>J. Egli</td>
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<td>Mentored Work Subject Didactics in Biology for Teaching Diploma, Teaching Diploma Biology as Minor Subject. The Subject Didactics as well as possible branch-specific requirements must be fulfilled prior to commencing the mentored paper.</td>
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<tr>
<td>551-0962-00L</td>
<td>Mentored Work Subject Didactics Biology B</td>
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<td>2</td>
<td>4A</td>
<td>J. Egli</td>
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<td>Mentored Work Subject Didactics in Biology for Teaching Diploma, Teaching Diploma Biology as Minor Subject and for students upgrading TC to Teaching Diploma. The Subject Didactics as well as possible branch-specific requirements must be fulfilled prior to commencing the mentored paper.</td>
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<tr>
<td>551-0971-00L</td>
<td>Subject Didactics Biology I</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>P. Faller</td>
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<td></td>
<td>Simultaneous enrolment in Introductory Internship Biology</td>
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Abstract
- Basic conditions for tuition (MAR - recognition of Matura certificates - curricula, standards), selection of topics and reduction of the complexity of topics.
- Application of teaching methods and techniques from educational science in biology classes.
- Planning and preparation of lessons.

Objective
- Students can discuss and put into practice in their teaching work the conditions and objectives set out in the regulations governing the school-leaving examination (Matura), the framework curriculum and the conditions and objectives specified by their school.
- They are in a position to select learning objectives and formulate these on the basis of the target level model. They can plan and prepare lessons and can also develop appropriate learning assignments.
- Students can reconstruct specialist contents in didactic terms and develop teaching modules suitable for the different levels from these on the basis of the subject structure and learner requirements.
- They can reduce the complexity of subject-based specialist contents and present them in such a way that they are comprehensible and meaningful for learners.
- They can select appropriate media for their work (e.g. school books) and use these. They can employ appropriate experiments.
- The students can use different forms of examination for monitoring performance.
- Students are in a position to implement and discuss the concepts of biology teaching and learning on the basis of specific topics covered in school biology.
Content

Lecture notes
Wird laufend in der Vorlesung abgegeben.

Prerequisites / notice
Studierende müssen LE zusammen mit dem Einführungspraktikum - LE 551-0968-00L - belegen.

Professional Training
Important: You can only enrol in the courses of this category if you have not more than 12 CP left for possible additional requirements.

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<tr>
<th>Number</th>
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<tr>
<td>551-0968-00L</td>
<td>Introductory Internship Biology ■ Simultaneous enrolment in Biology Didactics I - course 551-0871-00L - is compulsory.</td>
<td>O</td>
<td>3 credits</td>
<td>6P</td>
<td>P. Faller</td>
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<td>Abstract</td>
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<td>During the introductory teaching practice, the students sit in on five lessons given by the teacher responsible for their teaching practice, and teach five lessons themselves. The students are given observation and reflection assignments by the teacher responsible for their teaching practice.</td>
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<td>Right at the start of their training, students acquire initial experience with the observation of teaching, the establishment of concepts for teaching and the implementation of teaching. This early confrontation with the complexity of everything that teaching involves helps students decide whether they wish to and, indeed, ought to, continue with the training. It forms a basis for the subsequent pedagogical and subject-didactics training.</td>
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<td>Wird von der Praktikumslehrperson bestimmt.</td>
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<td>551-0966-00L</td>
<td>Teaching Internship Biology ■ Teaching Internship Biology for Teaching Diploma Biology as Major Subject.</td>
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<td>8 credits</td>
<td>17P</td>
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<td>The teaching practice takes in 50 lessons: 30 are taught by the students, and the students sit in on 20 lessons. The teaching practice lasts 4-6 weeks. It gives students the opportunity to implement the contents of their specialist-subject, educational science and subject-didactics training in the classroom. Students also conduct work assignments in parallel to their teaching practice.</td>
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<td></td>
<td>- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.</td>
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<td>- They are able to assess the significance of tuition topics in their subject from different angles (including interdisciplinary angles) and impart these to their pupils.</td>
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<td>- They acquire the skills of the teaching trade.</td>
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<td>- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.</td>
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<td>- They learn to assess pupils' work.</td>
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<td>- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.</td>
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<td>Wird von der Praktikumslehrperson bestimmt.</td>
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<tr>
<td>551-0967-00L</td>
<td>Teaching Internship Biology ■ Teaching Internship for students upgrading TC to Teaching Diploma.</td>
<td>W</td>
<td>4 credits</td>
<td>9P</td>
<td>P. Faller</td>
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<td>This is a supplement to the Teaching Internship required to obtain in the corresponding subject. It is aimed at enlarging the already acquired teaching experience. Students observe 10 lessons and teach 15 lessons independently.</td>
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<td>Students are able to assess in their subject the importance of teaching topics from different angles. They learn and master the teaching trade. They can structure a given lesson topic for a group of learners technically and didactically correctly and they can transfer it into an appropriate learning environment. They manage to find the balance between instruction and openness, so that the learners have both, the necessary freedom and sufficient orientation to acquire actively and a effectively adaptive (expert) knowledge.</td>
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<tr>
<td>551-0969-00L</td>
<td>Examination Lesson I Biology ■ Simultaneous enrolment in &quot;Examination Lesson II Biology&quot; (551-0969-02L) is compulsory.</td>
<td>O</td>
<td>1 credit</td>
<td>2P</td>
<td>P. Faller</td>
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<td>Abstract</td>
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<td>In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.</td>
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<td>- On the basis of a specified topic, the candidate shows that they are in a position:</td>
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<td>- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle</td>
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<td>- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.</td>
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Examination Lesson II Biology


Die gehaltene Lektion wird kriteriумsbezogen beurteilt. Die Beurteilung umfasst auch die schriftliche Vorbereitung und eine mündliche Reflexion des Kandidaten/der Kandidatin über die gehaltene Lektion im Rahmen eines kurzen Kolloquiums.

Dokument: Schriftliche Vorbereitung für Prüfungslektionen.

Nach Abschluss der übrigen Ausbildung.

Professional Exercises in Biology

Students conduct a series of "classical" biological school experiments and therefore gain practice and experience in this area. Implementation of Subject Didactics I and II with the focus on conducting biological experiments in schools. This includes finding, testing and further developing suitable protocols for different subject areas of school biology. Working out how to didactically embed the experiments in lessons.

Students can perform, off the cuff, 12 school experiments (which they have tested themselves), from the different subject areas, and conduct these correctly in technical terms. They can incorporate these experiments in their tuition in a didactically meaningful manner.

Comments:
By contrast to the Subject Specialisation 1 and 2 course units, these are "basic tests" and do not involve the implementation of current research topics. The students' compilations are available in a data archive.

Hand out of course material.

Der Teil biologische Experimente findet im Rahmen von 7 Halbtagen statt.


Teaching Diploma in 2 Subjects in One-Step Procedure: no courses from this category have to be completed.

Specialized Biology Course with an Educational Focus: Teaching Diploma

Specialised Courses in the Respective Subject with an Educational Focus in Biology for Teaching Diploma.

After successfully completing the module, students should be in a position:
- to call up more in-depth specialist knowledge of biology, covering a wide range of topics, and to impart this to others.
- to explain biological concepts and principles, as well as the way they fit together.
- to analyse controversial topics and to give factual explanations for these.
- to conduct more in-depth work on a research topic and to compile a tuition unit based on this topic.
- to prepare tuition units involving complex learning matter at a high specialist level which are suitably tailored to the recipients, and to teach these in a manner conducive to learning.

Demanding biological topics are dealt with under consideration of the special needs of persons involved in teaching. The module comprises the parts:

1) Lecture (Tues. 08.00-09.45 hrs)
2) Colloquium (every second Tues. 10.15-12.00 hrs., begins on first lecture day)
3) Seminar with presentation (every second Tues. 10.15-12.00 hrs., begins in second lecture week)
4) Semester thesis in a research group (7 weeks)

Unterlagen für den Unterricht werden online mit Hilfe der e-learning Platform OLAT abgegeben.

Literatur und Literaturhinweise werden mit der e-learning Platform OLAT abgegeben.
Prerequisites / notice

This Course lasts for two semesters. It can be started in autumn or in spring. Booking is only required once.

Performance Assessment:
Performance is assessed during the course of the entire modul, with a final test. Active participation in the colloquia and group seminars is required. The thesis report and an oral presentation have to be completed.

The Specialized Biology Course with an Educational Focus (12 CP) can be acknowledged, in agreement with the advisor of the respective elective major, as one of the two obligatory research projects (each 15 CP). In such a case, additional 3 CP must be obtained in another course.

In case of overbooking of the course, students enrolled in the Teaching Diploma in Biology will have priority for registration.

The course is organized jointly with the University of Zurich (Fachbereich Biologie) and is held at the Life Science Zurich Learning Center of the ETH Zurich and the University of Zurich.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0963-02L</td>
<td>Specialized Biology Course with an Educational Focus II: Teaching Diploma</td>
<td>W</td>
<td>6 credits</td>
<td>13A</td>
<td>E. Hafen, J. Egli, M. Zwicky</td>
</tr>
</tbody>
</table>

Abstract
Specialized aspects of biology are dealt with under the viewpoint of their presentation, their historical development, their significance for the field, the individual and society.

Objective
The goal is to promote the ability to understand biological concepts, principles and their interrelationships and to communicate specialist knowledge to various groups of recipients in an understandable manner.

Content
Demanding biological topics are dealt with under consideration of the special needs of persons involved in teaching. The module:

1) Lecture (Tues. 08.00-09.45 hrs)
2) Colloquium (every second Tues. 10.15-12.00 hrs., begins on first lecture day)
3) Seminar with presentation (every second Tues. 10.15-12.00 hrs., begins in second lecture week)
4) Semester thesis in a research group (3.5 weeks)

Lecture notes
None.

Literature
Specific references will be made available for the individual projects.

Prerequisites / notice
The program of this course represents one half (6 CP) of that of the Specialized Biology Course with an Educational Focus (551-0963-00, 12 CP).

Compulsory Elective Courses

Further course offerings from the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC". Teaching Diploma in 2 Subjects in One-Step Procedure:

a) courses from the category Compulsory Elective Courses of the Minor Subject may also be selected;
b) courses from the category Specialized Courses in the Respective Subject, either of the Major or the Minor Subject, may also be selected.

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<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>851-0180-00L</td>
<td>Research Ethics</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>G. Achermann</td>
</tr>
</tbody>
</table>

Abstract
This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.

Objective
The main goal of this course is to enhance the student's ability to:
- recognize and identify ethical issues and conflicts,
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.
I. Ethics & the Process of Ethical Inquiry

Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)

Integrity in Research & Research Misconduct
- What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 R's (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks;
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Literature
Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.

701-0015-00L Seminar on Transdisciplinary Research for Sustainable Development

Abstract
The seminar is designed for students and researchers (MA, PhD, PostDoc) who use inter- and transdisciplinary elements in their projects. It addresses the challenges of this research: How to integrate disciplines? How (and in what role) to include societal actors? How to bring results to fruition? We discuss these questions based on case studies and theories and on the participant's projects.

Objective
The participants understand the specific challenges of inter- and transdisciplinary research in general and in the context of sustainable development in particular. They know methods and concepts to address these challenges and apply them to their research projects.
The course is structured as follows:

To understand how an environmental problem may (or not) become a policy and explain political processes, using basic concepts and techniques from political science. To analyze the evolution as well as the key elements of environmental governance. To allocate the challenges and opportunities for environmental governance and to critically discuss them with reference to various practical policy examples. 

Improvements in environmental quality and sustainable management of natural resources cannot be achieved through technical solutions alone. The quality of the environment and the achievement of sustainable development strongly depend on human behavior and specifically the human uses of nature. To influence human behavior, we rely on public policies and other societal rules, which aim to steer the way humans use natural resources and their effects on the environment. Such steering can take place through government intervention alone. However, this often also involves governance, which includes the interplay between governmental and non-governmental actors, the use of diverse tools such as emission standards or financial incentives to steer actors' behavior and can occur at the local, regional, national, or international level.

In this course, we will address both the practical aspects of as well as the scientific debate on environmental governance. The course gives future environmental experts a strong basis to position themselves in the governance debate, which does not preclude government but rather involves a spectrum from government to governance.

Key questions that this course seeks to answer: What are the core characteristics of environmental challenges from a policy perspective? What are key elements of 'environmental governance' and how legitimate and effective are these approaches in addressing persistent environmental challenges?

Lecture notes
Lecture slides and additional course material will be provided throughout the semester.

Literature
We will mostly work with readings from the following books:


Prerequisites / notice
We recommend that students have (a) Three-years BSc education of a (technical) university; (b) Successfully completed Bachelor introductory course to environmental policy (Entwicklungen nationaler Umweltpolitik (or equivalent)) and (c) Familiarity with key issues in environmental policy and some fundamental knowledge of one social science or humanities discipline (political science, economics, sociology, history, psychology, philosophy)

The seminar covers the following topics:

1. Theories and concepts of inter- and transdisciplinary research
2. The specific challenges of inter- and transdisciplinary research
3. Involving stakeholders
4. Collaborating disciplines
5. Exploration of tools and methods
6. Analysing participants' projects to improve inter- and transdisciplinary elements

The seminar is specifically suitable for PhD or PostDoc researchers. It is open to master students (minor "global change and sustainability") and further interested people, who preferably are preparing, or working on, a project/thesis.

Year: 2015
Course: Sustainability Assessment
W 3 credits
2G
E. Lieberherr, G. de Bure

Abstract
The course deals with the concepts and methodologies for the analysis and assessment of sustainable development. A special focus is given to the social dimension and to social justice as a guiding principle of sustainability as well as to trade-offs between the three dimensions of sustainability.

Objective
At the end of the course students should know:
- core concepts of sustainable development, and;
- the concept of social justice - normatively and empirically - as a core element of social sustainability;
- important empirical methods for the analysis and assessment of local / regional sustainability issues.

Understand and reflect on:
- the challenges of trade-offs between the different goals of sustainable development;
- and the respective impacts on individual and societal decision-making.

Content
The course is structured as follows:
- Overview of rationale, objectives, concepts and origins of sustainable development;
- Importance and application of sustainability in science, politics, society, and economy;
- Sustainable (local / regional) development in different national / international contexts;
- Analysis and evaluation methods of sustainable development with a focus on social justice;
- Tradeoffs in selected examples.

Lecture notes
Handouts.

Literature
Selected scientific articles & book chapters

Year: 2015
Course: Learning and Teaching Biology
W 6 credits
7G
E. Hafen, M. Klymkowsky

Abstract
The block course will only take place with a minimum of 10 participants.

This course represents an introduction to recent research into student learning on the conceptual foundations of modern biology, together with pedagogical methods associated with effective instruction and its evaluation. Students will be involved in active research into conceptual and practical issues involved in biology education and methods to discover student preconceptions.

Objective
Provides an overview on student's learning and shows ways to make the classroom experience more engaging and effective for students. Students will learn to produce a research-based paper on a project they work on during the course.
Students can discuss and put into practice in their teaching work the conditions and objectives set out in the regulations governing the Subject Didactics Biology I, Mentored Work Subject Didactics Biology A, and Maturitätsreglement, Lehrpläne und Standards. Lernziele in der J. Egli Wird laufend in der Vorlesung abgegeben.

The objective is for the students:

- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is comprehensible and meaningful for learners.
- to select appropriate media for their work (e.g., school books) and use these. They can employ appropriate experiments.
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to reduce the complexity of subject-based specialist contents and present them in such a way that they are comprehensible and meaningful for learners.
- to select appropriate media for their work (e.g., school books) and use these. They can employ appropriate experiments.
- Students are in a position to implement and discuss the concepts of biology teaching and learning on the basis of specific topics covered in school biology.

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- They can reduce the complexity of subject-based specialist contents and present them in such a way that they are comprehensible and meaningful for learners.
- They can select appropriate media for their work (e.g., school books) and use these. They can employ appropriate experiments.
- The students can use different forms of examination for monitoring performances.
- Students are in a position to implement and discuss the concepts of biology teaching and learning on the basis of specific topics covered in school biology.

- Students are in a position to implement and discuss the concepts of biology teaching and learning on the basis of specific topics covered in school biology.

- They can reduce the complexity of subject-based specialist contents and present them in such a way that they are comprehensible and meaningful for learners.
- They can select appropriate media for their work (e.g., school books) and use these. They can employ appropriate experiments.
- The students can use different forms of examination for monitoring performances.
- Students are in a position to implement and discuss the concepts of biology teaching and learning on the basis of specific topics covered in school biology.

The course is not taught by a particular book, but recommended literature (review articles and selected primary literature) will be provided during the course. See the introductory video to the course here: http://youtu.be/GFJuNncSsdE

### Biology as Second Subject

#### Subject Didactics in Biology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>551-0971-00L</td>
<td>Subject Didactics Biology I - Simultaneous enrolment in Introductory Internship Biology</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>P. Faller</td>
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<tr>
<td></td>
<td>- course 551-0968-00L - is compulsory.</td>
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<tr>
<td>Abstract</td>
<td>- Basic conditions for tuition (MAR - recognition of Matura certificates - curricula, standards), selection of topics and reduction of the complexity of topics.</td>
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<td>- Application of teaching methods and techniques from educational science in biology classes.</td>
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<td>- Planning and preparation of lessons.</td>
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<tr>
<td>Objective</td>
<td>- Students can discuss and put into practice in their teaching work the conditions and objectives set out in the regulations governing the school-leaving examination (Matura), the framework curriculum and the conditions and objectives specified by their school.</td>
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<td>- They are in a position to select learning objectives and formulate these on the basis of the target level model. They can plan and prepare lessons and can also develop appropriate learning assignments.</td>
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<td>- Students can reconstruct specialist contents in didactic terms and develop teaching modules suitable for the different levels from these on the basis of the subject structure and learner requirements.</td>
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<td>- They can reduce the complexity of subject-based specialist contents and present them in such a way that they are comprehensible and meaningful for learners.</td>
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<td>- They can select appropriate media for their work (e.g., school books) and use these. They can employ appropriate experiments.</td>
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<td>- The students can use different forms of examination for monitoring performances.</td>
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<td>- Students are in a position to implement and discuss the concepts of biology teaching and learning on the basis of specific topics covered in school biology.</td>
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<tbody>
<tr>
<td>Lecture notes</td>
<td>Wird laufend in der Vorlesung abgegeben.</td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Studierende müssen LE zusammen mit dem Einführungspraktikum - LE 551-0968-00L - belegen.</td>
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</table>

<table>
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<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>551-0961-00L</td>
<td>Mentored Work Subject Didactics Biology A - Mentored Work Subject Didactics in Biology for Teaching Diploma, Teaching Diploma Biology as Minor Subject. The Subject Didactics as well as possible branch-specific requirements must be fulfilled prior to commencing the mentored paper.</td>
<td>O</td>
<td>2</td>
<td>4A</td>
<td>J. Egli</td>
</tr>
<tr>
<td>Abstract</td>
<td>In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.</td>
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<td>Objective</td>
<td>The objective is for the students:</td>
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<td>- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.</td>
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<td>- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.</td>
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<tr>
<td>Content</td>
<td>Themenwahl nach Vereinbarung. Reflexion über Themen aus allen biologiespezifischen Bereichen des Unterrichts.</td>
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<tr>
<td>Lecture notes</td>
<td>Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt.</td>
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<tr>
<td>Literature</td>
<td>Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Beginn nach Absprache jederzeit möglich, jedoch erst nach Abschluss der Fachdidaktik I und II und nach der Absolvierung allfälliger fachwissenschaftlicher Voraussetzungen.</td>
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<td></td>
<td>Die Arbeit sollte vor Beginn des Unterrichtspraktikums abgeschlossen werden.</td>
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</thead>
<tbody>
<tr>
<td>551-0962-00L</td>
<td>Mentored Work Subject Didactics Biology B - Mentored Work Subject Didactics in Biology for Teaching Diploma, Teaching Diploma Biology as Minor Subject and for students upgrading TC to Teaching Diploma. The Subject Didactics as well as possible branch-specific requirements must be fulfilled prior to commencing the mentored paper.</td>
<td>O</td>
<td>2</td>
<td>4A</td>
<td>J. Egli</td>
</tr>
<tr>
<td>Abstract</td>
<td>In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.</td>
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</tbody>
</table>

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 198 of 1434
Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.


Die Themen für die beiden Prüfungslektionen am Schluss des Praktikums erfahren die Studierenden in der Regel eine Woche vor dem Prüfungstermin. Sie erstellen eine Vorbereitung gemäss Anleitung und reichen sie bis am Vortrag um 12 Uhr den beiden Prüfungsexperten.

Prüfungstermin. Sie erstellen eine Vorbereitung gemäss Anleitung und reichen sie bis am Vortrag um 12 Uhr den beiden Prüfungsexperten, auch die schriftliche Vorbereitung und eine mündliche Reflexion des Kandidaten/der Kandidatin über die gehaltenen Lektionen im Rahmen eines kurzen Kolloquiums.

Die Arbeit sollte vor Beginn des Unterrichtspraktikums abgeschlossen werden. Allfällige fachwissenschaftliche Auflagen müssen alle erfüllt sein, bevor mit der Mentorierten Arbeit begonnen werden kann.

Professional Training in Biology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>551-0965-00L</td>
<td>Teaching Internship Including Examination Lessons in Biology</td>
<td>O</td>
<td>4</td>
<td>9P</td>
<td>P. Faller</td>
</tr>
</tbody>
</table>

Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as assessed as Examination Lessons.

- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They understand the skills of the teaching trade.
- They practises finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils' work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Course Units for Additional Admission Requirements

The courses below are only available for students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0980-00L</td>
<td>Anthropology (University of Zurich)</td>
<td>E-</td>
<td>3</td>
<td>6G</td>
<td>University lecturers</td>
</tr>
</tbody>
</table>

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Genetics, fossil remains, comparative anatomy and behavioral research prove the affiliation of humans to primates. This mammalian order represents variations of a single theme. The main adaptations and the critical steps of phylogeny are presented.

Upon successfully completing of the module the students can:
- interpret the main features of primates and especially of fossil hominids in the evolutionary and functional context;
- explain the genetic, phenetic and cultural diversity of modern human populations as the result of evolutionary processes;
- recognize similarities and differences in the behavior and the cognitive lines from humans and animals, in particular monkeys;
- explain why cultural evolution occurs only in humans;
- discuss the question "What are human beings?" from an evolutionary biological perspective.

Anatomy I and Physiology I

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>376-0151-00L</td>
<td>Anatomy I and Physiology I</td>
<td>E-</td>
<td>6</td>
<td>4V</td>
<td>M. Ristow, M. Flück, L. Slomianka, C. Spengler, N. Wenderoth, D. P. Wolfer</td>
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</table>

Basic knowledge of the anatomy and physiology of tissues, of the embryonal and postnatal development, of the basic terminology of pathology, the neuro-muscular system, the cardiovascular system and the respiratory system.

Basic knowledge of human anatomy and physiology and basics of clinical pathophysiology.
Content

Short overview of human anatomy, physiology and general pathology.

Anatomy and Physiology I (fall term):
Basics of cytology, histology, embryology, general pathology; nervous system, muscles, cardiovascular system, respiratory system

Anatomy and Physiology II (spring term):
digestive system, kidney and urinary tract, endocrine system, skin, thermoregulation, sensory organs, male and female reproductive system, pregnancy and child birth.

Lecture notes

Literature
Anatomie:
Schiebler TH, Korf H-W: Anatomie (10. vollständig überarbeitete Auflage)
Steinkopf / Springer, Heidelberg 2007

Martini FH, Timmons MJ, Tallitsch RB. Human Anatomy

Physiologie:

Prerequisites / notice
Voraussetzungen: 1. Jahr, naturwissenschaftlicher Teil

<table>
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<tr>
<th>Biology Teaching Diploma - Key for Type</th>
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<th>Key for Hours</th>
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ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Abstract
The concept course 'Evolutionary Genetics' consists of two lectures that jointly provide an introduction to the fields of population and quantitative genetics (emphasis on basic concepts) and ecological genetics (more emphasis on evolutionary and ecological processes of adaptation and speciation).

Objective
The aim of the course is to provide students with a solid introduction to the fields of population genetics, quantitative genetics, and ecological genetics. The concepts and research methods developed in these fields have undergone profound transformations; they are of fundamental importance in our understanding of evolutionary processes, both past and present. Students should gain an appreciation for the concepts, methods and explanatory power of evolutionary genetics.

Content
Population genetics - Types and sources of genetic variation; randomly mating populations and the Hardy-Weinberg equilibrium; effects of inbreeding; natural selection; random genetic drift and effective population size; gene flow and hierarchical population structure; molecular population genetics: neutral theory of molecular evolution and basics of coalescent theory.
Quantitative genetics - Continuous variation; measurement of quant. characters; genes, environments and their interactions; measuring their influence; response to selection; inbreeding and crossbreeding, effects on fitness; Fisher's fundamental theorem.
Ecological Genetics - Concepts and methods for the study of genetic variation and its role in adaptation, reproductive isolation, hybridization and speciation

Prerequisites / notice
There will be 5 optional extra sessions for the population genetics part (following lectures 2-6) for computer simulations, designed to help understand the course material.

Number Title Type ECTS Hours Lecturers
701-2413-00L Evolutionary Genetics O 6 credits 4V T. Städler, A. Widmer, P. C. Brunner, M. C. Fischer, A. Guggisberg

Number Title Type ECTS Hours Lecturers
701-0323-00L Plant Ecology O 3 credits 2V S. Güsewell, J. Levine

Number Title Type ECTS Hours Lecturers
751-4801-00L System-Oriented Management of Herbivore Insects I W 2 credits 2G D. Mazzi

Number Title Type ECTS Hours Lecturers
551-1701-00L Research Seminar: Ecological Genetics W 2 credits 1S A. Widmer, S. Fior

Elective Compulsory Master Courses

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Number Title Type ECTS Hours Lecturers
551-1701-00L Research Seminar: Ecological Genetics W 2 credits 1S A. Widmer, S. Fior
Prerequisites / notice
Active participation in the discussions is a prerequisite for this course.

551-1703-00L Ecology of Anthropogenic Habitats W 2 credits 1V D. Ramseier
Abstract
The focus will be on agro-ecology and ecology of urban habitats. Both experience frequent disturbances, specific chemical influences, and extreme climatic conditions. Additionally, in urban habitats edaphic conditions are difficult as well. Turnover of species diversity and composition are higher, both locally and temporally, compared to natural conditions at comparable sites.
Objective
Knowledge of agro-ecosystems and urban ecosystems; their origin, ecosystem services, mechanisms and importance for the maintenance of biodiversity.

701-1441-00L Alpine Ecology and Environments W 2 credits 2G S. Dietz, D. Ramseier
Abstract
The online course ALPECOLe provides a global overview of the complex ecosystems of mountain regions, and of their great diversity of habitats and organisms. The course is strongly interdisciplinary and the various approaches are designed to help understand the past, present and future of mountain ecosystems.
Objective
Knowledge of Alpine environments worldwide and their ecology
Content
The online course is subdivided into
- 5 lessons on abiotic factors: geology, soils and their forming processes, climate, and disturbance factors
- 12 lessons on plants: diversity, patterns and processes, treelines, water & nutrients, carbon cycle, atmospheric influences, sexual and clonal reproduction, and one specific lesson on aquatic environments
- 5 lessons on animals: habitats and adaptations, origin of species, food ecology and impact of domestic livestock
- 3 lessons on landscape evolution: quaternary paleoenvironments, methods like radiocarbon dating, pollen records, dendrochronology, stable isotopes, and historical data
- 1 lesson on global change

Students can also follow a virtual walk through alpine areas where context-based information on alpine environments can be accessed. Moreover, all major alpine areas of the world can be selected on a map and then informative pictures of those landscapes and faunistic and floristic inhabitants will be shown.

Online exercises and tests allow to test the learned matter.
Additionally to the online lessons, three supplementary papers will be read and discussed during the tutorials.

Prerequisites / notice
Online course
Course language is English

751-5121-00L Insect Ecology W 2 credits 2V S. Halloran, C. De Moraes, M. Mescher
Abstract
This is an introductory course in insect ecology. Students will learn about the ways in which insects interact with and adapt to their abiotic & biotic environments and their roles in diverse ecosystems. The course will entail lectures, outside readings, and critical analysis of contemporary literature.
Objective
Students completing this course should become familiar with the application of ecological principles to the study of insects, as well as major areas of inquiry in this field. Highlighted topics will include insect behavior, chemical and sensory ecology, physiological responses to biotic and abiotic stressors, plant-insect interactions, community and food-web dynamics, and disease ecology. The course will emphasize insect evolution and adaptation in the context of specific interactions with other organisms and the abiotic environment. Examples from the literature incorporated into lectures will highlight the methods used to study insect ecology.

Lecture notes
Provided to students through ILIAS

Literature
Selected required readings (peer reviewed literature, selected book chapters). Optional recommended readings with additional information.

401-0625-01L Applied Analysis of Variance and Experimental Design W 5 credits 2V+1U L. Meier
Abstract
Key concepts of experimental design. Planning and analysis of single factor experiments, block designs, full factorial and fractional designs, split-plot and strip-plot designs. Random effects and mixed effects models.
Objective
Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R.
Content

Lecture notes
see website

Literature

401-0649-00L Applied Statistical Regression W 5 credits 2V+1U M. Dettling
Abstract
This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning “good practice” that can be applied in every student's own projects and daily work life.
Objective
The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.
Content
The course starts with the basics of linear regression modeling, and then proceeds to parameter estimation, tests and confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, categorical input variables, shrinkage and general modeling strategies.

The last third of the course is dedicated to an introduction into generalized linear regression models: this includes logistic regression for binary response variables, Poisson regression for count data, cumulative logit models for ordered, and multinomial regression for categorical response variables.

Lecture notes
A script will be available.

Literature
Faraway (2005): Linear Models with R
Faraway (2006): Extending the Linear Model with R
Draper & Smith (1998): Applied Regression Analysis
Fox (2008): Applied Regression Analysis and GLMs
Montgomery et al. (2006): Introduction to Linear Regression Analysis
The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

<table>
<thead>
<tr>
<th>701-0301-00L</th>
<th>Ecosystem Ecology (Advanced Course)</th>
<th>W</th>
<th>3 credits</th>
<th>2V</th>
<th>D. Schröter, A. Gessler</th>
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</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>This course provides the ecological systems' knowledge needed to question applied solutions to current environmental issues. Our central aim is to balance participants' respect for complexity with a sense of possibility by providing examples from the vast solution space offered by ecological systems, such as e.g. green infrastructure to manage water.</td>
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<tr>
<td>Objective</td>
<td>At the end of the course... ...you know how to structure your inquiry and how to proceed the analysis when faced with a complex environmental issue. You can formulate the relevant questions, find answers (supported by discussions, input from the lecturers and the literature), and you are able to present your conclusions clearly and cautiously. ...you understand the complexity of interactions and structures in ecosystems. You know how ecosystem processes, functions and services interact and feed back across multiple spatio-temporal scales (in general, plus in depth case examples). ...you understand that biodiversity and the interaction between organisms are an integral part of ecosystems. You are aware that the link between biodiversity and process/function/service is rarely fully understood. You know how to honestly deal with this lack of understanding and can nevertheless, analytically and communicative solve. ...you understand the importance of ecosystem services for society. ...you have an overview of the methods of ecosystem research and have a deeper insight into some of them, e.g. ecosystem observation, manipulation and modelling. ...you have reflected on ecology as a young discipline at the heart of significant applied questions.</td>
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<tr>
<td>Content</td>
<td>This course provides the ecological systems' knowledge needed to question applied sustainability solutions. We will critically assess the complexity of current environmental issues, illustrating basic ecological concepts and principles. Our central aim is to balance participants' respect for complexity with a sense of possibility by providing examples from the vast solution space offered by ecological systems, such as e.g. green infrastructure to manage water. The course is structured around four larger topical areas: (1) Integrated Water Management -- Green infrastructure (land management options) as an alternative to engineered solutions (e.g. large reservoirs) in flood and drought management; (2) Fire dynamics, the water cycle and biodiversity -- The surprising dynamics of species life cycles and populations in arid landscapes; (3) Rewilding, e.g. re-introducing apex predators (e.g. wolves), or large ungulates (e.g. bison) in protected areas -- A nature conservation trend with counterintuitive effects; (4) Coupling of aquatic and terrestrial systems: carbon, nitrogen and phosphorus transfers of global importance on landscape scale.</td>
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<td>Lecture notes</td>
<td>We would be happy to collaborate with interested participants to produce an (online)script of this course on the basis of our materials (this is a new course that runs for the first time). We will discuss this during the first lecture.</td>
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<tr>
<td>Literature</td>
<td>It is not essential to borrow/buy the following books. We will continuously provide exerpts and other literature during the course.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The course combines elements of a classic lecture, group discussions and problem based learning. It is helpful, but not essential to be familiar with the &quot;seven stages&quot; method (see e.g. course 701-0352-00L &quot;Analysis and Assessment of Environmental Sustainability&quot; by Christian Pohl et al.).</td>
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<tr>
<th>401-6215-00L</th>
<th>Using R for Data Analysis and Graphics (Part I)</th>
<th>W</th>
<th>1 credit</th>
<th>1G</th>
<th>A. J. Papritz, C. B. Schwierz</th>
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</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>The course provides the first part an introduction to the statistical software R for scientists. Topics covered are data generation and selection, graphical and basic statistical functions, creating simple functions, basic types of objects.</td>
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<tr>
<td>Objective</td>
<td>The students will be able to use the software R for simple data analysis.</td>
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<tr>
<td>Content</td>
<td>The course provides the first part of an introduction to the statistical software R for scientists. R is free software that contains a huge collection of functions with focus on statistics and graphics. If one wants to use R one has to learn the programming language R - on very rudimentary level. The course aims to facilitate this by providing a basic introduction to R. Part I of the course covers the following topics: - What is R? - R Basics: reading and writing data from/to files, creating vectors &amp; matrices, selecting elements of dataframes, vectors and matrices, arithmetic; - Types of data: numeric, character, logical and categorical data, missing values; - Simple (statistical) functions: summary, mean, var, etc., simple statistical tests; - Writing simple functions; - Introduction to graphics: scatter-, boxplots and other high-level plotting functions, embellishing plots by title, axis labels, etc., adding elements (lines, points) to existing plots. The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www rstudio.org</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The course resources will be provided via the Moodle web learning platform Please login (with your ETH (or other University) username+password) at <a href="https://moodle-app2.let.ethz.ch/enrol/users.php?id=1145">https://moodle-app2.let.ethz.ch/enrol/users.php?id=1145</a> Choose the course &quot;Using R for Data Analysis and Graphics&quot; and follow the instructions for registration.</td>
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<tr>
<th>401-6217-00L</th>
<th>Using R for Data Analysis and Graphics (Part II)</th>
<th>W</th>
<th>1 credit</th>
<th>1G</th>
<th>A. J. Papritz, C. B. Schwierz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>The course provides the second part an introduction to the statistical software R for scientists. Topics are data generation and selection, graphical functions, important statistical functions, types of objects, models, programming and writing functions. Note: This part builds on &quot;Using R... (Part I)&quot;, but can be taken independently if the basics of R are already known.</td>
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<tr>
<td>Objective</td>
<td>The students will be able to use the software R efficiently for data analysis.</td>
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The course provides the second part of an introduction to the statistical software R for scientists. R is free software that contains a huge collection of functions with focus on statistics and graphics. If one wants to use R one has to learn the programming language R - on very rudimentary level. The course aims to facilitate this by providing a basic introduction to R.

Part II of the course builds on part I and covers the following additional topics:
- Elements of the R language: control structures (if, else, loops), lists, overview of R objects, attributes of R objects;
- More on R functions;
- Applying functions to elements of vectors, matrices and lists;
- Object oriented programming with R: classes and methods;
- Tayloring R: options;
- Extending basic R: packages

Lecture notes
The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www rstudio.org


Basic knowledge of R equivalent to "Using R ... (part 1)" (= 401-6215-00L) is a prerequisite for this course.

The course resources will be provided via the Moodle web learning platform Please login (with your ETH (or other University) username+password) at https://moodle-app2.let.ethz.ch/enrol/users.php?id=1145

Choose the course "Using R for Data Analysis and Graphics" and follow the instructions for registration.

### Abstract

**Lecture Topics and Tentative Schedule**

**Week 1**
- No Lecture: First day of autumn semester

**Week 2**
- The nature of plant diseases, symbiosis, parasites, mutualism, biotrophs and necrotrophs, disease cycles and pathogen life cycles. Nematode attack strategies and types of damage.

**Week 3**

**Week 4**

**Week 5**
- Symptoms and signs of fungal infection. Example fungal diseases: potato late blight, wheat stem rust, grape powdery mildew, wheat Septoria leaf blotch.

**Week 6**
- Plant defense mechanisms, host range and non-host resistance. Passive structural and chemical defenses, preformed chemical defenses. Active structural defense, papillae, active chemical defense, hypersensitive response, pathogenesis-related (PR) proteins, phytoalexins and disease resistance.

**Week 7**
- Pisatin and pisatin demethylase. Local and systemic acquired resistance, signal molecules.

**Week 8**
- Pathogen effects on food quality and safety.

**Week 9**
- Epidemiology: historical epidemics, disease pyramid, environmental effects on epidemic development. Plant effects on development of epidemics, including resistance, phyiology, density, uniformity.

**Week 10**
- Disease assessment: incidence and severity measures, keys, diagrams, scales, measurement errors. Correlations between incidence and severity.

**Week 11**
- Molecular detection and diagnosis of pathogens. Host indexing, serology, monoclonal and polyclonal antibodies, ELISA, PCR, rDNA and rep-PCR.

**Week 12**
- Strategies for minimizing disease risks: principles of disease control and management.

**Week 13**
- Disease control strategies: economic thresholds, physical control methods.

**Week 14**
- Cultural control methods: avoidance, tillage practices, crop sanitation, fertilizers, crop rotation.

### Lecture notes

Detailed lecture notes (~160 pages) will be available for purchase at the cost of reproduction at the start of the semester.

### Abstract

**Molecular Evolution, Phylogenetics and Phyloodynamics**

The aim of the course is to provide up-to-date knowledge on how we can obtain an understanding of the evolution and population dynamics of organisms based on their genetic sequencing data, employing key concepts from molecular evolution, phylogenetics and phyloodynamics. Throughout the course, we tie the models and methods closely with applications, mainly in the field of epidemiology and evolution.

### Abstract

**Molecular Evolution, Phylogenetics and Phyloodynamics**

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Objective

Attendees will learn what information is contained in genetic sequencing data and how this information is extracted from the sequencing data. The main concepts introduced are:

* models in molecular evolution
* phylogenetic & phylodynamic inference
* maximum likelihood and Bayesian statistics
* stochastic processes

Attendees will apply these concepts to a number of applications yielding biological insight into:

* epidemiology
* pathogen evolution
* macroevolution of species

Content

The course consists of three parts. We first introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Second, we employ these evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades.

Lecture notes

Slides of the lecture will be available online.

Literature

The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:

* Yang, Z. 2006. Computational Molecular Evolution.
* Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST.

Prerequisites / notice

Basic knowledge in linear algebra, analysis, and statistics.

701-1419-00L Analysis of Ecological Data

Abstract

This class provides students with an overview of techniques for data analysis used in modern ecological research, as well as practical experience in running these analyses with R and interpreting the results. Topics include linear models, generalized linear models, mixed models, model selection and randomization methods.

Objective

Students will be able to:

- describe the aims and principles of important techniques for the analysis of ecological data
- choose appropriate techniques for given problems and types of data
- evaluate assumptions and limitations
- implement the analyses in R
- represent the relevant results in graphs, tables and text
- interpret and evaluate the results in ecological terms

Content

- Linear models for experimental and observational studies
- Model selection
- Introduction to likelihood inference and Bayesian statistics
- Analysis of counts and proportions (generalised linear models)
- Models for non-linear relationships
- Grouping and correlation structures (mixed models)
- Randomisation methods

Lecture notes

Lecture notes and additional reading will be available electronically a few days before the course.

Literature

Suggested books for additional reading (available electronically)


Prerequisites / notice

Time schedule

The course takes place over a period of nine days from Thursday 14.01 to Friday 22.01, with classes on 14, 15, 18, 19 and 20.01. and an exam on 22.01.

Prerequisites

- Basic statistical training (e.g. Mathematik IV in D-USYS): Data distributions, descriptive statistics, hypothesis testing, linear regression, analysis of variance
- Basic experience in data handling and data analysis in R

Individual preparation

Students without the required knowledge are asked to contact the lecturer before Christmas for support with individual preparation.
Objective

Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

Content

Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

551-0313-00L Microbiology (Part I) W 3 credits 2V W.D. Hardt, L. Eberl, H.M. Fischer, O. Voinnet

Abstract

Advanced lecture class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Objective

This concept class will be based on common concepts (Grundlagen der Biologie IIB, Teil Mikrobiologie) and introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Content

Advanced class covering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Lecture notes

Updated handouts will be provided during the class.

Literature

Current literature references will be provided during the lectures.

Prerequisites / notice

English

The lecture "Grundlagen der Biologie II: Mikrobiologie" is the basis for this advanced lecture.

551-0309-00L Concepts in Modern Genetics W 6 credits 4V Y. Barral, D. Bopp, A. Hajnal, O. Voinnet

Abstract

Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Objective

This lecture focuses on the concepts of classical and modern genetics and genomics.

Content

The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Lecture notes

Scripts and additional material will be provided during the semester.

Prerequisites / notice

This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hoenggerberg, and on Tuesday morning at UniZH Irchel.

Elective Major: Neurosciences

Elective Compulsory Concept Courses

Number Title Type ECTS Hours Lecturers

376-1305-10L Neurobiology O 6 credits 4V M. E. Schwab, E. Stoeckli, L. Filli, K. A. Martin, further lecturers

Abstract

Development of the nervous system (NS): the adult NS, plasticity and regeneration, sensory systems, cognitive functions, learning and memory, molecular and cellular mechanisms, animal models, diseases of the NS.

Objective

Overview of normal development, plasticity and regeneration of the nervous system based on molecular, cellular and biochemical approaches.

Content

Development: Early development of the nervous system, cellular level, nerve fiber growth, building of neuronal networks; biology of the adult nervous system; structural plasticity of the adult nervous system, regeneration and repair: networks and nerve fibers, regeneration, pathological loss of cells.

Lecture notes

Structure, Plasticity and Repair of the Nervous System (376-1305-01L): Lecture notes will be provided on Moodle https://moodle-app2.let.ethz.ch/course/view.php?id=694
Password will be provided at the beginning of the lecture.

Development of the Nervous System (376-1305-00L): Lecture notes will be provided on OLAT https://www.olat.uzh.ch/olat/dmz/

Literature

The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures.

Elective Compulsory Concept Courses

See D-BIOL Master Studies Guide

Number Title Type ECTS Hours Lecturers

551-0317-00L Immunology I W 3 credits 2V A. Oxenius, M. Kopf

Abstract

Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response.
This course focuses on the concepts of classical and modern genetics and genomics.

Introduction into structural and functional aspects of the immune system.

The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of neuronal and neuromorphic engineering that are relevant for our Institute.

Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute to this process.

To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.
The goal of these talks is to provide insight into recent research results. The talks are not meant for the general public, but really aimed at specialists in the field.

The topics depend heavily on the invited speakers, and thus change from week to week. Since we are all experts on consciousness, we expect active participation and discussions!

The course's goal is to give an overview of the contemporary state of consciousness research, with emphasis on the contributions brought by modern cognitive neuroscience. We aim to clarify concepts, explain their philosophical and scientific backgrounds, and to present experimental protocols that shed light on a variety of consciousness related issues.

The course includes discussions of scientific as well as philosophical articles. We review current schools of thought, models of consciousness, and proposals for the neural correlate of consciousness (NCC).

For students: Critical discussion of current research. Students aiming at getting a credit point for this colloquium choose one topic and write a critical essay on the presented research topic.

To understand the basic concepts underlying perceptual, motor and cognitive functions.


"Sociology" of science, the pursuit of basic science questions over a century of research.

Different national and international scientific guests are invited to present and discuss their actual scientific results.

Dynamical Systems in Biology

Applying concepts from nonlinear dynamics to biological systems. Combining theoretical modeling with supporting computer simulations.

http://www.uzh.ch/studies/application/mobilitaet_en.html


Mind the enrolment deadlines at UZH:

This seminar reviews the philosophical and phenomenological as well as the neurobiological aspects of consciousness. The subjective features of consciousness are explored, and modern research into its neural substrate, particularly in the visual domain, is explained. Emphasis is placed on students developing their own thinking through a discussion-centered course structure.

The course's goal is to give an overview of the contemporary state of consciousness research, with emphasis on the contributions brought by modern cognitive neuroscience. We aim to clarify concepts, explain their philosophical and scientific backgrounds, and to present experimental protocols that shed light on a variety of consciousness related issues.

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To understand the basic concepts underlying perceptual, motor and cognitive functions.


"Sociology" of science, the pursuit of basic science questions over a century of research.
It is a commonplace that scientists rarely cite literature that is older than 10 years and when they do, they usually cite one paper that serves as the representative for a larger body of work that has long since been incorporated anonymously in textbooks. Worse than that many authors have not even read the papers they cite in their own publications. This course, Foundations of Neuroscience is one antidote.

Thirteen major areas of research have been selected, which cover the key concepts that have lead to our current ideas of how the nervous system is built and functions. Unusually, we will explore these areas of research reading the original publications, instead of reading someone else's digested summary from a textbook or review. By doing this, we will learn how the discoveries were made, what instrumentation was used, how the scientists interpreted their own findings, and how their work, often over many decades and by many different scientists, linked together to generate the current view of mechanism and structure. We will also explore the personalities of the scientists and the context in which they made their seminal discoveries. To give one concrete example, in 1890 Roy and Sherrington showed that there was a neural activity-dependent regulation of blood flow in the brain. One hundred years later, Ogawa discovered that they could use Nuclear Magnetic Resonance (NMR) to measure a blood oxygen-level dependent (BOLD) signal, which they showed was neural activity-dependent. This discovery led to the development of human functional Magnetic Resonance Imaging (fMRI), which has revolutionized neuropsychology and neuropsychiatry. We will read both these original papers and explore the conceptual links between them and discuss the sociology of science, which in this case, the pursuit of basic science questions over a century of research, led to an explosion in applications. Each week the course members will be given between 2 and 4 papers to read for homework and we will then meet weekly for an hour long interactive seminar. An intimate knowledge of the papers will be assumed so that the discussion does not center simply on an explication of the contents of the papers. Assessment will be done continuously as the individual students are asked to explain a figure, technique, or concept.

551-1145-00L
Viral and non-Viral Vectors for Human Gene-Therapy - from Pathogens to Safe Medical Applications
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
UZH Module Code: BIO708

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
Basic aspects of virology, the viral mechanisms for transfer of genetic material into cells, different vector-systems and target cells, animal models, specific applications for inborn diseases of the immune system and of metabolism, adverse effects, and new developments of vector systems will be taught.

Objective

636-0017-00L
Molecular Evolution, Phylogenetics and Phylodynamics

Abstract
The aim of the course is to provide up-to-date knowledge on how we can obtain an understanding of the evolution and population dynamics of organisms based on their genetic sequencing data, employing key concepts from molecular evolution, phylogenetics and phylodynamics. Throughout the course, we tie the models and methods closely with applications, mainly in the field of epidemiology and evolution.

Objective
Attendees will learn what information is contained in genetic sequencing data and how this information is extracted from the sequencing data. The main concepts introduced are:
* models in molecular evolution
* phylogenetic & phylodynamic inference
* maximum likelihood and Bayesian statistics
* stochastic processes

Attendees will apply these concepts to a number of applications yielding biological insight into:
* epidemiology
* pathogen evolution
* macroevolution of species

Content
The course consists of three parts. We first introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Second, we employ these evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the course, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades.

Lecture notes
Slides of the lecture will be available online.

Literature
The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:
* Yang, Z. 2006. Computational Molecular Evolution.
* Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST.

Prerequisites / notice
Basic knowledge in linear algebra, analysis, and statistics.

551-1409-00L
RNA Biology Lecture Series II: Non-coding RNAs: Biology and Therapeutics

Abstract
This course covers aspects of RNA biology related to the functions of non-coding RNAs as well as their use as drugs to treat diseases.

Objective
Micro RNAs: computational approaches to miRNAs; micro RNA function in metabolism; viruses and viral RNAs; nucleic acid-based drugs; ncRNA-mediated genome regulation; epigenetic programming of genome remodelling in ciliates; telomerase and telomeres; tRNA biology. http://www.nccr-rna-and-disease.ch/tiki-index.php?page=LectureSeries

Prerequisites / notice
Basic knowledge of cell and molecular biology.

Elective Concept Courses

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>551-0317-00L</td>
<td>Immunology I</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>A. Oxenius, M. Kopf</td>
</tr>
</tbody>
</table>

Abstract
Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response.

Objective
Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response.
Content - Introduction and historical background - Innate and adaptive immunity, Cells and organs of the immune system - B cells and antibodies - Generation of diversity - Antigen presentation and Major Histocompatibility (MHC) antigens - Thymus and T cell selection - Autoimmunity - Cytotoxic T cells and NK cells - Th1 and Th2 cells, regulatory T cells - Allergies - Hypersensitivities - Vaccines, immune-therapeutic interventions

Lecture notes Electronic access to the documentation will be provided. The link can be found at “Lernmaterialien”


Prerequisites / notice Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a “Sessionsprüfung”.

551-0319-00L Concepts in Modern Genetics W 6 credits 4V Y. Barral, D. Bopp, A. Hajnal, O. Voinnet

Abstract Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Objective This course focuses on the concepts of classical and modern genetics and genomics.

Content The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Lecture notes Scripts and additional material will be provided during the semester.

Prerequisites / notice This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hönggerberg, and on Tuesday morning at UniZH Irchel.

551-0319-00L Cellular Biochemistry (Part I) W 3 credits 2V U. Kutay, C. M. Azzalin, B. Kornmann, M. Peter

Abstract Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

Objective The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry. The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

Content Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes. Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.

Lecture notes Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biol.ethz.ch)

Literature Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

Prerequisites / notice To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

Elective Major: Microbiology and Immunology

Compulsory Concept Courses

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<tr>
<th>Number</th>
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<th>ECTS</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>551-0313-00L</td>
<td>Microbiology (Part I)</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>W.D. Hardt, L. Eberl, H.M. Fischer, J. Piel, M. Pilhofer</td>
</tr>
</tbody>
</table>

Abstract Advanced lecture class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Objective This concept class will be based on common concepts (Grundlagen der Biologie IIB, Teil Mikrobiologie) and introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Content Advanced class covering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Lecture notes Updated handouts will be provided during the class.

Literature Current literature references will be provided during the lectures.

Prerequisites / notice English The lecture ”Grundlagen der Biologie II: Mikrobiologie“ is the basis for this advanced lecture.

551-0317-00L Immunology I O 3 credits 2V A. Oxenius, M. Kopf

Abstract Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response.

Objective Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response.
The course introduces you to recent developments in the fields of cellular and molecular neurobiology. It also supports you to develop your understanding of the physiology and metabolism of microorganisms. Emphasis is on processes that are specific to bacteria and archaea and that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest.

**Objective**
- Development and selection of CD4 and CD8 T cells, natural killer T cells (NKT), and regulatory T cells (Treg)
- T cell function and dysfunction in acute and chronic viral infections
- Evolution of the "Danger" concept
- Dendritic cells
- Co-stimulation (signals 1-3)
- Overview of cytokines and their effector function
- Evolution of the "Danger" concept
- Cells expressing Pattern Recognition Receptors and their downstream signals
- T cell function and dysfunction in acute and chronic viral infections

**Content**
- The course introduces you to recent developments in the fields of cellular and molecular neurobiology. It also supports you to develop your understanding of the physiology and metabolism of microorganisms.
- The course covers a range of themes related to development and neurobiology. Before starting your preparations, check with Jorge Pereira (jorge.pereira@biol.ethz.ch), who helps you with finding an appropriate paper.
- You must attend at least 80% of the journal clubs, and give a presentation of your own. At the end of the semester there will be a 30 minute oral exam on the material presented during the semester. The grade will be based on the exam (45%), your presentation (45%), and a contribution based on your active participation in discussion of other presentations (10%).

**Lecture notes**
Presentations will be made available after the seminars.

**Prerequisites / notice**
You are expected to take part in the discussion and to ask questions. To prepare for this you should read all the papers beforehand (they will be announced a week in advance of the presentation).

**Prerequisites**
Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a “Sessionsprüfung”.

### Elective Compulsory Master Courses

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>551-0223-00L</td>
<td>Immunology III</td>
<td>W</td>
<td>4 credits</td>
<td>2V</td>
<td>M. Kopf, M. Bachmann, J. Kisielow, A. Lanzavecchia, S. R. Leibundgut, A. Oxenius, R. Spörri</td>
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<tr>
<td>Content</td>
<td>This course provides a detailed understanding of</td>
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<td></td>
<td>- development of T and B cells</td>
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<td>- the dynamics of a immune response during acute and chronic infection</td>
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<td>- mechanisms of immunopathology</td>
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<td>- modern vaccination strategies</td>
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<tr>
<td>Objective</td>
<td>Obtain a detailed understanding of</td>
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<td></td>
<td>- the development, activation, and differentiation of different types of T cells and their effectormechanisms during immune responses,</td>
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<td>- Recognition of pathogenic microorganisms by the host cells and molecular events thereafter,</td>
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<td></td>
<td>- events and signals for maturation of naive B cells to antibody producing plasma cells and memory B cells.</td>
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<td></td>
<td>- Optimization of B cell responses by intelligent design of new vaccines</td>
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<tr>
<td>Literature</td>
<td>Documents of the lectures are available for download at:</td>
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<td></td>
<td><a href="https://moodle-app2.let.ethz.ch/course/view.php?id=998">https://moodle-app2.let.ethz.ch/course/view.php?id=998</a></td>
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<tr>
<td>Prerequisites / notice</td>
<td>Immunology I and II</td>
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<tr>
<td>551-0512-00L</td>
<td>Current Topics in Molecular and Cellular Neurobiology</td>
<td>W</td>
<td>2 credits</td>
<td>1S</td>
<td>U. Suter</td>
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<tr>
<td>Number</td>
<td>Title</td>
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<td>ECTS</td>
<td>Hours</td>
<td>Lecturers</td>
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<tr>
<td>551-1103-00L</td>
<td>Microbial Biochemistry</td>
<td>W</td>
<td>4 credits</td>
<td>2V</td>
<td>J. Vorholt-Zambelli, T. J. Erb, J. Piel</td>
</tr>
<tr>
<td>Abstract</td>
<td>The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms. Emphasis is on processes that are specific to bacteria and archaea and that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest.</td>
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<td>Objective</td>
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</table>
The course will cover six grand topics in immunology (B cells, innate immunity, antigen presentation, tumor immunity, thymus and T cells, some exotic biochemistry: nucleotides, cofactors, Secondary metabolites: playground of evolution).

The goal of the course is to train students in critical analysis of current research. Analysis by individual students will be assessed in oral and written form. The students will be able to introduce, present, evaluate, critically discuss and write about recent scientific articles in the research area of cellular biochemistry.
The course is composed of seminar lectures on specific topics, followed by discussions of scientific papers relevant to these topics. The students will work in small groups under the supervision of a tutor. Each group prepares and presents a lecture, and leads a critical discussion of the selected articles. While being exposed to advanced research in cellular biochemistry, the students practice the critical reading of scientific literature, the evaluation of experimental approaches, and the interpretation of results.

The course is taught in English.

<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Author</th>
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</thead>
<tbody>
<tr>
<td>636-0001-00L</td>
<td>Separations in Biotechnology and Bioprocess Economy</td>
<td>W 6</td>
<td>3G</td>
<td>S. Panke</td>
</tr>
<tr>
<td>Abstract</td>
<td>Separations play an integral part of any biotechnological process. This course aims at enabling students specifically with a chemistry/biology background to select &amp; roughly design suitable separation processes for typical biotechnological products such as monoclonal antibodies, antibiotics, and fine chemicals and at providing a basic set of purification &amp; judge on process economy.</td>
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<tr>
<td>Objective</td>
<td>Students should be able to select for a given biotechnological product a suitable set of purification operations and judge on process economy.</td>
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<tr>
<td>Content</td>
<td>Introduction membrane operations adsorption and chromatography crystallization overall process economics</td>
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<tr>
<td>Lecture notes</td>
<td>Handouts during course</td>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Author</th>
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<tbody>
<tr>
<td>752-4009-00L</td>
<td>Molecular Biology of Foodborne Pathogens</td>
<td>W 3</td>
<td>2V</td>
<td>M. Loessner, M. Schuppler</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.</td>
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<tr>
<td>Objective</td>
<td>Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks.</td>
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<tr>
<td>Content</td>
<td>Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks?</td>
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<tr>
<td>Lecture notes</td>
<td>Electronic copies of the presentation slides (PDF) will be made available for download to registered students.</td>
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<th>Course Code</th>
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<th>Credits</th>
<th>Type</th>
<th>Author</th>
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<tbody>
<tr>
<td>752-5103-00L</td>
<td>Functional Microorganisms in Foods</td>
<td>W 3</td>
<td>2G</td>
<td>C. Lacroix, T. de Wouters, L. Meile, C. Schwab</td>
</tr>
<tr>
<td>Abstract</td>
<td>This integration course will discuss new applications of microorganisms with functional properties in food and functional food products. Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of functional microorganisms to produce food with high quality, safety and potential health benefits for consumers.</td>
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<tr>
<td>Objective</td>
<td>To understand the principles, roles and mechanisms of microorganisms with metabolic activities of high potential for application in traditional and functional foods utilization with high quality, safety and potential health benefits for the consumers. This course will integrate basic knowledge in food microbiology, microbial physiology, biochemistry, and technology.</td>
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<tr>
<td>Content</td>
<td>This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products and characterization of functionality and safety of food bacteria. Specialists from the Laboratory of Food Biotechnology, as well as invited speakers from the industry will contribute to the selected topics as follows:</td>
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<td>- Probiotics and Prebiotics: Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.</td>
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<td></td>
<td>- Bioprotective Cultures and Antimicrobial Metabolites: Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.</td>
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<td>- Legal and Protection Issues Related Functional Foods</td>
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<td></td>
<td>- Industrial Biotechnology of Flavor and Taste Development</td>
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<td></td>
<td>- Safety of Food Starter Cultures and Probiotics</td>
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<tr>
<td>Lecture notes</td>
<td>Copy of the power point slides from lectures will be provided.</td>
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<tr>
<td>Literature</td>
<td>A list of references will be given at the beginning of the course for the different topics presented during this course.</td>
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<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Author</th>
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<tbody>
<tr>
<td>751-4504-00L</td>
<td>Plant Pathology I</td>
<td>W 2</td>
<td>2G</td>
<td>F. Talas, B. McDonald, J. Palma Guerrero, A. Sanchez Vallet</td>
</tr>
<tr>
<td>Abstract</td>
<td>Plant Pathology I will focus on pathogen-plant interactions, epidemiology, disease assessment, and disease development in agroecosystems. Themes will include: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems.</td>
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<tr>
<td>Objective</td>
<td>Students will understand: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems as a basis for implementing disease management strategies in agroecosystems.</td>
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</tbody>
</table>
Course description: Plant Pathology I will focus on pathogen-plant interactions, epidemiology, disease assessment, and disease development in agroecosystems. Themes will include: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems. Topics under the first theme will include pathogen life cycles, disease cycles, and an overview of plant pathogenic nematodes, viruses, bacteria, and fungi. Topics under the second theme will include plant defense strategies, host range, passive and active defenses, and chemical and structural defenses. Topics under the third theme will include the disease triangle and cultural control strategies.

Lecture Topics and Tentative Schedule

Week 1 No Lecture: First day of autumn semester

Week 2 The nature of plant diseases, symbiosis, parasites, mutualism, biotrophs and necrotrophs, disease cycles and pathogen life cycles. Nematode attack strategies and types of damage.


Week 5 Symptoms and signs of fungal infection. Example fungal diseases: potato late blight, wheat stem rust, grape powdery mildew, wheat Septoria leaf blotch.

Week 6 Plant defense mechanisms, host range and non-host resistance. Passive structural and chemical defenses, preformed chemical defenses. Active structural defense, papillae, active chemical defense, hypersensitive response, pathogenesis-related (PR) proteins, phytoalexins and disease resistance.

Week 7 Pisatin and pisatin demethylase. Local and systemic acquired resistance, signal molecules.

Week 8 Pathogen effects on food quality and safety.

Week 9 Epidemiology: historical epidemics, disease pyramid, environmental effects on epidemic development. Plant effects on development of epidemics, including resistance, physiology, density, uniformity.

Week 10 Disease assessment: incidence and severity measures, keys, diagrams, scales, measurement errors. Correlations between incidence and severity.

Week 11 Molecular detection and diagnosis of pathogens. Host indexing, serology, monoclonal and polyclonal antibodies. ELISA, PCR, rDNA and rep-PCR.

Week 12 Strategies for minimizing disease risks: principles of disease control and management.

Week 13 Disease control strategies: economic thresholds, physical control methods.

Week 14 Cultural control methods: avoidance, tillage practices, crop sanitation, fertilizers, crop rotation.

Lecture notes
Detailed lecture notes (~160 pages) will be available for purchase at the cost of reproduction at the start of the semester.

551-1145-00L Viral and non-Viral Vectors for Human Gene-Therapy - W 2 credits 3V University lecturers

Abstract
Basic aspects of virology, the viral mechanisms for transfer of genetic material into cells, different vector-systems and target cells, animal models, specific applications for inborn diseases of the immune system and of metabolism, adverse effects, and new developments of vector systems will be taught.

Objective

636-0017-00L Molecular Evolution, Phylogenetics and Phylodynamics W 4 credits 3G T. Stadler

Abstract
The aim of the course is to provide up-to-date knowledge on how we can obtain an understanding of the evolution and population dynamics of organisms based on their genetic sequencing data, employing key concepts from molecular evolution, phylogenetics and phylodynamics. Throughout the course, we tie the models and methods closely with applications, mainly in the field of epidemiology and evolution.

Objective
Attendees will learn what information is contained in genetic sequencing data and how this information is extracted from the sequencing data. The main concepts introduced are:
* models in molecular evolution
  * phylogenetic & phylodynamic inference
  * maximum likelihood and Bayesian statistics
* stochastic processes

Attendees will apply these concepts to a number of applications yielding biological insight into:
* epidemiology
  * pathogen evolution
  * macroevolution of species

Content
The course consists of three parts. We first introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Second, we employ these evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades.

Lecture notes
Slides of the lecture will be available online.
Students will gain insight into the role of sensory cues and signals in mediating interactions within and between species. There will be a primary, but not exclusive, focus on chemical signaling in interactions among plants, insects and microbes. The course will focus on the discussion of current literature addressing key conceptual questions and state-of-the-art research techniques and methods.

Objective

Students will gain insight into the role of sensory cues and signals in mediating interactions within and between species. There will be a primary, but not exclusive, focus on chemical signaling in interactions among plants, insects and microbes. The course will focus on the discussion of current literature addressing key conceptual questions and state-of-the-art research techniques and methods. Students will engage in discussion and critical analyses of relevant papers and present their evaluations in a seminar setting.

### Elective Concept Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>752-4005-00L</td>
<td>Food Microbiology I</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>M. Loessner</td>
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<tr>
<td></td>
<td>For students of the study programme Biology BSc the course can only be selected as 4th concept course.</td>
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<tr>
<td></td>
<td>Abstract</td>
<td></td>
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<td></td>
<td>This lecture is the first part of a one-year course. It offers insights into the fundamentals and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts and molds present in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms.</td>
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<tr>
<td></td>
<td>Objective</td>
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<td>The lecture offers insights into the basics, practical consequences and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts, molds and protozoa in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms.</td>
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<tr>
<td></td>
<td>Content</td>
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<td>The focus of this first part of the lecture will be on the organisms, but also on the factors which determine spoilage and foodborne disease.</td>
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<tr>
<td></td>
<td>1. History of Food Microbiology</td>
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<td>1. Significance and Transmission of Foodborne pathogens</td>
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<td></td>
<td>1.1. Short synopsis of foodborne microorganisms</td>
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<td>4.1. Significance and Transmission of Foodborne pathogens</td>
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<td></td>
<td>1.2. Spoilage of Foods</td>
<td></td>
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<td>4.2. Staphylococcus aureus</td>
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<td></td>
<td>1.3. Foodborne Disease</td>
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<td>4.3. Gram-positive Sporeformers (Bacillus &amp; Clostridium)</td>
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<td>1.4. Food Preservation</td>
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<td>4.4. Listeria monocytogenes</td>
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<td>1.5. VIP's of Food Microbiology</td>
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<td>4.5. Salmonella, Shigella, Escherichia coli</td>
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<td></td>
<td>2. Overview of Microorganisms in Foods</td>
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<td>4.6. Vibrio, Yersinia, Campylobacter</td>
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<tr>
<td></td>
<td>2.1 Origin of foodborne Microorganisms</td>
<td></td>
<td></td>
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<td>4.7. Brucella, Mycobacterium, Aeromonas, Plesiomonas</td>
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<tr>
<td></td>
<td>2.2 Bacteria</td>
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<td></td>
<td>4.8. Parasites</td>
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<td></td>
<td>2.3 Yeasts</td>
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<td>4.9. Viruses and Bacteriophages</td>
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<td>2.4 Molds</td>
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<td>4.10. Mycotoxins</td>
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<td></td>
<td>3.1 Intrinsic and Extrinsic Parameters</td>
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<td>4.12. Miscellaneous (Antibiotic-resistant Bacteria, Biofilms)</td>
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<td>3.2 Meats, Seafoods, Eggs</td>
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<td>3.3 Milk and Milk Products</td>
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<td></td>
<td>3.4 Vegetable and Fruit Products</td>
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<td>3.5 Miscellaneous (baked goods, nuts, spices, ready-to-eat products)</td>
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<td></td>
<td>3.6 Drinks and Canned Foods</td>
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<td>4. Foodborne Disease</td>
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<td>4.1. Significance and Transmission of Foodborne pathogens</td>
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<td>4.2. Staphylococcus aureus</td>
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<td>4.3. Gram-positive Sporeformers (Bacillus &amp; Clostridium)</td>
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<td>4.4. Listeria monocytogenes</td>
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<td>4.5. Salmonella, Shigella, Escherichia coli</td>
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<td>4.6. Vibrio, Yersinia, Campylobacter</td>
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<td>4.7. Brucella, Mycobacterium, Aeromonas, Plesiomonas</td>
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<td></td>
<td>4.8. Parasites</td>
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<td>4.9. Viruses and Bacteriophages</td>
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<td>4.10. Mycotoxins</td>
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<td>4.11. Bioactive Amines</td>
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<tr>
<td></td>
<td>4.12. Miscellaneous (Antibiotic-resistant Bacteria, Biofilms)</td>
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</tbody>
</table>

**Literature**

Electronic copies of the presentation slides (PDF) will be made available for download.

**Recommendations will be given in the first lecture**

**Literature**

Electronic copies of the presentation slides (PDF) will be made available for download.

**Recommendations will be given in the first lecture**

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.
Content

Bioinformatics I will cover the following topics:
From genes to databases and information
BLAST searches
Prediction of gene function and regulation
RNA structure prediction
Gene expression analysis using microarrays
Protein sequence and structure databases
WWW for bioinformatics
Protein sequence comparisons
Proteomics and de novo protein sequencing
Protein structure prediction
Cellular and protein interaction networks
Molecular dynamics simulation

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<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
<th>Semesters</th>
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</thead>
<tbody>
<tr>
<td>701-2413-00L</td>
<td>Evolutionary Genetics</td>
<td>W 6 credits</td>
<td>4V</td>
</tr>
<tr>
<td>T. Städler, A. Widmer, P. C. Brunner, M. C. Fischer, A. Guggisberg</td>
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</table>

Abstract

The concept course 'Evolutionary Genetics' consists of two lectures that jointly provide an introduction to the fields of population and quantitative genetics (emphasis on basic concepts) and ecological genetics (more emphasis on evolutionary and ecological processes of adaptation and speciation).

Objective

The aim of the course is to provide students with a solid introduction to the fields of population genetics, quantitative genetics, and ecological genetics. The concepts and research methods developed in these fields have undergone profound transformations; they are of fundamental importance in our understanding of evolutionary processes, both past and present. Students should gain an appreciation for the concepts, methods and explanatory power of evolutionary genetics.

Content

Population genetics - Types and sources of genetic variation; randomly mating populations and the Hardy-Weinberg equilibrium; effects of inbreeding; natural selection; random genetic drift and effective population size; gene flow and hierarchical population structure; molecular population genetics: neutral theory of molecular evolution and basics of coalescent theory.
Quantitative genetics - Continuous variation; measurement of quant. characters; genes, environments and their interactions; measuring their influence; response to selection; inbreeding and crossesbreeding; effects on fitness; Fisher’s fundamental theorem.
Ecological Genetics - Concepts and methods for the study of genetic variation and its role in adaptation, reproductive isolation, hybridization and speciation.

Lecture notes

Handouts

Literature


Prerequisites / notice

There will be 5 optional extra sessions for the population genetics part (following lectures 2-6) for computer simulations, designed to help understand the course material.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
<th>Semesters</th>
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<tbody>
<tr>
<td>551-0311-00L</td>
<td>Molecular Life of Plants</td>
<td>W 6 credits</td>
<td>4V</td>
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<tr>
<td>W. Gruissem, A. Rodriguez-Villalon, C. Sánchez-Rodríguez, O. Voinnet, S. C. Zeeman</td>
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</table>

Abstract

The advanced course introduces students to plants through a concept-based discussion of developmental processes that integrates physiology and biochemistry with genetics, molecular biology, and cell biology. The course follows the life of the plant, starting with the seed, progressing through germination to the seedling and mature plant, and ending with reproduction and senescence.

Objective

The new course "Molecular Life of Plants" reflects the rapid advances that are occurring in the field of experimental plant biology as well as the changing interests of students being trained in this discipline. Contemporary plant biology courses emphasize a traditional approach to experimental plant biology by discussing discrete topics that are removed from the context of the plant life cycle. The course will take an integrative approach that focuses on developmental concepts. Whereas traditional plant physiology courses were based on research carried out on intact plants or plant organs and were often based on phenomenological observations, current research in plant biology emphasizes work at the cellular, subcellular and molecular levels.

The goal of "Molecular Life of Plants" is to train students in integrative approaches to understand the function of plants in a developmental context. While the course focuses on plants, the training integrative approaches will also be useful for other organisms.

Content

The course "Molecular Life of Plants" will cover the following topics in a developmental context:
- Plant genome organization
- Seed anatomy
- Food reserves and mobilization
- Seedling emergence
- Heterotrophic to autotrophic growth
- Chlorophyll biosynthesis, photoreceptors
- Integration of metabolism
- Hormones
- Cell cycle
- Cell differentiation and expansion
- Environmental interactions: abiotic
- Environmental interactions: biotic
- Flower development and fertilization
- Embryo and seed development
- Fruit development
- Senescence

551-0307-00L Biomolecular Structure and Mechanism I: Protein Structure and Function

Abstract

Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNAi, current topics in protein biophysics and structural biology.

Objective

Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalytics.

Lecture notes

Scripts on the individual topics can be found under http://www.mol.biol.ethz.ch/teaching.
**551-0309-00L Concepts in Modern Genetics**

- **Abstract**: Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

- **Objective**: This course focuses on the concepts of classical and modern genetics and genomics. The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

- **Content**: The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry. The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

- **Lecture notes**: Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials.

- **Prerequisites / notice**: This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hoenggerberg, and on Tuesday morning at UniZH Irchel.

**551-0319-00L Cellular Biochemistry (Part I)**

- **Abstract**: Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

- **Objective**: The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry. The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

- **Content**: Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes. Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.

- **Lecture notes**: Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials.

- **Prerequisites / notice**: To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

**529-0731-00L Nucleic Acids and Carbohydrates**

- **Abstract**: Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNA; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

- **Objective**: Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNA; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

- **Content**: Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNA; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccine

- **Lecture notes**: No script

- **Literature**: Mainly based on recent original literature, a detailed list will be distributed during the first lecture

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**Autumn Semester 2015**

**Elective Major: Cell Biology**

**Elective Compulsory Concept Courses**

*See D-BIOL Master Studies Guide*

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
551-0319-00L | Cellular Biochemistry (Part I) | W | 3 credits | 2V | U. Kutay, C. M. Azzalin, B. Kommann, M. Peter

**Abstract**: Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

**Objective**: The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry. The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

**Content**: Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes. Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.

**Lecture notes**: Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials.

**Literature**: Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

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**Data: 06.02.2019 13:00**

**Autumn Semester 2015**

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To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

**551-0309-00L Concepts in Modern Genetics**

**Abstract**

Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

**Objective**

This course focuses on the concepts of classical and modern genetics and genomics.

**Content**

- Principles of classical genetics
- Yeast genetics
- Gene mapping
- Forward and reverse genetics
- Structure and function of eukaryotic chromosomes
- Molecular mechanisms and regulation of transcription
- RNAi and DNA repair
- Analysis of developmental processes
- Epigenetics
- RNA interference

**Lecture notes**

Scripts and additional material will be provided during the semester.

**Prerequisites / notice**

This course is co-produced by the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hönggerberg, and on Tuesday morning at UniZI Irchel.

**551-0317-00L Immunology I**

**Abstract**

Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and regulation of an immune response.

**Objective**

Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and regulation of an immune response.

**Content**

- Introduction and historical background
- Innate and adaptive immunity
- Cells and organs of the immune system
- B cells and antibodies
- Generation of diversity
- Antigen presentation and Major Histocompatibility (MHC) antigens
- Thymus and T cell selection
- Autoimmunity
- Cytotoxic T cells and NK cells
- Th1 and Th2 cells, regulatory T cells
- Allergies
- Hypersensitivities
- Vaccines, immune-therapeutic interventions

**Lecture notes**

Electronic access to the documentation will be provided. The link can be found at "Lernmaterialien".

**Literature**


**Prerequisites / notice**

Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a "Sessionsprüfung".

**551-1295-00L Introduction to Bioinformatics: Concepts and Applications**

**Abstract**

Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.

**Objective**

Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large datasets. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

**Content**

Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

**376-1305-10L Neurobiology**

**Abstract**

Development of the nervous system (NS); the adult NS, plasticity and regeneration, sensory systems, cognitive functions, learning and memory, molecular and cellular mechanisms, animal models, diseases of the NS.

**Objective**

Overview of normal development, plasticity and regeneration of the nervous system based on molecular, cellular and biochemical approaches.

**Content**

Development: Early development of the nervous system, cellular level, nerve fiber growth, building of neuronal networks; biology of the adult nervous system; structural plasticity of the adult nervous system, regeneration and repair: networks and nerve fibers, regeneration, pathological loss of cells.
The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms. Emphasis is on monogenic and polygenic processes that are specific to bacteria and archaea and that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest.

By the end of this module, each student should be able to:

- recognize the universal principles underlying the development of different animal body plans.
- explain how the genes encoding the molecular toolkit have evolved to create animal diversity.
- relate changes in gene structure or function to evolutionary changes in animal development.
- present and discuss a relevant evolutionary topic in an oral presentation.
- select and integrate key concepts in animal evolution from primary literature.
- participate in discussions on topics presented by others.

You will present one paper yourself. Give an introduction to the field of the paper, then show and comment on the main results (all the papers we present are available online, so you can show original figures with a beamer). Finish with a summary of the main points and a discussion of their significance.

Prerequisites / notice

You must attend at least 80% of the journal clubs, and give a presentation of your own. At the end of the semester there will be a 30 minute oral exam on the material presented during the semester. The grade will be based on the exam (45%), your presentation (45%), and a contribution based on your active participation in discussion of other presentations (10%).

You are expected to take part in the discussion and to ask questions. To prepare for this you should read all the papers beforehand (they will be announced a week in advance of the presentation).

Presentations will be made available after the seminars. The mechanisms of disease development will be studied. Main topics will be: Genetic regulation of disease development with a focus on monogenic and polygenic processes in addition to elucidating genetic components in disease progression will be discussed. Aging and disease and development associated disease progression including the underlying microbial mechanisms.

To understand the mechanisms governing disease development with a special emphasis on genetic and ageing associated components to understand the mechanisms governing disease development with a special emphasis on genetic and ageing associated components.

Learning outcomes:

- Key skills:
  - explain how the genes encoding the molecular toolkit have evolved to create animal diversity.
  - relate changes in gene structure or function to evolutionary changes in animal development.
- Mind the enrolment deadlines at UZH:
- Prerequisites / notice:
  - You must attend at least 80% of the journal clubs, and give a presentation of your own. At the end of the semester there will be a 30 minute oral exam on the material presented during the semester. The grade will be based on the exam (45%), your presentation (45%), and a contribution based on your active participation in discussion of other presentations (10%).
  - You are expected to take part in the discussion and to ask questions. To prepare for this you should read all the papers beforehand (they will be announced a week in advance of the presentation).

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
551-0512-00L | Current Topics in Molecular and Cellular Neurobiology | W | 2 credits | 2V | U. Suter

Abstract:
The course introduces you to recent developments in the fields of cellular and molecular neurobiology. It also supports you to develop your skills in critically reading the scientific literature. You should be able to grasp what the authors wanted to learn i.e. their goals, why the authors chose the experimental approach they used, the strengths and weaknesses of the experiments and the data presented, and how the work fits into the wider literature in the field. You will present one paper yourself, which provides you with practice in public speaking.

Content:
- present and discuss a relevant evolutionary topic in an oral presentation
- select and integrate key concepts in animal evolution from primary literature
- participate in discussions on topics presented by others

551-0571-00L | From DNA to Diversity (University of Zurich) | W | 2 credits | 2V | A. Hajnal, D. Bopp, E. Hafen

Abstract:
The evolution of the various body-plans is investigated by means of comparison of developmentally essential control genes of molecularly analysed model organisms.

Objective:
- recognize the universal principles underlying the development of different animal body plans.
- explain how the genes encoding the molecular toolkit have evolved to create animal diversity.
- relate changes in gene structure or function to evolutionary changes in animal development.
- Key skills:
  - present and discuss a relevant evolutionary topic in an oral presentation
  - select and integrate key concepts in animal evolution from primary literature
  - participate in discussions on topics presented by others

551-1103-00L | Microbial Biochemistry | W | 4 credits | 2V | J. Vorholt-Zambelli, T. J. Erb, J. Piel

Abstract:
The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms. Emphasis is on processes that are specific to bacteria and archaea and that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest.

Objective:
- important biochemical processes specific to bacteria and archaea will be presented that contribute to the widespread occurrence of prokaryotes.
- Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest.
- Emphasis is on concepts of energy generation and assimilation.

List of topics:
- Eating sugars and letting them in
- Challenging: Aromatics, xenobiotics, and oil
- Complex: (Ligno-)Cellulose and in demand for bioenergy
- Living on a diet and the anaplerotic provocation
- Of climate relevance: The microbial C1 cycle
- What are AMO and Anammox?
- 20 amino acids: the making of
- Extending the genetic code
- The 21st and 22nd amino acid
- Some exotic biochemistry: nucleotides, cofactors
- Ancient biochemistry? Iron-sulfur clusters, polymers
- Secondary metabolites: playground of evolution
The goal of the course is to train students in critical analysis of current research. Analysis by individual students will be assessed in oral presentations, where they will introduce, present, evaluate, critically discuss, and write about recent scientific articles in the research area of cellular biochemistry. Students will work in small groups under the supervision of a tutor. Each group prepares and presents a lecture, and leads a critical discussion of the selected articles. While being exposed to advanced research in cellular biochemistry, the students practice the critical evaluation of scientific publications in this field.

Prerequisites / notice

The course will be in English. It will include the preparation of short essays (marked) about defined topics in Glycobiology.

551-1171-00L

Systems Biology of Metabolism

Objectives:
- Starting from contemporary biological problems related to metabolism, the course focuses on systems biological approaches to address them.
- Develop a deeper understanding of how relevant biological problems can be solved, thereby providing advanced insights to key experimental and computational methods in systems biology.

Content:
- The course will be given as a mixture of lectures, studies of original research and guided discussions that focus on current research topics. For each particular problem studied, we will work out how the various methods work and what their capabilities/limits are. The problem areas range from microbial metabolism to cancer cell metabolism and from metabolic networks to regulation networks in populations and single cells. Key methods to be covered are various modeling approaches, metabolic flux analyses, metabolomics and other omics.

Lecture notes

Script and original publications will be supplied during the course.

Prerequisites / notice

The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.

551-1171-00L

Immunology: from Milestones to Current Topics

Objectives:
- The course will cover six grand topics in immunology (B cells, innate immunity, antigen presentation, tumor immunity, thymus and T cells, and tumor immunity) and for each grand topic four hours will be allocated. During the first double hour, historical milestone papers will be presented by the supervisor providing an overview on the development of the conceptional framework and critical technological advances. The students will also prepare themselves for this double lecture by reading the historical milestone papers and contributing to the discussion. In the following lecture up to four students will present each a recent high impact research paper which emerged from the landmark achievements of the previously discussed milestone concepts.

Content:
- Milestones and current topics of innate immunity, antigen presenting, B cells, thymus and T cells, cytotoxic T cells and NK cells, and tumor immunology.

Lecture notes

Original and review articles will be distributed by the lecturer.

551-1303-00L

Current Research Topics in Cellular Biochemistry

Objectives:
- The goal of the course is to train students in critical analysis of current research. Analysis by individual students will be assessed in oral and written form. The students will be able to introduce, present, evaluate, critically discuss and write about recent scientific articles in the research area of cellular biochemistry.

Content:
- The course is composed of seminar lectures on specific topics, followed by discussions of scientific papers relevant to these topics. The students will work in small groups under the supervision of a tutor. Each group prepares and presents a lecture, and leads a critical discussion of the selected articles. While being exposed to advanced research in cellular biochemistry, the students practice the critical reading of scientific literature, the evaluation of experimental approaches, and the interpretation of results.

Prerequisites / notice

The relevant references to primary literature and review articles will be provided during the course.

Research Seminar: Ecological Genetics

Objectives:
- In this research seminar we will critically discuss current topics in Ecological Genetics using publications from the leading scientific journals in this field.

Prerequisites / notice

none

Lecture notes

Research Seminar: Ecological Genetics

Research Seminar: Ecological Genetics

Minimum number of participants is 4.

In this research seminar we will critically discuss current topics in Ecological Genetics using publications from the leading scientific journals in this field.

The course will be taught in English. It will include the preparation of short essays (marked) about defined topics in Glycobiology.

551-1117-00L

Cutting Edge Topics: Immunology and Infection Biology

Objectives:
- Weekly seminar about cutting edge topics in immunology and infection biology. Internationally renowned experts present their current research followed by an open discussion.

Content:
- The aim of this course is to confront students with current research topics and with scientific presentation. The course offers the opportunity to gain in depth knowledge about diverse topics which are often only briefly touched in the concept courses and to engage in discussion with experts in the field.

Prerequisites / notice

The course will be in English. It will include the preparation of short essays (marked) about defined topics in Glycobiology.

551-1105-00L

Glycobiology

Objectives:
- Structural principles, nomenclature and different classes of glycosylation. The different pathways of N- and O-linked protein glycosylation and glycolipid biosynthesis in prokaryotes and eukaryotes are discussed. Specific glycans binding proteins and their role in deciphering the glycan code are reviewed. The role of glycans in infectious diseases, antigen mimicry and autoimmune diseases are discussed.

Content:
- Detailed knowledge in 1) the different areas of prokaryotic and eukaryotic glycobiology, in particular in the biosynthesis of glycoproteins and glycolipids, 2) the cellular machinery required for these pathways, 3) the principles of carbohydrate/protein interaction, 4) the function of lectins, 5) the role of glycans in infectious disease.

Prerequisites / notice

The course will be in English. It will include the preparation of short essays (marked) about defined topics in Glycobiology.

551-1153-00L

Systems Biology of Metabolism

Objectives:
- Starting from contemporary biological problems related to metabolism, the course focuses on systems biological approaches to address them.
- Develop a deeper understanding of how relevant biological problems can be solved, thereby providing advanced insights to key experimental and computational methods in systems biology.

Content:
- The course will be given as a mixture of lectures, studies of original research and guided discussions that focus on current research topics. For each particular problem studied, we will work out how the various methods work and what their capabilities/limits are. The problem areas range from microbial metabolism to cancer cell metabolism and from metabolic networks to regulation networks in populations and single cells. Key methods to be covered are various modeling approaches, metabolic flux analyses, metabolomics and other omics.

Lecture notes

Script and original publications will be supplied during the course.

Prerequisites / notice

The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.

551-1171-00L

Immunology: from Milestones to Current Topics

Objectives:
- Milestones in Immunology: on old concepts and modern experiments
- The course will cover six grand topics in immunology (B cells, innate immunity, antigen presentation, tumor immunity, thymus and T cells, and tumor immunity) and for each grand topic four hours will be allocated. During the first double hour, historical milestone papers will be presented by the supervisor providing an overview on the development of the conceptional framework and critical technological advances. The students will also prepare themselves for this double lecture by reading the historical milestone papers and contributing to the discussion. In the following lecture up to four students will present each a recent high impact research paper which emerged from the landmark achievements of the previously discussed milestone concepts.

Content:
- Milestones and current topics of innate immunity, antigen presenting, B cells, thymus and T cells, cytotoxic T cells and NK cells, and tumor immunology.

Lecture notes

Original and review articles will be distributed by the lecturer.

551-1303-00L

Current Research Topics in Cellular Biochemistry

Objectives:
- Introduction, presentation, evaluation, critical discussion and written analysis of recent scientific articles in the research area of cellular biochemistry.

Content:
- The course is composed of seminar lectures on specific topics, followed by discussions of scientific papers relevant to these topics. The students will work in small groups under the supervision of a tutor. Each group prepares and presents a lecture, and leads a critical discussion of the selected articles. While being exposed to advanced research in cellular biochemistry, the students practice the critical reading of scientific literature, the evaluation of experimental approaches, and the interpretation of results.

Literature

The relevant references to primary literature and review articles will be provided during the course.

Research Seminar: Ecological Genetics

Objectives:
- In this research seminar we will critically discuss current topics in Ecological Genetics using publications from the leading scientific journals in this field.

Prerequisites / notice

none

Lecture notes

Research Seminar: Ecological Genetics

Research Seminar: Ecological Genetics

Minimum number of participants is 4.

In this research seminar we will critically discuss current topics in Ecological Genetics using publications from the leading scientific journals in this field.

The course will be taught in English. It will include the preparation of short essays (marked) about defined topics in Glycobiology.
Prerequisites / notice
Active participation in the discussions is a prerequisite for this course.

529-0733-00L  Enzymes  W  7 credits  3G  D. Hilvert

Abstract
Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

Objective
Overview of enzymes, enzyme-catalyzed reactions and metabolic processes.

Content
Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

Lecture notes
A script will not be handed out.

Literature
General:

In addition, citations from the original literature relevant to the individual lectures will be assigned weekly.

551-1409-00L  RNA Biology Lecture Series II: Non-coding RNAs: Biology and Therapeutics  W  4 credits  2V  J. Hall, M. Stoffel, O. Voinnet, further lecturers

Abstract
This course covers aspects of RNA biology related to the functions of non-coding RNAs as well as their use as drugs to treat diseases.

Objective
The students should get familiar with the wide array of roles, which non-coding RNAs play in cellular functions.

Content
Micro RNAs; computational approaches to miRNAs; micro RNA function in metabolism; viruses and viral RNAs; ncRNA-mediated genome regulation; epigenetic programming of genome remodelling in ciliates; telomerase and telomeres; tRNA biology.

Prerequisites / notice
Basic knowledge of cell and molecular biology.

E elective Major: Molecular Health Sciences

E Compulsory Concept Courses

Number  Title  Type  ECTS  Hours  Lecturers
376-0205-00L  Molecular Disease Mechanisms I  W  6 credits  4V  C. Wolfrum, C. Ciaudo, M. Ristow, M. Stoffel, A. Wutz, M. Zenobi-Wong

Abstract
The mechanisms of disease development will be studied. Main topics will be: Genetic regulation of disease development with a focus on monogenic and polygenic forms. In addition the methods used in elucidating genetic components in disease progression will be discussed. Ageing and development associated disease progression including the underlying molecular mechanisms.

Objective
To understand the mechanisms governing disease development with a special emphasis on genetic and ageing associated components to understand the mechanisms governing disease development with a special emphasis on genetic and ageing associated components.

E Compulsory Master Courses

Number  Title  Type  ECTS  Hours  Lecturers
551-0571-00L  From DNA to Diversity (University of Zurich)  W  2 credits  2V  A. Hajnal, D. Bopp, E. Hafen

Abstract
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: BIO336

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

The evolution of the various body-plans is investigated by means of comparison of developmentally essential control genes of molecularly analysed model organisms.

Objective
By the end of this module, each student should be able to
- recognize the universal principles underlying the development of different animal body plans.
- explain how the genes encoding the molecular toolkit have evolved to create animal diversity.
- relate changes in gene structure or function to evolutionary changes in animal development.

Key skills:
By the end of this module, each student should be able to
- present and discuss a relevant evolutionary topic in an oral presentation
- select and integrate key concepts in animal evolution from primary literature
- participate in discussions on topics presented by others

551-1303-00L  Current Research Topics in Cellular Biochemistry  W  4 credits  2S  V. Panse, C. M. Azzalin, V. Korkhov, R. Kroschewski, P. Picotti, A. E. Smith, F. van Drogen

Abstract
Introduction, presentation, evaluation, critical discussion and written analysis of recent scientific articles in the research area of cellular biochemistry.

Objective
The goal of the course is to train students in critical analysis of current research. Analysis by individual students will be assessed in oral and written form. The students will be able to introduce, present, evaluate, critically discuss and write about recent scientific articles in the research area of cellular biochemistry.

Content
The course is composed of seminar lectures on specific topics, followed by discussions of scientific papers relevant to these topics. The students will work in small groups under the supervision of a tutor. Each group prepares and presents a lecture, and leads a critical discussion of the selected articles. While being exposed to advanced research in cellular biochemistry, the students practice the critical reading of scientific literature, the evaluation of experimental approaches, and the interpretation of results.

Literature
The relevant references to primary literature, the evaluation and review articles will be provided during the course.

551-0512-00L  Current Topics in Molecular and Cellular Neurobiology  W  2 credits  1S  U. Suter

Abstract
Number of participants limited to 8.

The evolution of the various body-plans is investigated by means of comparison of developmentally essential control genes of molecularly analysed model organisms.

Objective
By the end of this module, each student should be able to
- recognize the universal principles underlying the development of different animal body plans.
- explain how the genes encoding the molecular toolkit have evolved to create animal diversity.
- relate changes in gene structure or function to evolutionary changes in animal development.

Key skills:
By the end of this module, each student should be able to
- present and discuss a relevant evolutionary topic in an oral presentation
- select and integrate key concepts in animal evolution from primary literature
- participate in discussions on topics presented by others

The evolution of the various body-plans is investigated by means of comparison of developmentally essential control genes of molecularly analysed model organisms.

Objective
By the end of this module, each student should be able to
- recognize the universal principles underlying the development of different animal body plans.
- explain how the genes encoding the molecular toolkit have evolved to create animal diversity.
- relate changes in gene structure or function to evolutionary changes in animal development.

Key skills:
By the end of this module, each student should be able to
- present and discuss a relevant evolutionary topic in an oral presentation
- select and integrate key concepts in animal evolution from primary literature
- participate in discussions on topics presented by others

551-0571-00L  From DNA to Diversity (University of Zurich)  W  2 credits  2V  A. Hajnal, D. Bopp, E. Hafen

Abstract
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: BIO336

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

The evolution of the various body-plans is investigated by means of comparison of developmentally essential control genes of molecularly analysed model organisms.

Objective
By the end of this module, each student should be able to
- recognize the universal principles underlying the development of different animal body plans.
- explain how the genes encoding the molecular toolkit have evolved to create animal diversity.
- relate changes in gene structure or function to evolutionary changes in animal development.

Key skills:
By the end of this module, each student should be able to
- present and discuss a relevant evolutionary topic in an oral presentation
- select and integrate key concepts in animal evolution from primary literature
- participate in discussions on topics presented by others

The evolution of the various body-plans is investigated by means of comparison of developmentally essential control genes of molecularly analysed model organisms.

Objective
By the end of this module, each student should be able to
- recognize the universal principles underlying the development of different animal body plans.
- explain how the genes encoding the molecular toolkit have evolved to create animal diversity.
- relate changes in gene structure or function to evolutionary changes in animal development.

Key skills:
By the end of this module, each student should be able to
- present and discuss a relevant evolutionary topic in an oral presentation
- select and integrate key concepts in animal evolution from primary literature
- participate in discussions on topics presented by others
Abstract

The course is a lecture course and seminar on "journal club". Each Friday a student, or a member of the Suter Lab in the Institute of Molecular Health Sciences, will present a paper from the recent literature.

Objective

The course introduces you to recent developments in the fields of cellular and molecular neurobiology. It also supports you to develop your skills in critically reading the scientific literature. You should be able to grasp what the authors wanted to learn i.e. their goals, why the authors chose the experimental approach they used, the strengths and weaknesses of the experiments and the data presented, and how the work fits into the wider literature in the field. You will present one paper yourself, which provides you with practice in public speaking.

Content

You will present one paper yourself. Give an introduction to the field of the paper, then show and comment on the main results (all the papers we present are available online, so you can show original papers and the like). Finish with a summary of the main points and a discussion of their significance.

Lecture notes

Presentations will be made available after the seminars.

Literature

We cover a range of topics related to development and neurobiology. Before starting your preparations, check with Jorge Pereira (jorge.pereira@biol.ethz.ch), who helps you with finding an appropriate paper.

Prerequisites / notice

You must attend at least 80% of the journal clubs, and give a presentation of your own. At the end of the semester there will be a 30 minute oral exam on the material presented during the semester. The grade will be based on the exam (45%), your presentation (45%), and a contribution based on your active participation in discussion of other presentations (10%).

551-1153-00L Systems Biology of Metabolism  W  4 credits  2V  U. Sauer, N. Zamboni, M. Zampieri

Number of participants limited to 15.

Abstract

Starting from contemporary biological problems related to metabolism, the course focuses on systems biological approaches to address them. In a problem-oriented, this-is-how-it-is-done manner, we thereby teach modern methods and concepts.

Objective

Develop a deeper understanding of how relevant biological problems can be solved, thereby providing advanced insights to key experimental and computational methods in systems biology.

Content

The course will be given as a mixture of lectures, studies of original research and guided discussions that focus on current research topics. For each particular problem studied, we will work out how the various methods work and what their capabilities/limits are. The problem areas range from microbial metabolism to cancer cell metabolism and from metabolic networks to regulation networks in populations and single cells. Key methods to be covered are various modeling approaches, metabolic flux analyses, metabolomics and other omics.

Lecture notes

Script and original publications will be supplied during the course.

Prerequisites / notice

The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.

551-1105-00L Glycobiology  W  4 credits  2V  M. Aebi, T. Hennet

Structural principles, nomenclature and different classes of glycosylation. The different pathways of N- and O-linked protein glycosylation, specific glycan binding proteins and their role in deciphering the glycan code are presented. The role of glycans in infectious diseases, antigen mimicry and autoimmunity are discussed.

Objective

Detailed knowledge in 1) the different areas of prokaryotic and eukaryotic glycobiology, in particular in the biosynthesis of glycoproteins and glycolipids, 2) the cellular machinery required for these pathways, 3) the principles of carbohydrate/protein interaction, 4) the function of lectins, 5) the role of glycans in infectious disease.

Content

Structure and linkages; analytical approaches; N-linked protein glycosylation (ER, Golgi); glycans; prokaryotic and eukaryotic pathways; lectins; glycans and infectious disease.

Lecture notes

Outlines, handouts.

Literature


Prerequisites / notice

The course will be in English. It will include the preparation of short essays (marked) about defined topics in Glycobiology.

551-1171-00L Immunology: from Milestones to Current Topics  W  4 credits  2S  B. Ludewig, M. Kopf, A. Oxenius, University lecturers

Milestones in Immunology: on old concepts and modern experiments.

Objective

The course will cover six grand topics in immunology (B cells, innate immunity, antigen presentation, tumor immunity, thymus and T cells, cytokines, T cells and NK cells). You should be able to discuss four topics per hour. During the first double-hour, historical milestone papers will be presented by the supervisor providing an overview on the development of the conceptual framework and critical technological advances. The students will also prepare themselves for this double-hour by reading the historical milestone papers and contributing to the discussion. In the following lecture up to four students will present each a recent high impact research paper which emerged from the landmark achievements of the previously discussed milestone concepts.

Content

Milestones and current topics of innate immunity, antigen presentation, B cells, thymus and T cells, cytokotoxic T cells and NK cells, and tumor immunology.

Lecture notes

Original and review articles will be distributed by the lecturer.

Literature

Literaturunterlagen werden vor Beginn des Kurses auf folgender website zugänglich sein: Moodle Course https://moodle-app2.let.ethz.ch/course/view.php?id=1002

752-6105-00L Epidemiology and Prevention  W  3 credits  2V  M. Eichholzer

The module Epidemiology and Prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented.

Objective

Students are able - to evaluate the scientific evidence on the effects of diet on human health - to describe the role of nutritional factors in the prevention of chronic diseases - to assess the nutritional status of a population (Switzerland taken as an example) - to put forward preventive measures addressing individuals but also our society in relation to the obesity epidemic

Content

The module Epidemiology and Prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented. Switzerland taken as an example, the health risks associated with our nutritional habits will be evaluated. Finally, examples of preventive measures addressing individuals but also the society in relation to the obesity epidemic and other threats to health are discussed.

636-0003-00L Biological Engineering and Biotechnology  W  6 credits  3V  M. Fussenegger

Biological Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutic from target to market.

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 222 of 1434
To be provided by the individual lecturers, at their discretion.

Recommendations will be given in the first lecture, M. Schuppler.

The students are supposed to acquire a deep understanding of the process of biological design including model representation of a S. Panke.

Handouts during course 1. Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical Manufacturing.

2. The Licence To Kill. Apoptosis Regulatory Networks - Engineering of Survival Pathways To Increase Robustness of Production Cell Lines.


5. From Target To Market. An Antibody’s Journey From Cell Culture to Biopharmaceutical Manufacturing I. Introduction to Process Development.

6. Biogenic and Malignant Applications. Do Life Sciences Enable the Development of Biological Weapons?

7. Functional Food. Enjoy your Meal!


Lecture notes Handouts during the course.

752-4009-00L Molecular Biology of Foodborne Pathogens W 3 credits 2V M. Loessner, M. Schuppler

Abstract The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.

Objective Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks.

Content Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks?

Literature Electronic copies of the presentation slides (PDF) will be made available for download to registered students.

Prerequisites / notice Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until 11:15 h), with no break.

752-6101-00L Nutrition and Chronic Disease (HS) W 3 credits 2V M. B. Zimmermann

Abstract To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

Objective To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.

Content The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

Literature There is no script. Powerpoint presentations will be made available on-line to students.

Prerequisites / notice No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.

636-0507-00L Synthetic Biology II W 4 credits 4A S. Panke, Y. Benenson, J. Stelling

Abstract 7 months biological design project, during which the students are required to give presentations on advanced topics in synthetic biology (specifically genetic circuit design) and then select their own biological system to design. The system is subsequently modeled, analyzed, and experimentally implemented. Results are presented at an international student competition at the MIT (Cambridge).

Objective The students are supposed to acquire a deep understanding of the process of biological design including model representation of a biological system, its thorough analysis, and the subsequent experimental implementation of the system and the related problems.

Content Presentations on advanced synthetic biology topics (eg genetic circuit design, adaptation of systems dynamics, analytical concepts, large scale de novo DNA synthesis), project selection, modeling of selected biological system, design space exploration, sensitivity analysis, conversion into DNA sequence, (DNA synthesis external,) implementation and analysis of design, summary of results in form of scientific presentation and poster, presentation of results at the iGEM international student competition (www.igem.org).

Literature Handouts during course

Prerequisites / notice The final presentation of the project is typically at the MIT (Cambridge, US). Other competing schools include regularly Imperial College, Cambridge University, Harvard University, UC Berkeley, Princeton University, CalTech, etc.

This project takes place between end of Spring Semester and beginning of Autumn Semester. Registration in April.

Please note that the number of ECTS credits and the actual work load are disconnected.

376-0300-00L Translational Science for Health and Medicine  W 3 credits 2G J. Goldhahn, C. Wolfrum

Abstract Translational science is a cross disciplinary scientific research that is motivated by the need for practical applications that help people. The course should help to clarify basics of translational science, illustrate successful applications and should enable students to integrate key features into their future projects.

Objective After completing this course, students will be able to understand: Principles of translational science (including project planning, ethics application, basics of resource management and interdisciplinary communication)

Content What is translational science and what is it not? How to identify need? Disease concepts and consequences for research Basics about incidence, prevalence etc., and orphan indications How to choose the appropriate research type and methodology Ethical considerations including ethics application Pros and cons of different types of research Coordination of complex approaches incl. timing and resources How to measure success? Outcome variables Improving the translational process Challenges of communication? How independent is translational science? Academic boundary conditions vs. industrial influences Positive and negative examples will be illustrated by distinguished guest speakers.

551-1145-00L Viral and non-Viral Vectors for Human Gene-Therapy - W 2 credits 3V University lecturers

from Pathogens to Safe Medical Applications

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
The goal of the course is to train students in critical analysis of current research. Analysis by individual students will be assessed in oral and written form. The students will be able to introduce, present, evaluate, critically discuss and write about recent scientific articles in the research area of cellular biochemistry.

**Objective**
- Knowledge of important viral and non-viral vector systems.
- Knowledge of application in human diseases.
- Knowledge of limiting factors.

**Content**
- Micro RNAs; computational approaches to miRNAs; micro RNA function in metabolism; viruses and viral RNAs; ncRNA-mediated genome regulation; epigenetic programming of genome remodelling in ciliates; telomerase and telomeres; TRNA biology.

**Lecture notes**
Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials.

**Literature**
Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

**Prerequisites / notice**
Basic knowledge of cell and molecular biology.

### Elective Major: Biochemistry

#### Compulsory Concept Courses

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>551-0319-00L</td>
<td>Cellular Biochemistry (Part I)</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>U. Kutay, C. M. Azzalin, B. Kommann, M. Peter</td>
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</table>

**Abstract**
Concepts and molecular mechanisms underlyng the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

**Objective**
The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry.

**Content**
Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes. Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.

**Lecture notes**
Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials.

**Literature**
Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

**Prerequisites / notice**
To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

### Compulsory Master Course

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>551-1303-00L</td>
<td>Current Research Topics in Cellular Biochemistry</td>
<td>O</td>
<td>4</td>
<td>2S</td>
<td>V. Panse, C. M. Azzalin, V. Korkhov, R. Kroschewski, P. Picotti, A. E. Smith, F. van Drogen</td>
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</tbody>
</table>

**Abstract**
Introduction, presentation, evaluation, critical discussion and written analysis of recent scientific articles in the research area of cell and molecular biology.

**Objective**
The goal of the course is to train students in critical analysis of current research. Analysis by individual students will be assessed in oral and written form. The students will be able to introduce, present, evaluate, critically discuss and write about recent scientific articles in the research area of cell and molecular biology.

**Content**
The course is composed of seminar lectures on specific topics, followed by discussions of scientific papers relevant to these topics. The students will work in small groups under the supervision of a tutor. Each group prepares and presents a lecture, and leads a critical discussion of the selected articles. While being exposed to advanced research in cellular biochemistry, the students practice the critical reading of scientific literature, the evaluation of experimental approaches, and the interpretation of results.

**Literature**
The relevant references to primary literature and review articles will be provided during the course.

**Prerequisites / notice**
The course will be taught in English.

### Elective Compulsory Concept Courses

See D-BIOL Master Studies Guide

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<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>551-0307-00L</td>
<td>Biomolecular Structure and Mechanism I: Protein Structure and Function</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>R. Glockshuber, K. Locher, E. Weber-Barr</td>
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</table>

**Abstract**
Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNAi, current topics in protein biophysics and structural biology.

**Objective**
Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalyticals.

**Lecture notes**
Scripts on the individual topics can be found under http://www.mol.biol.ethz.ch/teaching.
Current topics: References will be given during the lectures.

551-0309-00L Concepts in Modern Genetics

Abstract
Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Objective
This course focuses on the concepts of classical and modern genetics and genomics.

Content
The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Lecture notes
Scripts and additional material will be provided during the semester.

Prerequisites / notice
This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hoenggerberg, and on Tuesday morning at UniZHz Irchel.

Autumn Semester 2015

4 credits

Number of participants limited to 15.
Objective

Develop a deeper understanding of how relevant biological problems can be solved, thereby providing advanced insights to key experimental and computational methods in systems biology.

Content

The course will be given as a mixture of lectures, studies of original research and guided discussions that focus on current research topics. For each particular problem studied, we will work out how the various methods work and what their capabilities/limits are. The problem areas range from microbial metabolism to cancer cell metabolism and from metabolic networks to regulation networks in populations and single cells. Key methods to be covered are various modeling approaches, metabolic flux analyses, metabolomics and other omics.

Lecture notes

Script and original publications will be supplied during the course.

Prerequisites / notice

The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of bioinformatics and basics of mathematics and chemistry.

<table>
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<tr>
<th>Course Code</th>
<th>Title</th>
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<th>Instructor</th>
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<tbody>
<tr>
<td>636-0001-00L</td>
<td>Separations in Biotechnology and Bioprocess</td>
<td>6</td>
<td>V+1U</td>
<td>S. Panke</td>
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<tr>
<td>636-0007-00L</td>
<td>Computational Systems Biology</td>
<td>6</td>
<td>V+2U</td>
<td>J. Stelling</td>
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<tr>
<td>401-0649-00L</td>
<td>Applied Statistical Regression</td>
<td>5</td>
<td>2+1U</td>
<td>M. Dettling</td>
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<tr>
<td>636-0003-00L</td>
<td>Biological Engineering and Biotechnology</td>
<td>6</td>
<td>V</td>
<td>M. Fussenegger</td>
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</tbody>
</table>

Abstract

Separations play an integral part of any biotechnological process. This course aims at enabling students specifically with a chemistry/biology background to select & roughly design suitable separation processes for typical biotechnological products such as monoclonal antibodies, antibiotics, and fine chemicals and at providing a basic set of purification operations & judge on process economy.

Objective

Students should be able to select for a given biotechnological product a suitable set of purification operations and judge on process economy.

Content

Introduction membrane operations adsorption and chromatography crystallization overall process economics

Lecture notes

Handouts during course.

Objective

Study of fundamental concepts, models and computational methods for the analysis of complex biological networks. Topics: Systems approaches in biology, biology and reaction network fundamentals, modeling and simulation approaches (topological, probabilistic, stoichiometric, qualitative, linear / nonlinear ODEs, stochastic), and systems analysis (complexity reduction, stability, identification).

Objective

The aim of this course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.

Content

Biology has witnessed an unprecedented increase in experimental data and, correspondingly, an increased need for computational methods to analyze this data. The explosion of sequenced genomes, and subsequently of bioinformatics methods for the storage, analysis and comparison of genetic sequences provides a prominent example. Recently, however, an additional area of research, captured by the label "Systems Biology", focuses on how networks, which are more than the mere sum of their parts' properties, establish biological functions. This is essentially a task of reverse engineering. The aim of this course is to provide an introductory overview of corresponding computational methods for the modeling, simulation and analysis of biological networks.

We will start with an introduction into the basic units, functions and design principles that are relevant for biology at the level of individual cells. Making extensive use of example systems, the course will then focus on methods and algorithms that allow for the investigation of biological networks with increasing detail. These include (i) graph theoretical approaches for revealing large-scale network organization, (ii) probabilistic (Bayesian) network representations, (iii) structural network analysis based on reaction stoichiometries, (iv) qualitative methods for dynamic modeling and simulation (Boolean and piece-wise linear approaches), (v) mechanistic modeling using ordinary differential equations (ODEs) and finally (vi) stochastic simulation methods.

Literature


Abstract

This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning "good practice" that can be applied in every student's own projects and daily work life.

Objective

The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

Content

The course starts with the basics of linear regression modeling, and then proceeds to parameter estimation, tests and confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, categorical input variables, shrinkage and general modeling strategies.

The last third of the course is dedicated to an introduction into generalized linear regression models: this includes logistic regression for binary response variables, Poisson regression for count data, cumulative logit models for ordered, and multinomial regression for categorical response variables.

Prerequisites / notice

A script will be available.

Literature

Faraway (2005): Linear Models with R
Faraway (2006): Extending the Linear Model with R
Draper & Smith (1998): Applied Regression Analysis
Fox (2008): Applied Regression Analysis and GLMs
Montgomery et al. (2006): Introduction to Linear Regression Analysis

The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

Abstract

Biological Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutic from target to market.

Objective

1. Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical Manufacturing.
2. The Licence To Kill. Apoptosis Regulatory Networks - Engineering of Survival Pathways To Increase Robustness of Production Cell Lines.
5. From Target To Market. An Antibody's Journey From Cell Culture to Therapy. The Clinics.
6. Development of Biological Weapons?

Lecture notes

Handout during the course.
### Elective Concept Courses

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<td>Structure and Function</td>
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<td>Scripts on the individual topics can be found under</td>
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<td>529-0051-00 &quot;Analytische Chemie I (3. Semester)&quot;</td>
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<td>529-0058-00 &quot;Analytische Chemie II (4. Semester)&quot;</td>
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<tr>
<td>551-0309-00L</td>
<td>Concepts in Modern Genetics</td>
<td>W</td>
<td>6</td>
<td>4V</td>
<td>Y. Barral, D. Bopp, A. Hajnal, O. Voinnet</td>
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<td>chromosomes; molecular mechanisms and regulation of</td>
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<td>recombination; analysis of developmental processes;</td>
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<td>epigenetics and RNA interference.</td>
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<td>This course is a co-production of the University of</td>
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<td>The course takes place on Monday afternoon at ETH</td>
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<td>551-0313-00L</td>
<td>Microbiology (Part I)</td>
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<td>W.D. Hardt, L. Eberl, H.M. Fischer, J. Piel, M. Pilhofer</td>
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<td>introduce to the enormous diversity among bacteria</td>
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<td>and archaea. It will cover the current research on</td>
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<td>Advanced class covering the state of the research</td>
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<td>in bacterial cell structure, genetics, metabolism,</td>
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<td>The lecture &quot;Grundlagen der Biologie II: Mikrobiologie&quot; is the basis for this advanced lecture.</td>
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<td>551-0317-00L</td>
<td>Immunology I</td>
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<td>A. Oxenius, M. Kopf</td>
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<td><strong>Abstract</strong></td>
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The new course "Molecular Life of Plants" reflects the rapid advancements that are occurring in the field of experimental plant biology as well as the changing interests of students being trained in this discipline. Contemporary plant biology courses emphasize a traditional approach as the changing interests of students being trained in this discipline. However, current research in plant biology carries out on intact plants or plant organs and were often based on phenomenological observations. The goal of "Molecular Life of Plants" is to train students in integrative approaches to understand the function of plants in a developmental context. The course follows the life of the plant, starting with the seed, progressing through germination to the seedling and mature plant, and ending with reproduction and senescence.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

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Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation
- Protein structure and expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

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- Protein structure prediction
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- Molecular dynamics simulation
- Protein structure and expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.
The course "Molecular Life of Plants" will cover the following topics in a developmental context:

- Plant genome organization
- Seed anatomy
- Food reserves and mobilization
- Seedling emergence
- Heterotrophic to autotrophic growth
- Chlorophyll biosynthesis, photoreceptors
- Integration of metabolism
- Hormones
- Cell cycle
- Cell differentiation and expansion
- Environmental interactionsabiotic
- Environmental interactionsbiotic
- Flower development and fertilization
- Embryo and seed development
- Fruit development
- Senescence

### Elective Compulsory Concept Courses

**See D-BIOL Master Studies Guide**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>551-0307-00L</td>
<td>Biomolecular Structure and Mechanism I: Protein Structure and Function</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>R. Glockshuber, K. Locher, E. Weber-Ban</td>
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<tr>
<td>Abstract</td>
<td>Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNAi, current topics in protein biophysics and structural biology.</td>
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<td>Objective</td>
<td>Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalytics.</td>
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</table>
| Literature | - Creighton, T.E., Proteins, Freeman, (1993)  
- Fersht, A., Enzyme, Structure and Mechanism in Protein Science (1999), Freeman.  
Current topics: References will be given during the lectures. |
| Prerequisites / notice | - Bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis. |

| 551-0309-00L | Concepts in Modern Genetics | W    | 6 credits | 4V    | Y. Barral, D. Bopp, A. Hajnal, O. Voinnet |
| Abstract   | Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference. |
| Objective  | This course focuses on the concepts of classical and modern genetics and genomics. |
| Content    | The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference. |
| Literature | - Creighton, T.E., Proteins, Freeman, (1993)  
- Fersht, A., Enzyme, Structure and Mechanism in Protein Science (1999), Freeman.  
| Prerequisites / notice | - Bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis. |

| 551-0313-00L | Microbiology (Part I) | W    | 3 credits | 2V    | W.D. Hardt, L. Eberl, H.M. Fischer, J. Piel, M. Pilhofer |
| Abstract   | Advanced lecture class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis. |
| Objective  | This concept class will be based on common concepts (Grundlagen der Biologie IIB, Teil Mikrobiologie) and introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis. |
| Content    | Advanced class covering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis. |
| Literature | Updated handouts will be provided during the class. |
| Prerequisites / notice | Current literature references will be provided during the lectures. |

| 551-0319-00L | Cellular Biochemistry (Part I) | W    | 3 credits | 2V    | U. Kutay, C. M. Azzalin, B. Kornmann, M. Peter |
| Abstract   | Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration. |
| Objective  | The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry. The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer. |
| Content    | Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes. |
| Lecture notes | Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biol.ethz.ch) |
Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

**551-1295-00L**

**Introduction to Bioinformatics: Concepts and Applications**

**W** 6 credits 4G  
W. Gruissem, K. Bärenfänger, A. Callisch, G. Capitani, J. Fütterer, M. Robinson, A. Wagner

**Abstract**

Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.

**Objective**

Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although *Introduction to Bioinformatics I* will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course *Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms* that will be offered in the following semester.

**Content**

Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

**701-2413-00L**

**Evolutionary Genetics**

**W** 6 credits 4V  
T. Städler, A. Widmer, P. C. Brunner, M. C. Fischer, A. Guggisberg

**Abstract**

The concept course 'Evolutionary Genetics' consists of two lectures that jointly provide an introduction to the fields of population and quantitative genetics (emphasis on basic concepts) and ecological genetics (more emphasis on evolutionary and ecological processes of adaptation and speciation).

**Objective**

The aim of the course is to provide students with a solid introduction to the fields of population genetics, quantitative genetics, and ecological genetics. The concepts and research methods developed in these fields have undergone profound transformations; they are of fundamental importance in our understanding of evolutionary processes, both past and present. Students should gain an appreciation for the concepts, methods and explanatory power of evolutionary genetics.

**Content**

Population genetics - Types and sources of genetic variation; randomly mating populations and the Hardy-Weinberg equilibrium; effects of natural selection; random genetic drift and effective population size; gene flow and hierarchical population structure; molecular population genetics: neutral theory of molecular evolution and basics of coalescent theory.

Quantitative genetics - Continuous variation; measurement of quant. characters; genes, environments and their interactions; measuring their influence; response to selection; inbreeding and crossbreeding; effects on fitness; Fisher's fundamental theorem.

Ecological Genetics - Concepts and methods for the study of genetic variation and its role in adaptation, reproductive isolation, hybridization and speciation

**Lecture notes**

Handouts

**Literature**


**Prerequisites / notice**

There will be 5 optional extra sessions for the population genetics part (following lectures 2-6) for computer simulations, designed to help understand the course material.

#### Elective Compulsory Master Courses

**Number**

**Title**

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<th>Number</th>
<th>Type</th>
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<tr>
<td>751-4801-00L</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>D. Mazzù</td>
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<tr>
<td>551-1105-00L</td>
<td>W</td>
<td>4 credits</td>
<td>2V</td>
<td>M. Aeobi, T. Hennet</td>
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**551-1105-00L**

**Glycobiology**

**W** 4 credits 2V  
M. Aeobi, T. Hennet

**Abstract**

Structural principles, nomenclature and different classes of glycosylation. The different pathways of N- and O-linked protein glycosylation and glycolipid biosynthesis in prokaryotes and eukaryotes are discussed. Specific glycan binding proteins and their role in deciphering the glycan code are presented. The role of glycans in infectious diseases, antigen mimicry and autoimmunity are discussed.

**Objective**

Detailed knowledge in 1) the different areas of prokaryotic and eukaryotic glycobiology, in particular in the biosynthesis of glycoproteins and glycolipids, 2) the cellular machinery required for these pathways, 3) the principles of carbohydrate/protein interaction, 4) the function of lectins, 5) the role of glycans in infectious disease.

**Content**

Structure and linkages; analytical approaches; N-linked protein glycosylation (ER, Golgi); glycan-assisted protein folding and quality control; O-linked protein glycosylation; glucosaminoglycans; glycolipids; prokaryotic glycosylation pathways; lectins; glycans and infectious disease

**Lecture notes**

handouts

**Literature**

Introduction to Glycobiology; M. E. Taylor, K. Dickramer, Oxford University Press, 2003  
The course will be in English. It will include the preparation of short essays (marked) about defined topics in Glycobiology.

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<th>Course Code</th>
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<th>Credits</th>
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<tbody>
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<td>551-1103-00L</td>
<td>Microbial Biochemistry</td>
<td>W 4</td>
<td>J. Vorholt-Zambelli, T. J. Erb, J. Piel</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms. Emphasis is on processes that are specific to bacteria and archaea and that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest.</td>
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<td>Objective</td>
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<td>The course will be in English. It will include the preparation of short essays (marked) about defined topics in Glycobiology.</td>
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<td>Content</td>
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<td>Important biochemical processes specific to bacteria and archaea will be presented that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest. Emphasis is on concepts of energy generation and assimilation.</td>
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<td>List of topics:</td>
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<td></td>
<td>Eating sugars and letting them in</td>
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<td></td>
<td>Challenging: Aromatics, xenobiotics, and oil</td>
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<td></td>
<td>Complex: (Ligno-)Cellulose and in demand for bioenergy</td>
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<td></td>
<td>Of climate relevance: The microbial C1 cycle</td>
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<td></td>
<td>What are AMO and Anammox?</td>
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<td>20 amino acids: the making of</td>
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<td>Extending the genetic code</td>
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<td>The 21st and 22nd amino acid</td>
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<td>Some exotic biochemistry: nucleotides, cofactors</td>
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<td>Ancient biochemistry? Iron-sulfur clusters, polymers</td>
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<td>Secondary metabolites: playground of evolution</td>
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<td>Lecture notes</td>
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<td>A script will be provided during the course.</td>
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<tr>
<td>529-0733-00L</td>
<td>Enzymes</td>
<td>W 7</td>
<td>D. Hilvert</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.</td>
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<td>Objective</td>
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<td></td>
<td>Overview of enzymes, enzyme-catalyzed reactions and metabolic processes.</td>
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<td>Content</td>
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<td></td>
<td>Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.</td>
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<td>Lecture notes</td>
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<td></td>
<td>A script will not be handed out.</td>
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<td></td>
<td>Literature</td>
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<tr>
<td></td>
<td>General:</td>
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<tr>
<td>529-1153-00L</td>
<td>Insect Ecology</td>
<td>W 2</td>
<td>S. Halloran, C. De Moraes, M. Mescher</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>This is an introductory course in insect ecology. Students will learn about the ways in which insects interact with and adapt to their abiotic &amp; biotic environments and their roles in diverse ecosystems. The course will entail lectures, outside readings, and critical analysis of contemporary literature.</td>
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<td>Objective</td>
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<td>Students completing this course should become familiar with the application of ecological principles to the study of insects, as well as major areas of inquiry in this field. Highlighted topics will include insect behavior, chemical and sensory ecology, physiological responses to biotic and abiotic stressors, plant-insect interactions, community and food-web dynamics, and disease ecology. The course will emphasize insect ecology and adaptation in the context of specific interactions with other organisms and the abiotic environment. Examples from the literature incorporated into lectures will highlight the methods used to study insect ecology.</td>
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<td>Lecture notes</td>
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<td>Provided to students through ILIAS.</td>
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<td>Literature</td>
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<td>Selected required readings (peer reviewed literature, selected book chapters). Optional recommended readings with additional information.</td>
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<tr>
<td>551-1153-00L</td>
<td>Systems Biology of Metabolism</td>
<td>W 4</td>
<td>U. Sauer, N. Zamboni, M. Zampieri</td>
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<td>Number of participants limited to 15.</td>
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<td></td>
<td>Abstract</td>
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<td>Starting from contemporary biological problems related to metabolism, the course focuses on systems biological approaches to address them. In a problem-oriented, this-is-how-it-is-done manner, we thereby teach modern methods and concepts.</td>
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<td>Develop a deeper understanding of how relevant biological problems can be solved, thereby providing advanced insights to key experimental and computational methods in systems biology.</td>
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<td>Content</td>
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<td>The course will be given as a mixture of lectures, studies of original research and guided discussions that focus on current research topics. For each particular problem studied, we will work out how the various methods work and what their capabilities/limits are. The problem areas range from microbial metabolism to cancer cell metabolism and from metabolic networks to regulation networks in populations and single cells. Key methods to be covered are various modeling approaches, metabolic flux analyses, metabolomics and other omics.</td>
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<td>Lecture notes</td>
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<td>Script and original publications will be supplied during the course.</td>
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<td>Prerequisites / notice</td>
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<td>The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.</td>
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<tr>
<td>751-4504-00L</td>
<td>Plant Pathology I</td>
<td>W 2</td>
<td>F. Talas, B. McDonald, J. Palma Guerrero, A. Sanchez Vallet</td>
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<td></td>
<td>Abstract</td>
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<td>Plant Pathology I will focus on pathogen-plant interactions, epidemiology, disease assessment, and disease development in agroecosystems. Themes will include: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems.</td>
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<td>Objective</td>
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<td>Students will understand: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems as a basis for implementing disease management strategies in agroecosystems.</td>
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</table>
Course description: Plant Pathology I will focus on pathogen-plant interactions, epidemiology, disease assessment, and disease development in agroecosystems. Themes will include: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems. Topics under the first theme will include pathogen life cycles, disease cycles, and an overview of plant pathogenic nematodes, viruses, bacteria, and fungi. Topics under the second theme will include plant defense strategies, host range, passive and active defenses, and chemical and structural defenses. Topics under the third theme will include the disease triangle and cultural control strategies.

Lecture Topics and Tentative Schedule

Week 1  No Lecture: First day of autumn semester

Week 2  The nature of plant diseases, symbiosis, parasites, mutualism, biotrophs and necrotrophs, disease cycles and pathogen life cycles. Nematode attack strategies and types of damage.


Week 5  Symptoms and signs of fungal infection. Example fungal diseases: potato late blight, wheat stem rust, grape powdery mildew, wheat Septoria leaf blotch.

Week 6  Plant defense mechanisms, host range and non-host resistance. Passive structural and chemical defenses, preformed chemical defenses. Active structural defense, papillae, active chemical defense, hypersensitive response, pathogenesis-related (PR) proteins, phytoalexins and disease resistance.

Week 7  Pisatin and pisatin demethylase. Local and systemic acquired resistance, signal molecules.

Week 8  Pathogen effects on food quality and safety.

Week 9  Epidemiology: historical epidemics, disease pyramid, environmental effects on epidemic development. Plant effects on development of epidemics, including resistance, physiology, density, uniformity.

Week 10  Disease assessment: incidence and severity measures, keys, diagrams, scales, measurement errors. Correlations between incidence and severity.

Week 11  Molecular detection and diagnosis of pathogens. Host indexing, serology, monoclonal and polyclonal antibodies. ELISA, PCR, rDNA and rep-PCR.

Week 12  Strategies for minimizing disease risks: principles of disease control and management.

Week 13  Disease control strategies: economic thresholds, physical control methods.

Week 14  Cultural control methods: avoidance, tillage practices, crop sanitation, fertilizers, crop rotation.

Lecture notes

Detailed lecture notes (~160 pages) will be available for purchase at the cost of reproduction at the start of the semester.

751-4805-00L Recent Advances in Biocommunication W 2 credits 2S C. De Moraes

Abstract Students will gain insight into the role of sensory cues and signals in mediating interactions within and between species. There will be a primary, but not exclusive, focus on chemical signaling in interactions among plants, insects and microbes. The course will focus on the discussion of current literature addressing key conceptual questions and state-of-the-art research techniques and methods.

Objective Students will gain insight into the role of sensory cues and signals in mediating interactions within and between species. There will be a primary, but not exclusive, focus on chemical signaling in interactions among plants, insects and microbes. The course will focus on the discussion of current literature addressing key conceptual questions and state-of-the-art research techniques and methods.

551-1409-00L RNA Biology Lecture Series II: Non-coding RNAs: Number of participants limited to 25 W 4 credits 2V J. Hall, M. Stoffel, O. Voinnet, further lecturers

Abstract This course covers aspects of RNA biology related to the functions of non-coding RNAs as well as their use as drugs to treat diseases.

Objective The students should get familiar with the wide array of roles, which non-coding RNAs play in cellular functions.

Content Micro RNAs; computational approaches to miRNAs; micro RNA function in metabolism; viruses and viral RNAs; nucleic acid-based drugs; ncRNA-mediated genome regulation; epigenetic programming of genome remodelling in ciliates; telomerase and telomeres; tRNA biology. http://www.nccr-rna-and-disease.ch/tiki-index.php?page=LectureSeries

Prerequisites / notice Basic knowledge of cell and molecular biology.

Elective Concept Courses

Number Title Type ECTS Hours Lecturers
551-0307-00L Biomolecular Structure and Mechanism I: Protein Structure and Function W 3 credits 2V R. Glockshuber, K. Locher, E. Weber-Ban

Abstract Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNAi, current topics in protein biophysics and structural biology.

Objective Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalytics.

Lecture notes Scripts on the individual topics can be found under http://www.mol.biol.ethz.ch/teaching.
551-0309-00L Concepts in Modern Genetics

Abstract
Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Objective
This course focuses on the concepts of classical and modern genetics and genomics.

Content
The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Lecture notes
Scripts and additional material will be provided during the semester.

Prerequisites / notice
This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETZ Hoenggerberg, and on Tuesday morning at UniZH Irchel.

551-0313-00L Microbiology (Part I)

Abstract
Advanced lecture class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Objective
This concept class will be based on common concepts (Grundlagen der Biologie IIB, Teil Mikrobiologie) and introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Content
Advanced class covering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Lecture notes
Updated handouts will be provided during the class.

Literature
Current literature references will be provided during the lectures.

Prerequisites / notice
English

The lecture “Grundlagen der Biologie II: Mikrobiologie” is the basis for this advanced lecture.

551-0319-00L Cellular Biochemistry (Part I)

Abstract
Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

Objective
The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemical and model organism approaches. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry.

Content
Structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

Lecture notes
Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biol.ethz.ch)

Literature
Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

Prerequisites / notice
To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

551-1295-00L Introduction to Bioinformatics: Concepts and Applications

Abstract
Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.

Objective
Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed from the biological and computational science of how DNA sequence relates to structure, and how RNA sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although “Introduction to Bioinformatics I” will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course “Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms” that will be offered in the following semester.
Bioinformatics I will cover the following topics:
- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

### Elective Major: Systems Biology

#### Elective Compulsory Concept Courses

**See D-BIOL Master Studies Guide**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>551-0319-00L</td>
<td>Cellular Biochemistry (Part I)</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>U. Kutay, C. M. Azzalin, B. Kornmann, M. Peter</td>
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</table>

**Abstract**
Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

**Objective**
The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry.

The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

**Content**
Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes. Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.

**Lecture notes**
Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biol.ethz.ch)

**Literature**
Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

**Prerequisites / notice**
To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

| 551-0309-00L  | Concepts in Modern Genetics                      | W    | 6    | 4V    | Y. Barral, D. Bopp, A. Hajnal, O. Voinnet |

**Abstract**
Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

**Objective**
This course focuses on the concepts of classical and modern genetics and genomics.

**Content**
The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

**Lecture notes**
Scripts and additional material will be provided during the semester.

**Prerequisites / notice**
This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hoenggerberg, and on Tuesday morning at UniZH Irchel.

| 551-0313-00L  | Microbiology (Part I)                            | W    | 3    | 2V    | W.D. Hardt, L. Ebertl, H.M. Fischer, J. Piel, M. Pilhofer |

**Abstract**
Advanced lecture class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

**Objective**
This concept class will be based on common concepts (Grundlagen der Biologie IIB, Teil Mikrobiologie) and introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

**Content**
Advanced class covering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

**Lecture notes**
Updated handouts will be provided during the class.

**Literature**
Current literature references will be provided during the lectures.

**Prerequisites / notice**
The lecture “Grundlagen der Biologie II: Mikrobiologie“ is the basis for this advanced lecture.


**Abstract**
Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.
Objective Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

Content Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

Elective Compulsory Master Courses I: Computational

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<tr>
<th>Number</th>
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<tr>
<td>636-0007-00L</td>
<td>Computational Systems Biology</td>
<td>W</td>
<td>6 credits</td>
<td>3V+2U</td>
<td>J. Stelling</td>
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</table>

Abstract Study of fundamental concepts, models and computational methods for the analysis of complex biological networks. Topics: Systems approaches in biology, biology and reaction network fundamentals, modeling and simulation approaches (topological, probabilistic, stoichiometric, qualitative, linear / nonlinear ODEs, stochastic), and systems analysis (complexity reduction, stability, identification).

Objective The aim of this course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.

Content Biology has witnessed an unprecedented increase in experimental data and, correspondingly, an increased need for computational methods to analyze this data. The explosion of sequenced genomes, and subsequently, of bioinformatics methods for the storage, analysis and comparison of genetic sequences provides a prominent example. Recently, however, an additional area of research, captured by the label "Systems Biology", focuses on how networks, which are more than the mere sum of their parts' properties, establish biological functions. This is essentially a task of reverse engineering. The aim of this course is to provide an introductory overview of corresponding computational methods for the modeling, simulation and analysis of biological networks.

We will start with an introduction into the basic units, functions and design principles that are relevant for biology at the level of individual cells. Making extensive use of example systems, the course will then focus on methods and algorithms that allow for the investigation of biological networks with increasing detail. These include (i) graph theoretical approaches for revealing large-scale network organization, (ii) probabilistic (Bayesian) network representations, (iii) structural network analysis based on reaction stoichiometries, (iv) qualitative methods for dynamic modeling and simulation (Boolean and piece-wise linear approaches), (v) mechanistic modeling using ordinary differential equations (ODEs) and finally (vi) stochastic simulation methods.

Literature


Elective Compulsory Master Courses II: Biology

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<tr>
<th>Number</th>
<th>Title</th>
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<tr>
<td>252-0523-00L</td>
<td>Computational Biology</td>
<td>W</td>
<td>6 credits</td>
<td>3V+2U</td>
<td>G. H. Gonnet</td>
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Abstract Study of computational techniques, algorithms and data structures used to solve problems in computational biology. Topics: basic biology, string alignment, phylogeny (distance, character, parsimony), molecular evolution, multiple sequence alignment, probabilistic and statistical models, Markov models, microarrays, dynamic programming, maximum likelihood and specialized DNA and protein analysis.

Objective Familiarize the students with the basic concepts of molecular biology and the models and algorithms used to understand, classify and predict behaviour of living organism. This course is at the most basic level, where the main issues, mostly of molecular sequences, are studied.

Content This course lies in the intersection between Computer Science and Molecular Biology. The main purpose is to study computational techniques, algorithms and data structures which are usually applied to solve problems in Molecular Biology and Biochemistry. The following topics are likely to be covered: Introduction, mathematical models of evolution, protein and DNA sequence alignment and its meaning, phylogenetic tree construction, multiple sequence alignments, secondary structure prediction, molecular dynamics, threading, role of bioinformatics in drug design, etc. From the computer science point of view we concentrate our attention in practical solutions for the above problems. Biological knowledge is an asset but not a prerequisite.

Elective Compulsory Master Courses II: Biology

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<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-1103-00L</td>
<td>Microbial Biochemistry</td>
<td>W</td>
<td>4 credits</td>
<td>2V</td>
<td>J. Vorholt-Zambelli, T. J. Erb, J. Piel</td>
</tr>
</tbody>
</table>

Abstract The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms. Emphasis is on processes that are specific to bacteria and archaea and that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest.

Objective The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms.
Important biochemical processes specific to bacteria and archaea will be presented that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest. Emphasis is on concepts of energy generation and assimilation.

List of topics:
- Eating sugars and letting them in
- Challenging: Aromatics, xenobiotics, and oil
- Complex: (Ligno-)Cellulose and in demand for bioenergy
- Living on a diet and the anaeroplerotic provocation
- Of climate relevance: The microbial C1 cycle
- What are AMO and Anammox?
- 20 amino acids: the making of
- Extending the genetic code
- The 21st and 22nd amino acid
- Some exotic biochemistry: nucleotides, cofactors
- Ancient biochemistry? Iron-sulfur clusters, polymers
- Secondary metabolites: playground of evolution

A script will be provided during the course.

551-1153-00L Systems Biology of Metabolism

<table>
<thead>
<tr>
<th>Content</th>
<th>Objective</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starting from contemporary biological problems related to metabolism, the course focuses on systems biological approaches to address them. In a problem-oriented, this-is-how-it-is-done manner, we thereby teach modern methods and concepts.</td>
<td>Develop a deeper understanding of how relevant biological problems can be solved, thereby providing advanced insights to key experimental and computational methods in systems biology.</td>
<td>Script and original publications will be supplied during the course.</td>
</tr>
<tr>
<td>The course will be given as a mixture of lectures, studies of original research and guided discussions that focus on current research topics. For each particular problem studied, we will work out how the various methods work and what their capabilities/limits are. The problem areas range from microbial metabolism to cancer cell metabolism and from metabolic networks to regulation networks in populations and single cells. Key methods to be covered are various modeling approaches, metabolic flux analyses, metabolomics and other omics.</td>
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</table>

563-0001-00L Separations in Biotechnology and Bioprocess

<table>
<thead>
<tr>
<th>Content</th>
<th>Objective</th>
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</thead>
<tbody>
<tr>
<td>Separations play an integral part of any biotechnological process. This course aims at enabling students specifically with a chemistry/biology background to select &amp; roughly design suitable separation processes for typical biotechnological products such as monoclonal antibodies, antibiotics, and fine chemicals and at providing a basic set of purification operations &amp; judge on process economy.</td>
<td>Students should be able to select for a given biotechnological product a suitable set of purification operations and judge on process economy.</td>
</tr>
<tr>
<td>Introduction membrane operations adsorption and chromatography crystallization overall process economics</td>
<td>Handouts during course</td>
</tr>
</tbody>
</table>

563-0507-00L Synthetic Biology II

<table>
<thead>
<tr>
<th>Content</th>
<th>Objective</th>
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</thead>
<tbody>
<tr>
<td>The students are supposed to acquire a deep understanding of the process of biological design including model representation of a biological system, its thorough analysis, and the subsequent experimental implementation of the system and the related problems.</td>
<td>Presentations on advanced synthetic biology topics (eg genetic circuit design, adaptation of systems dynamics, analytical concepts, large scale de novo DNA synthesis), project selection, modeling of selected biological system, design space exploration, sensitivity analysis, conversion into DNA sequence, (DNA synthesis external,) implementation and analysis of design, summary of results in form of scientific presentation and poster, presentation of results at the iGEM international student competition (<a href="http://www.igem.org">www.igem.org</a>).</td>
</tr>
<tr>
<td>Handouts during course</td>
<td>The final presentation of the project is typically at the MIT (Cambridge, US). Other competing schools include regularly Imperial College, Cambridge University, Harvard University, UC Berkeley, Princeton University, CalTech, etc.</td>
</tr>
</tbody>
</table>

551-0571-00L From DNA to Diversity (University of Zurich)

<table>
<thead>
<tr>
<th>Content</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: BIO336</td>
<td>By the end of this module, each student should be able to - recognize the universal principles underlying the development of different animal body plans. - explain how the genes encoding the molecular toolkit have evolved to create animal diversity. - relate changes in gene structure or function to evolutionary changes in animal development. Key skills: By the end of this module, each student should be able to - present and discuss a relevant evolutionary topic in an oral presentation - select and integrate key concepts in animal evolution from primary literature - participate in discussions on topics presented by others</td>
</tr>
</tbody>
</table>

563-0009-00L Evolutionary Dynamics
Evolutionary dynamics is concerned with the mathematical principles according to which life has evolved. This course offers an introduction to mathematical modeling of evolution, including deterministic and stochastic models.

Objective
The goal of this course is to understand and to appreciate mathematical models and computational methods that provide insight into the evolutionary process.

Content
Evolution is the one theory that encompasses all of biology. It provides a single, unifying concept to understand the living systems that we observe today. We will introduce several types of mathematical models of evolution to describe gene frequency changes over time in the context of different biological systems, focusing on the processes occurring at the scale of the individual. Viruses and cancer cells provide the most prominent examples of such systems and are at the focus of a great biomedical interest. The course will cover some classical mathematical population genetics and population dynamics, and also introduce several new approaches. This is reflected in a diverse set of mathematical concepts which make their appearance throughout the course, all of which are introduced from scratch. Topics covered include the quasispecies equation, evolution of HIV, evolutionary game theory, birth-death processes, evolutionary stability, evolutionary graph theory, somatic evolution of cancer, stochastic tunneling, cell differentiation, hematopoietic tumor stem cells, genetic progression of cancer and the speed of adaptation, diffusion theory, fitness landscapes, neutral networks, branching processes, evolutionary escape, and epistasis.

Lecture notes
No.

Literature

Prerequisites / notice
Prerequisites: Basic mathematics (linear algebra, calculus, probability)

### Elective Major: Structural Biology and Biophysics

### Compulsory Concept Courses

#### See D-BIOL Master Studies Guide

### Elective Compulsory Concept Courses

#### No. Title Type ECTS Hours Lecturers
551-0307-00L Biomolecular Structure and Mechanism I: Protein Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymerases and transcription factors; catalytic RNA; RNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

Abstract
Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

Objective
The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry.

Content
Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.

Lecture notes
Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biol.ethz.ch)

Literature
Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

Prerequisites / notice
To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

529-0731-00L Nucleic Acids and Carbohydrates

Abstract
Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNA; polymerases and transcription factors; catalytic RNA; RNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

Objective
Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNA; polymerases and transcription factors; catalytic RNA; RNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

Content
Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNA; polymerases and transcription factors; catalytic RNA; RNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

Lecture notes
No script

Literature
Mainly based on recent original literature, a detailed list will be distributed during the first lecture
Advanced lecture class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis. This concept class will be based on common concepts (Grundlagen der Biologie II B, Teil Mikrobiologie) and introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Advanced class covering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis. Updated handouts will be provided during the class.

The lecture "Grundlagen der Biologie II: Mikrobiologie" is the basis for this advanced lecture.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

Bioinformatics I will cover the following topics:

- From genes to databases and information
- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

This course focuses on the concepts of classical and modern genetics and genomics.

The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hoenggerberg, and on Tuesday morning at UniZH Irchel.

ELECTIVE COMPULSORY MASTER COURSES

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0733-00L</td>
<td>Enzymes</td>
<td>W</td>
<td>7</td>
<td>3G</td>
<td>D. Hilvert</td>
</tr>
<tr>
<td>Abstract</td>
<td>Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibiotics.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>Overview of enzymes, enzyme-catalyzed reactions and metabolic processes. Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibiotics.</td>
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<tr>
<td>Lecture notes</td>
<td>A script will not be handed out.</td>
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</table>

In addition, citations from the original literature relevant to the individual lectures will be assigned weekly.

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<tr>
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<tbody>
<tr>
<td>551-1105-00L</td>
<td>Glycobiology</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>M. Aebl, T. Hennek</td>
</tr>
<tr>
<td>Abstract</td>
<td>Structural principles, nomenclature and different classes of glycosylation. The different pathways of N- and O-linked protein glycosylation and glycolipid biosynthesis in prokaryotes and eukaryotes are discussed. Specific glycan binding proteins and their role in deciphering the glycan code are presented. The role of glycans in infectious diseases, antigen mimicry and autoimmunity are discussed. Detailed knowledge in 1) the different areas of prokaryotic and eukaryotic glycoproteins, in particular in the biosynthesis of glycoproteins and glycolipids. 2) the cellular machinery required for these pathways, 3) the principles of carbohydrate/protein interaction, 4) the function of lectins, 5) the role of glycans in infectious disease.</td>
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<tr>
<td>Objective</td>
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</table>

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### Content
Structure and linkages; analytical approaches; N-linked protein glycosylation (ER, Golgi); glycan-assisted protein folding and quality control; O-linked protein glycosylation; glucosaminoglycans; glycolipids; prokaryotic glycosylation pathways; lectins; glycans and infectious disease

### Lecture notes
handouts

### Literature
Introduction to Glycobiology; M.E.Taylor, K.Drickamer, Oxford University Press, 2003

### Prerequisites / notice
The course will be in English. It will include the preparation of short essays (marked) about defined topics in Glycobiology.

#### 551-1103-00L

**Microbial Biochemistry**

<table>
<thead>
<tr>
<th>W</th>
<th>4 credits</th>
<th>2V</th>
<th>J. Vorholt-Zambelli, T. J. Erb, J. Piel</th>
</tr>
</thead>
</table>

**Abstract**
The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms. Emphasis is on processes that are specific to bacteria and archaea and that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest.

**Objective**
The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms.

**Content**
Important biochemical processes specific to bacteria and archaea will be presented that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest. Emphasis is on concepts of energy generation and assimilation.

**List of topics:**
- Eating sugars and letting them in
  - Challenging: Aromatics, xenobiotics, and oil
  - Complex: (Ligno-)Cellulose and in demand for bioenergy
  - Of climate relevance: The microbial C1 cycle
- What are AMO and Anammox?
- 20 amino acids: the making of
- Extending the genetic code
- The 21st and 22nd amino acid
- Some exotic biochemistry: nucleotides, cofactors
- Ancient biochemistry? Iron-sulfur clusters, polymers
- Secondary metabolites: playground of evolution

**Lecture notes**
A script will be provided during the course.

#### 551-1401-00L

**Advanced Protein Engineering (University of Zurich)**

<table>
<thead>
<tr>
<th>W</th>
<th>2 credits</th>
<th>2G</th>
<th>A. Plückthun</th>
</tr>
</thead>
</table>

**Abstract**
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: BCH420

**Objective**
Restricted to max. 10 students from ETH

**Content**
Introduction into current research strategies in protein science.

**Lecture notes**
Slides and references will be available on OLAT server.

**Literature**
PDFs will be available on OLAT server.

**Prerequisites / notice**
Solid knowledge in biochemistry strongly recommended

#### 551-1153-00L

**Systems Biology of Metabolism**

<table>
<thead>
<tr>
<th>W</th>
<th>4 credits</th>
<th>2V</th>
<th>U. Sauer, N. Zamboni, M. Zampieri</th>
</tr>
</thead>
</table>

**Abstract**
Number of participants limited to 15.

**Objective**
Starting from contemporary biological problems related to metabolism, the course focuses on systems biological approaches to address them. In a problem-oriented, this-is-how-it-is-done manner, we thereby teach modern methods and concepts.

**Content**
Develop a deeper understanding of how relevant biological problems can be solved, thereby providing advanced insights to key experimental and computational methods in systems biology.

**Lecture notes**
Script and original publications will be supplied during the course.

**Prerequisites / notice**
The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.

#### 529-0004-00L

**Computer Simulation in Chemistry, Biology and Physics**

<table>
<thead>
<tr>
<th>W</th>
<th>7 credits</th>
<th>4G</th>
<th>P. H. Hünenberger</th>
</tr>
</thead>
</table>

**Abstract**
Molecular models, Force fields, Boundary conditions, Electrostatic interactions, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

**Objective**
For more information: www.csms.ethz.ch/education/CSCBP

**Content**
Introduction to computer simulation of (bio)molecular systems, development of skills to carry out and interpret computer simulations of biomolecular systems.

**Lecture notes**
Molecular models, Force fields, Spatial boundary conditions, Calculation of Coulomb forces, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

**Literature**
Available (copies of powerpoint slides distributed before each lecture)

See: www.csms.ethz.ch/education/CSCBP
### 401-0649-00L Applied Statistical Regression

**W | 5 credits | 2V+1U | M. Dettling**

**Abstract**
The course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning “good practice” that can be applied in every student’s own projects and daily work life.

**Objective**
The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

**Content**
The course starts with the basics of linear regression modeling, and then proceeds to parameter estimation, tests and confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, categorical input variables, shrinkage and general modeling strategies.

The last third of the course is dedicated to an introduction into generalized linear regression models: this includes logistic regression for binary response variables, Poisson regression for count data, cumulative logit models for ordered, and multinomial regression for categorical response variables.

**Lecture notes**
A script will be available.

**Literature**
- Faraway (2005): Linear Models with R
- Faraway (2006): Extending the Linear Model with R
- Draper & Smith (1998): Applied Regression Analysis
- Fox (2008): Applied Regression Analysis and GLMs
- Montgomery et al. (2006): Introduction to Linear Regression Analysis

**Prerequisites / notice**

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

### 401-6215-00L Using R for Data Analysis and Graphics (Part I)

**W | 1 credit | 1G | A. J. Papritz, C. B. Schwierz**

**Abstract**
The course provides the first part an introduction to the statistical software R for scientists. Topics covered are data generation and selection, graphical and basic statistical functions, creating simple functions, basic types of objects.

**Objective**
The students will be able to use the software R for simple data analysis.

**Content**
The course provides the first part of an introduction to the statistical software R for scientists. R is free software that contains a huge collection of functions with focus on statistics and graphics. If one wants to use R one has to learn the programming language R - on very rudimentary level. The course aims to facilitate this by providing a basic introduction to R.

Part I of the course covers the following topics:
- What is R?
- R Basics: reading and writing data from/to files, creating vectors & matrices, selecting elements of dataframes, vectors and matrices, arithmetics;
- Types of data: numeric, character, logical and categorical data, missing values;
- Simple (statistical) functions: summary, mean, var, etc., simple statistical tests;
- Writing simple functions;
- Introduction to graphics: scatter-, boxplots and other high-level plotting functions, embellishing plots by title, axis labels, etc., adding elements (lines, points) to existing plots.

The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: http://www.rstudio.org

**Lecture notes**
An Introduction to R. http://stat.ethz.ch/CRAN/doc/contrib/Lam-IntroductionToR_LHL.pdf

**Prerequisites / notice**
The course resources will be provided via the Moodle web learning platform. Please login (with your ETH (or other University) username+password) at https://moodle-app2.let.ethz.ch/...?id=1145

Choose the course “Using R for Data Analysis and Graphics” and follow the instructions for registration.

### 529-0041-00L Modern Mass Spectrometry, Hyphenated Methods, and Chemometrics

**W | 6 credits | 3G | R. Zenobi, M. Badertscher, B. Hattendorf, P. Martinez-Lozano Sinues**

**Abstract**
Modern mass spectrometry, hyphenated analytical methods, speciation, methods of surface analysis, chemometrics.

**Objective**
Comprehensive knowledge about the analytical methods introduced in this course, and their applications.

**Content**
Coupling of separation with identification methods such as GC-MS, LC-MS, GC-IR, LC-IR, LC-NMR etc.; importance of speciation.
Modern mass spectrometry: Time of flight and ion cyclotron resonance mass spectrometry, ICP-MS. Soft ionization methods, desorption methods, spray methods.
Methods of surface analysis (ESCA, Auger, SIMS, raster microscopy methods).
Employment of computer science for processing data in chemical analysis (chemometrics).

**Lecture notes**
lecture notes will be available in the lecture at production cost.

**Literature**
information about relevant literature will be available in the lecture notes.

**Prerequisites / notice**

Exercises are an integral part of the lecture.
Prerequisites:
- 529-0051-00 "Analytische Chemie I (3. Semester)"
- 529-0058-00 "Analytische Chemie II (4. Semester)"
(or equivalent)

### 551-1409-00L RNA Biology Lecture Series II: Non-coding RNAs: Biology and Therapeutics

**W | 4 credits | 2V | J. Hall, M. Stoffel, O. Voinnet, further lecturers**

**Abstract**
This course covers aspects of RNA biology related to the functions of non-coding RNAs as well as their use as drugs to treat diseases.

**Objective**
The students should get familiar with the wide array of roles, which non-coding RNAs play in cellular functions.

**Content**
- Micro RNAs; computational approaches to miRNAs; micro RNA function in metabolism; viruses and viral RNAs: nucleic acid-based drugs; ncRNA-mediated genome regulation; epigenetic programming of genome remodelling in ciliates; telomerase and telomerases; tRNA biology.
Prerequisites / notice
Basic knowledge of cell and molecular biology.

Elective Major: Biological Chemistry

Compulsory Concept Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
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</tr>
</thead>
</table>

Abstract: Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

Objective: Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

Content: Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymerases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

Lecture notes: no script

Literature: Mainly based on original literature, a detailed list will be distributed during the first lecture

Elective Compulsory Master Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
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<tbody>
<tr>
<td>529-0731-00L</td>
<td>Enzymes</td>
<td>W</td>
<td>7 credits</td>
<td>3G</td>
<td>D. Hilvert</td>
</tr>
</tbody>
</table>

Abstract: Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies

Objective: Overview of enzymes, enzyme-catalyzed reactions and metabolic processes.

Content: Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies

Lecture notes: A script will not be handed out.


In addition, citations from the original literature relevant to the individual lectures will be assigned weekly.

Biological Engineering and Biotechnology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>636-0003-00L</td>
<td>Biological Engineering and Biotechnology</td>
<td>W</td>
<td>6 credits</td>
<td>3V</td>
<td>M. Fussenegger</td>
</tr>
</tbody>
</table>

Abstract: Biological Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutic from target to market.

Objective: 1. Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical Manufacturing.
2. The Licence To Kill. Apoptosis Regulatory Networks - Engineering of Survival Pathways To Increase Robustness of Production Cell Lines.
5. From Target To Market. An Antibody’s Journey From Cell Culture to The Clinics.
6. Development of Biological Weapons?
7. Functional Food. Enjoy your Meal!

Lecture notes: Handsout during the course.

Advanced Methods and Strategies in Synthesis

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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0241-00L</td>
<td>Advanced Methods and Strategies in Synthesis</td>
<td>W</td>
<td>7 credits</td>
<td>3G</td>
<td>J. W. Bode</td>
</tr>
</tbody>
</table>

Abstract: Advanced Modern Methods and Strategies in Synthesis

Objective: Knowledge of modern methods in asymmetric stereocentre, enantioclective catalysis, and organic reaction mechanisms.

Content: Current trends in methods for and approaches to synthesis of complex natural products, pharmaceuticals, and biological molecules; fragment coupling and protecting group strategies; chemical ligation and biomolecules synthesis; enantioselective catalysis including ligand design and optimization; cross coupling reactions from preactivated precursors; C-H activation and oxidation chemistry; building block synthesis with chiral auxiliaries and reagents; new concepts in asymmetric catalysis. Analysis of key primarily literature including identification of trends, key precedents, and emerging topics will be emphasized.

Lecture notes: will be provided in class and online

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 241 of 1434
Organic Synthesis: Methods and Strategies  
**W** 7 credits  3G  E. M. Carreira

**Abstract**  
The complex relation between structural analysis, methods leading to desired transformations, and insight into reaction mechanisms is exemplified. Relations between retrosynthetic analysis of target structures, synthetic methods and their combination in a synthetic strategy.

**Objective**  
Extension and deepening of the knowledge in organic synthesis.

**Content**  

**Literature**  

**Prerequisites / notice**  
OC I-IV

---

Reactive Intermediates  
**W** 7 credits  3G  P. Chen

**Abstract**  
Advanced physical organic chemistry. Methods for the elucidation of reaction mechanisms. Reactive intermediates. Thermochemistry; isotope labeling; cross-over experiments; kinetic isotope effects; thermodynamics-kinetics correlations; solvation and ion pairs; radical reactions; electron transfer; spectroscopic methods.

**Objective**  
Methods for the elucidation of organic reaction mechanisms.

**Content**  

**Lecture notes**  
A printed script is handed out in the course. This material is also available for download from the web page of the course (as pdf files).

**Literature**  
Additional reading and original publications are cited in the lectures.

**Prerequisites / notice**  
Required level: Courses in organic and physical chemistry of the first and second year. Each participant is expected to contribute to a 30 min. seminar (prepared by groups of 2-4 students), presented in the last weeks of the semester.

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RNA Biology Lecture Series II: Non-coding RNAs: Biology and Therapeutics  
**W** 4 credits  2V  J. Hall, M. Stoffel, O. Voinnet, further lecturers

**Abstract**  
This course covers aspects of RNA biology related to the functions of non-coding RNAs as well as their use as drugs to treat diseases.

**Objective**  
The students should get familiar with the wide array of roles, which non-coding RNAs play in cellular functions.

**Content**  
ncRNA-mediated genome regulation; epigenetic programming of genome remodelling in ciliates; telomerase and telomeres; tRNA biology.

**Literature**  
529-0051-00 "Analytische Chemie I (3. Semester)"  
529-0058-00 "Analytische Chemie II (4. Semester)"  
(or equivalent)

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Biomolecular Structure and Mechanism I: Protein Structure and Function  
**W** 3 credits  2V  R. Glockshuber, K. Locher, E. Weber-Ban

**Abstract**  
D-BIOL BSc students are obliged to take part I and part II (next semester) as a two-semester course

**Objective**  
Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalytic.

**Lecture notes**  
Scripts on the individual topics can be found under http://www.mol.biol.ethz.ch/teaching.

**Literature**  
Basics:  
- Creighton, T.E., Proteins, Freeman, (1993)  
- Fersht, A., Enzyme, Structure and Mechanism in Protein Science (1999), Freeman.  

Current topics: References will be given during the lectures.

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Cellular Biochemistry (Part I)  
**W** 3 credits  2V  U. Kutay, C. M. Azzalin, B. Kornmann, M. Peter

**Abstract**  
Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.
Objective
The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry. The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

Content
Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes. Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.

Lecture notes
Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biol.ethz.ch)

Literature
Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

Prerequisites / notice
To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

Recommended Elective Courses (for all Master Majors)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>851-0180-00L</td>
<td>Research Ethics  ■</td>
<td>W+</td>
<td>2 credits</td>
<td>2G</td>
<td>G. Achermann</td>
</tr>
</tbody>
</table>

Abstract
This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.

Objective
The main goal of this course is to enhance the student's ability to:
- recognize and identify ethical issues and conflicts,
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.
I. Ethics & the Process of Ethical Inquiry

Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)

Integrity in Research & Research Misconduct
- What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 Rs (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks;
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access;
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Literature
Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.

➤ Research Projects (for all Master Majors)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>551-1801-00L</td>
<td>Research Project I</td>
<td>O</td>
<td>15 credits</td>
<td>34A</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Abstract
Research projects, with themes from the chosen scientific fields of interest, are intended to familiarise candidates with scientific procedures and operational methodologies through supervised participation in current research work.
Research Project II

Abstract
Research projects, with themes from the chosen scientific fields of interest, are intended to familiarise candidates with scientific procedures and operational methodologies through supervised participation in current research work.

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-BIOL:

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses

ETH/UZH

Master Thesis

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<tr>
<th>Number</th>
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<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>551-1800-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30</td>
<td>64D</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Abstract
The Master research will be carried out on a theme in the chosen subject area and must be completed with a written report (Thesis) within six months.

Master Examination

see Study Regulations 2006 for the Master-curriculum Biology, Art. 38

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<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>551-1800-01L</td>
<td>Master's Examination</td>
<td>O</td>
<td>4</td>
<td></td>
<td>Lecturers</td>
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</tbody>
</table>

Abstract
The Master examination comprises a written part and an oral part. Both parts will receive an evaluation mark. The Master examination is passed when the arithmetic mean of both evaluation marks is at least 4. The Master examination must be taken within three months of submitting the thesis.

Literature
The Master examination comprises a written part and an oral part. Both parts will receive evaluation marks. The Master examination is passed when the arithmetic mean of both evaluation marks is at least 4. The Master examination must be taken within three months of submitting the master thesis.

Biology Master - Key for Type

| O | Compulsory |
|   |            |
| W+ | Eligible for credits and recommended |
| W | Eligible for credits |

E- Recommended, not eligible for credits
Z Courses outside the curriculum
Dr Suitable for doctorate

Key for Hours

| V | lecture |
|   |         |
| G | lecture with exercise |
| U | exercise |
| S | seminar |
| K | colloquium |

P practical/laboratory course
A independent project
D diploma thesis
R revision course / private study

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Biomedical Engineering Master

#### Track Courses

#### Bioelectronics

#### Track Core Courses

During the Master program, a minimum of 12 CP must be obtained from track core courses.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0604-00L</td>
<td>Microrobotics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>B. Nelson</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Microrobotics is an interdisciplin ary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Main topics of the course include: Scaling laws at micro/nano scales - Electrostatics - Electromagnetism - Low Reynolds number flows - Observation tools - Materials and fabrication methods - Applications of biomedical microrobots</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>The lecture will be taught in English.</td>
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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0605-00L</td>
<td>Nanosystems</td>
<td>W</td>
<td>4</td>
<td>4G</td>
<td>A. Stemmer, J.N. Tisserant</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles. Intermolecular forces, their macroscopic manifestations, and ways to control such interactions. Self-assembly and directed assembly of 2D and 3D structures. Special emphasis on the emerging field of molecular electronic devices.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Familiarize students with basic science and engineering principles governing the nano domain.</td>
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<tr>
<td><strong>Content</strong></td>
<td>The course addresses basic science and engineering principles ruling the nano domain. We particularly work out the links between topics that are traditionally taught separately. Special emphasis is placed on the emerging field of molecular electronic devices, their working principles, applications, and how they may be assembled. Topics are treated in 2 blocks: (I) From Quantum to Continuum From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles. (II) Interaction Forces on the Micro and Nano Scale Intermolecular forces, their macroscopic manifestations, and ways to control such interactions. Self-assembly and directed assembly of 2D and 3D structures.</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Course format: Lectures and Mini-Review presentations: Thursday 10-13, ML F 36</td>
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<tr>
<td><strong>Homework:</strong> Mini-Reviews</td>
<td>Students select a paper (list distributed in class) and expand the topic into a Mini-Review that illuminates the particular field beyond the immediate results reported in the paper.</td>
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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0621-00L</td>
<td>Microsystems Technology</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>C. Hierold, M. Haluska</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Students are introduced to the basics of micromachining and silicon process technology and will learn about the fabrication of Microsystems and devices by a sequence of defined processing steps (process flow). Students are introduced to the basics of micromachining and silicon process technology and will learn about the fabrication of microsystems and devices by the combination of unit process steps (= process flow).</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Students are introduced to the basics of micromachining and silicon process technology and will learn about the fabrication of microsystems and devices by the combination of unit process steps (= process flow).</td>
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<tr>
<td><strong>Content</strong></td>
<td>- Introduction to microsystems technology (MST) and micro electro mechanical systems (MEMS) - Basic silicon technologies: Thermal oxidation, photolithography and etching, diffusion and ion implantation, thin film deposition. - Specific microsystems technologies: Bulk and surface micromachining, dry and wet etching, isotropic and anisotropic etching, beam and membrane formation, wafer bonding, thin film mechanical and thermal properties, piezoelectric and piezoresistive materials. - Selected microsystems: Mechanical sensors and actuators, microresonators, thermal sensors and actuators, system integration and encapsulation.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Handouts (available online)</td>
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</table>
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.

2. The concept of biocompatibility.

3. Introduction into methodology used in biomaterials research and application.

4. Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

Handouts can be accessed online.
The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties and the understanding of atomic processes on surfaces. The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein adsorption/absorption and monocite behaviour.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxidic and organic surfaces are introduced. The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure's shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented. Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

### Recommended Elective Courses

These courses are particularly recommended for the Bioelectronics track. Please consult your track advisor if you wish to select other subjects.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-0166-00L</td>
<td>Analog Integrated Circuits</td>
<td>W 6 credits</td>
<td>2V+2U</td>
<td>Q. Huang</td>
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</tr>
</tbody>
</table>

This course provides a foundation in analog integrated circuit design based on bipolar and CMOS technologies.

### Abstract

The basic elements, design issues and techniques for analog integrated circuits will be taught in this course.

### Objective

Review of bipolar and MOS devices and their small-signal equivalent circuit models; Building blocks in analog circuits such as current sources, active load, current mirrors, supply independent biasing etc; Amplifiers: differential amplifiers, cascode amplifier, high gain structures, output stages, gain bandwidth product of op-amps; Stability; Comparators; Second-order effects in analog circuits such as mismatch, noise and offset; A/D and D/A converters; Introduction to switched capacitor circuits.

The exercise sessions aim to reinforce the lecture material by well guided step-by-step design tasks. The circuit simulator SPECTRE is used to facilitate the tasks. There is also an experimental session on op-amp measurements.

### Literature

Handouts of presented slides. No script but an accompanying textbook is recommended.

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**Data: 06.02.2019 13:00**

**Autumn Semester 2015**

**Page 248 of 1434**
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

The learning goal is that the students can apply signal-flow graphs and can understand the signal flow in such circuits and systems (including non-ideal effects) well enough to gain an understanding of further circuits and systems by themselves.

The main goal of this course is to demonstrate the differences in communication between the fields of medicine and engineering. For the engineering students, the specific aims of the course are to:

- Acquire a working understanding of the anatomy and physiology of the investigated system;
- Identify the engineering challenges in the project and communicate them to the medical students;
- Develop and implement, together with the medical students, solution strategies for the identified challenges;
- Present the found solutions to a cross-disciplinary audience.

The course covers analog circuits with emphasis on neuromorphic engineering: MOS transistors in CMOS technology, static circuits, dynamic circuits, systems (silicon neuron, silicon retina, silicon cochlea) with an introduction to multi-chip systems. The lectures are accompanied by weekly laboratory sessions.

The course language is English.
Neuromorphic circuits are inspired by the organizing principles of biological neural circuits. Their computational primitives are based on physics of semiconductor devices. Neuromorphic architectures often rely on collective computation in parallel networks. Adaptation, learning and memory are implemented locally within the individual computational elements. Transistors are often operated in weak inversion (below threshold), where they exhibit exponential I-V characteristics and low currents. These properties lead to the feasibility of high-density, low-power implementations of functions that are computationally intensive in other paradigms. Application domains of neuromorphic circuits include silicon retinas and cochleas for machine vision and audition, real-time emulations of networks of biological neurons, and the development of autonomous robotic systems. This course covers devices in CMOS technology (MOS transistor below and above threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, transconductance amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina and cochlea) and an introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory sessions on the characterization of neuromorphic circuits, from elementary devices to systems.

S.-C. Liu et al.: Analog VLSI Circuits and Principles; various publications.

Prerequisites: Background in basics of semiconductor physics helpful, but not required.

151-0255-00L Energy Conversion and Transport in Biosystems W 4 credits 2V+1U D. Poulikakos, A. Ferrari

Abstract
Theory and application of thermodynamics and energy conversion in biological systems and biomedicine at the macro scale and the cellular level.

Objective
Theory and application of energy conversion at the macro scale and the cellular level. Understanding of the basic features governing fluid transport in the principal systems of the human cell. Connection of characteristics and patterns from other fields of engineering to biofluidics. Heat and mass transport processes within the human body and relation to biomedical technologies.

Content
Mass transfer models for the transport of chemical species in the human cell. Organization and function of the cell membrane and of the cell cytoskeleton. The role of molecular motors in cellular force generation and their function in cell migration. Description of the functionality of these systems and of analytical experimental and computational techniques for understanding of their operation. Introduction to bioengineering approaches for the treatment of common pathogenic conditions of these systems. Introduction to cell metabolism, cellular energy transport and cellular thermodynamics.

Lecture notes
Script as well as additional material in the form of hand-outs will be distributed.

Literature
Lecture notes and references therein.

151-0509-00L Microscale Acoustofluidics W 4 credits 3G J. Dual

Abstract
In this lecture the basics as well as practical aspects (from modelling to design and fabrication) are described from a solid and fluid mechanics perspective with applications to microsystems and lab on a chip devices.

Objective
Understanding acoustophoresis, the design of devices and potential applications

Content
Linear and nonlinear acoustics, foundations of fluid and solid mechanics and piezoelectricity. Gorkov potential, numerical modelling, acoustic streaming, acoustic microfluidics to surface acoustic wave devices

Lecture notes

Literature

Notice
Solid and fluid continuum mechanics. Notice: The exercise part is a mixture of presentation, lab session and hand in homework.

252-0523-00L Computational Biology W 6 credits 3V+2U G. H. Gonnet

Abstract
Study of computational techniques, algorithms and data structures used to solve problems in computational biology. Topics: basic biology, string alignment, phylogeny (distance, character, parsimony), molecular evolution, multiple sequence alignment, probabilistic and statistical models, Markov models, microarrays, dynamic programming, maximum likelihood and specialized DNA and protein analysis.

Objective
Familiarize the students with the basic concepts of molecular biology and the models and algorithms used to understand, classify and predict behaviour of living organism. This course is at the most basic level, where the main issues, mostly of molecular sequences, are studied.

Content
This course lies in the intersection between Computer Science and Molecular Biology. The main purpose is to study computational techniques, algorithms and data structures which are usually applied to solve problems in Molecular Biology and Biochemistry. The following topics are likely to be covered: introduction, mathematical models of evolu, protein and DNA sequence alignment and its meaning, phylogenetic tree construction, multiple sequence alignments, secondary structure prediction, molecular dynamics, threading, role of bioinformatics in drug design, etc. From the computer science point of view we concentrate our attention in practical solutions for the above problems. Biological knowledge is an asset but not a prerequisite.

376-1103-00L Frontiers in Nanotechnology W 4 credits 4V V. Vogel, further lecturers

Abstract
Many disciplines are meeting at the nanoscale, from physics, chemistry to engineering, from the life sciences to medicine. The course will prepare students to communicate more effectively across disciplinary boundaries, and will provide them with deep insights into the various frontiers.
Objective

Building upon advanced technologies to create, visualize, analyze and manipulate nano-structures, as well as to probe their nano-chemistry, nano-mechanics and other properties within manmade and living systems, many exciting discoveries are currently made. They change the way we do science and result in so many new technologies.

The goal of the course is to give Master and Graduate students from all interested departments an overview of what nanotechnology is all about, from analytical techniques to nanosystems, from physics to biology. Students will start to appreciate the extent to which scientific communities are meeting at the nanoscale. They will learn about the specific challenges and what is currently sizzling in the respective fields, and learn the vocabulary that is necessary to communicate effectively across departmental boundaries.

Each lecturer will first give an overview of the state-of-the art in his/her field, and then describe the research highlights in his/her own research group. While preparing their Final Projects and discussing them in front of the class, the students will deepen their understanding of how to apply a range of new technologies to solve specific scientific problems and technical challenges. Exposure to the different frontiers will also improve their ability to conduct effective nanoscale research, recognize the broader significance of their work and to start collaborations.

Content

Starting with the fabrication and analysis of nanoparticles and nanostructured materials that enable a variety of scientific and technical applications, we will transition to discussing biological nanosystems, how they work and what bioinspired engineering principles can be derived, to finally discussing biomedical applications and potential health risk issues. Scientific aspects as well as many of the emerging technologies will be covered that start impacting so many aspects of our lives. This includes new phenomena in physics, advanced materials, novel technologies and new methods to address major medical challenges.

Lecture notes

All the enrolled students will get access to a password protected website where they can find pdf files of the lecture notes, and typically 1-2 journal articles per lecture that cover selected topics.
Introductory Books:


Selected Journal Articles and Web Links:


VideoTact, ForeThought Development, LLC. http://my.execpc.com/?dwysocki/videotac.html

Target Group:

Students of higher semesters and PhD students of
- D-MAVT, D-ITET, D-INFK, D-HEST
- Biomedical Engineering, Robotics, Systems and Control
- Medical Faculty, University of Zurich

Students of other departments, faculties, courses are also welcome

Prerequisites / notice

376-1351-00L Micro/Nanotechnology and Microfluidics for Biomedical Applications W 2 credits 2V 7 credits E. Delamarche

Abstract This course is an introduction to techniques in micro/nanotechnology and to microfluidics. It reviews how many familiar devices are built and can be used for research and biomedical applications. Transistors for DNA sequencing, beakers for patterning proteins, hard-disk technology for biosensing and scanning microfluidics for analyzing tissue sections are just a few examples of the covered topics.

Objective The main objective of the course is to introduce micro/nanotechnology and microfluidics to students having a background in the life sciences. The course should familiarize the students with the techniques used in micro/nanotechnology and show them how micro/nanotechnology pervades throughout life sciences. Microfluidics will be emphasized due to its increasing importance in research and medical applications. The second objective is to have life students less intimidated by micro/nanotechnology and make them able to link instruments and techniques to specific problems that they might have in their projects/studies. This will also help students getting access to the ETHZ/IBM Nanotech Center infrastructure if needed.

Content Mostly formal lectures (2 x 45 min), with a 2 hour visit and introduction to cleanroom and micro/nanotechnology instruments, last 3 sessions would be dedicated to the presentation and evaluation of projects by students (3 students per team).

Prerequisites / notice

529-0837-00L Biomicrofluidic Engineering W 7 credits 3G 2 credits A. de Mello

Abstract Microfluidics describes the behaviour, control and manipulation of fluids that are geometrically constrained within sub-microliter environments. The use of microfluidic devices offers an opportunity to control physical and chemical processes with unrivalled precision, and in turn provides a route to performing chemistry and biology in an ultra-fast and high-efficiency manner.

Target Group:

Students of other departments, faculties, courses are also welcome

Prerequisites / notice

VideoTact, ForeThought Development, LLC. http://my.execpc.com/?dwysocki/videotac.html

Target Group:

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Objective
In the course students will investigate the theoretical concepts behind microfluidic device operation, the methods of microfluidic device manufacture and the application of microfluidic architectures to important problems faced in modern day chemical and biological analysis. A design workshop will allow students to develop new microscale flow processes by appreciating the dominant physics at the microscale. The application of these basic ideas will primarily focus on biological problems and will include a treatment of diagnostic devices for use at the point-of-care, advanced functional material synthesis, DNA analysis, proteomics and cell-based assays. Lectures, assignments and the design workshop will acquaint students with the state-of-the-art in applied microfluidics.

Content
Specific topics in the course include, but not limited to:

1. Theoretical Concepts
   Features of mass and thermal transport on the microscale
   Key scaling laws
2. Microfluidic Device Manufacture
   Conventional lithographic processing of rigid materials
   Soft lithographic processing of plastics and polymers
   Mass fabrication of polymeric devices
3. Unit operations and functional components
   Analytical separations (electrophoresis and chromatography)
   Chemical and biological synthesis
   Sample pre-treatment (filtration, SPE, pre-concentration)
   Molecular detection
4. Design Workshop
   Design of microfluidic architectures for PCR, distillation & mixing
5. Contemporary Applications in Biological Analysis
   Microarrays
   Cellular analyses (single cells, enzymatic assays, cell sorting)
   Proteomics
6. System integration
   Applications in radiochemistry, diagnostics and high-throughput experimentation

Lecture notes
Lecture handouts, background literature, problem sheets and notes will be provided electronically.

Biology Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0399-10L</td>
<td>Physiology and Anatomy for Biomedical Engineers I</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>H. Niemann</td>
</tr>
<tr>
<td>227-0945-00L</td>
<td>Cell and Molecular Biology for Engineers I</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>C. Frei</td>
</tr>
</tbody>
</table>

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Bioimaging

Track Core Courses

During the Master program, a minimum of 12 CP must be obtained from track core courses.

<table>
<thead>
<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>227-0385-10L</td>
<td>Biomedical Imaging</td>
<td>W</td>
<td>6 credits</td>
<td>5G</td>
<td>S. Kozerke, U. Moser, K. P. Prüssmann, M. Rudin</td>
</tr>
<tr>
<td>227-0386-00L</td>
<td>Biomedical Engineering</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>J. Várös, S. J. Ferguson, S. Kozerke, U. Moser, M. Rudin, M. P. Wolf, M. Zenobi-Wong</td>
</tr>
<tr>
<td>227-0447-00L</td>
<td>Image Analysis and Computer Vision</td>
<td>W</td>
<td>6 credits</td>
<td>3V+1U</td>
<td>G. Székely, O. Göksel, L. Van Gool</td>
</tr>
<tr>
<td>227-0965-00L</td>
<td>Micro and Nano-Tomography of Biological Tissues</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>M. Stampanoni, K. S. Mader</td>
</tr>
</tbody>
</table>

Abstract

Introduction into selected topics of biomedical imaging as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.

Objective

Introduction into selected topics of biomedical imaging as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

Content


Lecture notes

Lecture notes and handouts

Literature

Weebb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011

Lecture notes

Introduction to Biomedical Imaging by Enderle, Banchard, and Bronzino

AND

https://www1.ethz.ch/lbb/Education/BME
Objective
Introduction to the basic concepts of X-ray tomographic imaging, image analysis and data quantification at the micro and nano scale with particular emphasis on biological applications.

Content
Synchrotron-based X-ray micro- and nano-tomography is today a powerful technique for non-destructive, high-resolution investigations of a broad range of materials. The high-brilliance and high-coherence of third generation synchrotron radiation facilities allow quantitative, three-dimensional imaging at the micro and nanometer scale and extend the traditional absorption imaging technique to edge-enhanced and phase-sensitive measurements, which are particularly suited for investigating biological samples.

The lecture includes a general introduction to the principles of tomographic imaging from image formation to image reconstruction. It provides the physical and engineering basics to understand how imaging beams lines at synchrotron facilities work, looks into the recently developed phase contrast methods, and explores the first applications of X-ray nano-tomographic experiments.

The course finally provides the necessary background to understand the quantitative evaluation of tomographic data, from basic image analysis to complex morphometrical computations and 3D visualization, keeping the focus on biomedical applications.

Lecture notes
Available online

Literature
Will be indicated during the lecture.

Recommended Elective Courses
These courses are particularly recommended for the Bioimaging track. Please consult your track advisor if you wish to select other subjects.

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<tr>
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<tbody>
<tr>
<td>227-0389-00L</td>
<td>Advanced Topics in Magnetic Resonance Imaging</td>
<td>Z</td>
<td>0</td>
<td>1V</td>
<td>K. Prüssmann</td>
</tr>
</tbody>
</table>

Abstract
This course is geared towards master and PhD students with a focus on bioimaging. It covers advanced topics in magnetic resonance imaging in biennial rotation, including the electrodynamics of MR signal detection, noise mechanisms, image reconstruction, radiofrequency pulse design, RF pulse trains, as well as advanced contrast mechanisms.

Objective
See above

Prerequisites / notice
None

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<tr>
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<tbody>
<tr>
<td>227-0391-00L</td>
<td>Medical Image Analysis</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>P.C. Cattin, M.A. Reyes Aguirre</td>
</tr>
</tbody>
</table>

Abstract
This is the objective of this lecture to introduce the basic concepts used in Medical Image Analysis. In particular, the lecture focuses on shape representation schemes, segmentation techniques, and the various image registration methods commonly used in Medical Image Analysis.

Objective
See above

Literature
Available online

<table>
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<tbody>
<tr>
<td>227-0967-00L</td>
<td>Computational Neuroimaging Clinic</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>K. Stephan</td>
</tr>
</tbody>
</table>

Abstract
This seminar teaches problem solving skills for the design and analysis of neuroimaging data (IMRI, EEG). It deals with a wide variety of real-life problems that are brought to this meeting from the neuroimaging community at Zurich. Examples may include mass-univariate and multivariate analyses of fMRI data, dynamic causal modeling of fMRI and EEG data.

Objective
1. Consolidation of theoretical knowledge (obtained in the ‘Methods & Models for fMRI Data Analysis’ lecture) in a practical setting.
2. Acquisition of practical problem solving strategies for computational modeling of neuroimaging and behavioural data.

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<tbody>
<tr>
<td>227-0969-00L</td>
<td>Methods &amp; Models for fMRI Data Analysis</td>
<td>W</td>
<td>6</td>
<td>3V</td>
<td>K. Stephan</td>
</tr>
</tbody>
</table>

Abstract
This course teaches methods and models for fMRI data analysis, covering all aspects of statistical parametric mapping (SPM), incl. preprocessing, the general linear model, statistical inference, multiple comparison corrections, and Dynamic Causal Modelling (DCM), a Bayesian framework for identification of nonlinear neuronal systems from neurophysiological data.

Objective
To obtain in-depth knowledge of the theoretical foundations of SPM and DCM and of their application to empirical fMRI data.

Content
This course teaches state-of-the-art methods and models for fMRI data analysis. It covers all aspects of statistical parametric mapping (SPM), incl. preprocessing, the general linear model, frequentist and Bayesian inference, multiple comparison corrections, and event-related designs, and Dynamic Causal Modelling (DCM), a Bayesian framework for identification of nonlinear neuronal systems from neurophysiological data. A particular emphasis of the course will be on methodological questions arising in the context of studies in neurophysiology, neuroeconomics, and joint translational research between fields that are usually worlds apart.

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</thead>
<tbody>
<tr>
<td>227-0971-00L</td>
<td>Computational Psychiatry</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>K. Stephan</td>
</tr>
</tbody>
</table>

Abstract
This four-day course teaches the toolkit for mastering challenges in computational psychiatry. It covers a variety of mathematical models for studying learning, decision-making or brain physiology in patients with psychiatric disorders. The course not only teaches the theory of computational modeling, but also demonstrate open source software in application to example data sets.

Objective
This course aims at bridging the gap between mathematical modelers and clinical neuroscientists by teaching computational techniques in the context of clinical applications. The hope is that the acquisition of a joint language and tool-kit will enable more effective communication and joint translational research between fields that are usually worlds apart.

Content
This four-day course teaches the toolkit for mastering challenges in computational psychiatry. It covers a variety of mathematical models for studying learning, decision-making or brain physiology in patients with psychiatric disorders. The course not only teaches the theory of computational modeling, but also demonstrate open source software in application to example data sets.

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<tr>
<td>227-2037-00L</td>
<td>Physical Modelling and Simulation</td>
<td>W</td>
<td>5</td>
<td>4G</td>
<td>C. Hafner, J. Leuthold, J. Smajic</td>
</tr>
</tbody>
</table>

Abstract
Physical modelling plays an important role in the analysis and design of new structures, especially for micro and nano devices where fabrication and measurement are difficult. After the fundamentals of electromagnetics, mechanics, and thermodynamics, an introduction to the main concepts and most widely used codes for physical modelling is given and commercial codes are applied.

Objective
Basic knowledge of the fundamental equations and effects of electromagnetics, mechanics, and thermodynamics. Knowledge of the main concepts of numerical methods for physical modelling and simulation. Ability 1) to select appropriate software, 2) to apply it for solving given problems, 3) to validate the results, 4) to interactively improve the models until sufficiently accurate results are obtained.
Virtual Reality has the potential to support medical training and therapy. This lecture will derive the technical principles of multi-modal input devices, displays, and rendering techniques. Several examples are presented that are currently being developed or already applied for surgical training, intra-operative augmentation, and rehabilitation. The lecture is accompanied by practical courses and excursions.

Abstract

The course provides an introduction to digital image analysis in modern flow diagnostics. Different techniques which are discussed include image velocimetry, laser induced fluorescence, liquid crystal thermography and interferometry. The physical foundations and measurement configurations are explained. Image analysis algorithms are presented in detail and programmed during the exercises.

Objective

Virtual Reality has the potential to provide descriptive and practical information for medical training and therapy while relieving the patient and/or the physician. Multi-modal interactions between the user and the virtual environment facilitate the generation of high-fidelity sensory impressions, by using not only visual and auditory modalities, but also kinesthetic, tactile, and even olfactory feedback. On the basis of the existing physiological constraints, this lecture will derive the technical requirements and principles of multi-modal input devices, displays, and rendering techniques. Several examples are presented that are currently being developed or already applied for surgical training, intra-operative augmentation, and rehabilitation. The lecture will be accompanied by several practical courses on graphical and haptic display devices as well as excursions to facilities equipped with large-scale VR equipment.

Content

- Intermolecular forces, their macroscopic manifestations, and ways to control such interactions.
- Self-assembly and directed assembly of 2D and 3D structures.
- Special emphasis on the emerging field of molecular electronic devices.

Target Group:

- Students of higher semesters and PhD students of
- D-HEST, D-MAVT, D-ITET, D-INFK, D-PHYS
- Robotics, Systems and Control Master
- Medical Faculty, University of Zurich
- Students of other departments, faculties, courses are also welcome!

Language: English. Basic experience in Information Technology and Computer Science will be of advantage.

More details will be announced in the lecture.
This course covers some of the fundamental concepts of computer graphics, namely 3D object representations and generation of photorealistic images from digital representations of 3D scenes.

Objective
At the end of the course the students will be able to build a rendering system. The students will study the basic principles of rendering and image synthesis techniques, covering topics such as lightfields and depth-image based rendering.


Abstract
This course covers some of the fundamental concepts of computer graphics, namely 3D object representations and the details of how to generate photorealistic images from digital representations of 3D scenes. Starting with an introduction to 3D shape modeling and representation, texture mapping and ray-tracing, we will move on to acceleration structures, the physics of light transport, appearance modeling and global illumination principles and algorithms. We will end with an overview of modern image-based image synthesis techniques.

Objective
At the end of the course the students will be able to build a rendering system. The students will study the basic principles of rendering and image synthesis techniques, covering topics such as lightfields and depth-image based rendering.

Prerequisites:
Fundamentals of calculus and linear algebra, basic concepts of algorithms and data structures, programming skills in C++, Visual Computing course recommended. The programming course must be taught in C++. This will not be taught in the class.

402-0674-00L Physics in Medical Research: From Atoms to Cells W 6 credits 2V+1U B. K. R. Müller

Abstract
Scanning probe and diffraction techniques allow studying activated atomic processes during early stages of epitaxial growth. For quantitative description, rate equation analysis, mean-field nucleation and scaling theories are applied on systems ranging from simple monolayers to complex organic materials. The knowledge is expanded to optical and electronic properties as well as to proteins and cells.

Objective
The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocyte behaviour.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxide and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure's shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetry and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

227-1033-00L Neuromorphic Engineering I W 6 credits 2V+3U T. Delbrück, G. Indiveri, S.C. Liu

Abstract
This course covers analog circuits with emphasis on neuromorphic engineering: MOS transistors in CMOS technology, static circuits, dynamic circuits, systems (silicon neuron, silicon retina, silicon cochlea) with an introduction to multi-chip systems. The lectures are accompanied by weekly laboratory sessions.

Objective
Understanding the characteristics of neuromorphic circuit elements.

Neuromorphic circuits are inspired by the organizing principles of biological neural circuits. Their computational primitives are based on physics of semiconductor devices. Neuromorphic architectures often rely on collective computation in parallel networks. Adaptation, learning and memory are implemented locally within the individual computational elements. Transistors are often operated in weak inversion (below threshold), where they exhibit exponential I-V characteristics and low currents. These properties lead to the feasibility of high-density, low-power implementations of functions that are computationally intensive in other paradigms. Application domains of neuromorphic circuits include silicon retinas and cochleas for machine vision and audition, real-time emulations of networks of biological neurons, and the development of autonomous robotic systems. This course covers devices in CMOS technology (MOS transistor below and above threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, transconductance amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina and cochlea) and an introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory sessions on the characteristics of neuromorphic circuits, from elementary devices to systems.

S.-C. Liu et al.: Analog VLSI Circuits and Principles; various publications.

Prerequisites:
Fundamentals of semiconductor devices, static and dynamic circuits, introduction to multi-chip systems that communicate events analogous to spikes, and above threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, transconductance amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina and cochlea) and an introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory sessions on the characteristics of neuromorphic circuits, from elementary devices to systems. Students select a paper (list distributed in class) and expand the topic into a Mini-Review that illuminates the particular field beyond the immediate results reported in the paper.

227-1037-00L Introduction to Neuroinformatics W 6 credits 2V+1U K. A. Martin, M. Cook, V. Mante, M. Pfeiffer
Abstract
The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.

Objective
Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monocolonies of physics, maths, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enchantments and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions.

Content
This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.

465-0953-00L Biostatistics W 2 credits 2V+1U
Abstract
Does not take place this semester.


Abstract
Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.

Content
Bioinformatics I will cover the following topics:
- From genes to databases and information
  BLAST searches
  Prediction of gene function and regulation
  RNA structure prediction
  Gene expression analysis using microarrays
  Protein sequence and structure databases
  WWW for bioinformatics
  Protein sequence comparisons
  Proteomics and de novo protein sequencing
  Protein structure prediction
  Cellular and protein interaction networks
  Molecular dynamics simulation

Biology Courses

Number Title Type ECTS Hours Lecturers
227-0399-10L Physiology and Anatomy for Biomedical Engineers I W 3 credits 2G H. Niemann
Abstract
This course offers an introduction into the structure and function of the human body, and how these are interlinked with one another. Focusing on physiology, the visualization of anatomy is supported by 3D-animation, Computed Tomography and Magnetic Resonance imaging.

Objective
To understand basic principles and structure of the human body in consideration of the clinical relevance and the medical terminology used in medical work and research.

Content
- The human body: nomenclature, axes, planes, orientations
  - Musculoskeletal system, Muscle contraction
  - Blood, Blood vessels
  - Immune system and lymphoid organs
  - Fundamentally in their wiring
  - Cardiovascular system
  - Respiratory system
  - Acid-Base-Homeostasis
  - Physical work

Lecture notes
Lecture notes and handouts

Literature
Silbernagl S., Despopoulos A. Color Atlas of Physiology; Thieme 2008
Faller A., Schuenke M. The Human Body; Thieme 2004
Netter F. Atlas of human anatomy; Elsevier 2014

227-0945-00L Cell and Molecular Biology for Engineers I O 3 credits 3G C. Frei

This course is part I of a two-semester course.
Biomechanics

During the Master program, a minimum of 12 CP must be obtained from track core courses.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0385-10L</td>
<td><strong>Biomedical Imaging</strong></td>
<td>W</td>
<td>6</td>
<td>5G</td>
<td>S. Kozerke, U. Moser, K. P. Prüsmann, M. Rudin</td>
</tr>
<tr>
<td></td>
<td><em>New course. Not to be confounded with 227-0385-00L of fall 2014.</em></td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.</td>
</tr>
<tr>
<td></td>
<td><strong>Objective</strong></td>
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<td></td>
<td>To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.</td>
</tr>
<tr>
<td></td>
<td><strong>Content</strong></td>
<td></td>
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<td></td>
<td>- X-ray imaging</td>
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<tr>
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<td></td>
<td></td>
<td></td>
<td>- Computed tomography</td>
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<td></td>
<td></td>
<td></td>
<td>- Single photon emission tomography</td>
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<td></td>
<td></td>
<td>- Positron emission tomography</td>
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<td></td>
<td></td>
<td></td>
<td>- Magnetic resonance imaging</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Ultrasound/Doppler imaging</td>
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<tr>
<td></td>
<td><strong>Lecture notes</strong></td>
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<td></td>
<td>Lecture notes and handouts</td>
</tr>
<tr>
<td></td>
<td><strong>Literature</strong></td>
<td></td>
<td></td>
<td></td>
<td>Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011</td>
</tr>
<tr>
<td></td>
<td><strong>Prerequisites / notice</strong></td>
<td></td>
<td></td>
<td></td>
<td>Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming</td>
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</tbody>
</table>

**Biomedical Engineering**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0386-00L</td>
<td><strong>Biomedical Engineering</strong></td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>J. Vörös, S. J. Ferguson, S. Kozerke, U. Moser, M. Rudin, M. P. Wolf, M. Zenobi-Wong</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.</td>
</tr>
<tr>
<td></td>
<td><strong>Objective</strong></td>
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<td></td>
<td>Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.</td>
</tr>
<tr>
<td></td>
<td><strong>Lecture notes</strong></td>
<td></td>
<td></td>
<td></td>
<td>Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino AND</td>
</tr>
<tr>
<td></td>
<td><strong>Literature</strong></td>
<td></td>
<td></td>
<td></td>
<td><a href="https://www1.ethz.ch/lbb/Education/BME">https://www1.ethz.ch/lbb/Education/BME</a></td>
</tr>
</tbody>
</table>

**Image Analysis and Computer Vision**

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0447-00L</td>
<td><strong>Image Analysis and Computer Vision</strong></td>
<td>W</td>
<td>6</td>
<td>3V+1U</td>
<td>G. Székely, O. Göksel, L. Van Gool</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>Light and perception. Digital image formation. Image enhancement and feature extraction. Unitary transformations. Color and texture. Image segmentation and deformable shape matching. Motion extraction and tracking. 3D data extraction. Invariant features. Specific object recognition and object class recognition.</td>
</tr>
<tr>
<td></td>
<td><strong>Objective</strong></td>
<td></td>
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<td></td>
<td>Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.</td>
</tr>
</tbody>
</table>
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

### Recommended Elective Courses

These courses are particularly recommended for the Biomechanics track. Please consult your track advisor if you wish to select other subjects.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0255-00L</td>
<td>Energy Conversion and Transport in Biosystems</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>D. Poulikakos, A. Ferrari</td>
</tr>
<tr>
<td>Abstract</td>
<td>Theory and application of thermodynamics and energy conversion in biological systems and biomedicine at the macro scale and the cellular level.</td>
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<tr>
<td>Objective</td>
<td>Theory and application of energy conversion at the macro scale and the cellular level. Understanding of the basic features governing fluid transport in the principal systems of the human cell. Connection of characteristics and patterns from other fields of engineering to biofluidics. Heat and mass transport processes within the human body and relation to biomedical technologies.</td>
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<tr>
<td>Content</td>
<td>Mass transfer models for the transport of chemical species in the human cell. Organization and function of the cell membrane and of the cell cytoskeleton. The role of molecular motors in cellular force generation and their function in cell migration. Description of the functionality of these systems and of analytical experimental and computational techniques for understanding of their operation. Introduction to biomechanical approaches for the treatment of the common pathogenic conditions of these systems. Introduction to cell metabolism, cellular energy transport and cellular thermodynamics.</td>
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<tr>
<td>Lecture notes</td>
<td>Script as well as additional material in the form of hand-outs will be distributed.</td>
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</tr>
<tr>
<td>Literature</td>
<td>Lecture notes and references therein.</td>
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</tbody>
</table>

| 151-0511-00L | Mechanics of Nano- and Micro-Materials | W    | 4 credits  | 2V+1U          | C. Daraio               |
| Abstract   | The course provides an introduction to the mechanics of nano- and micro-materials and devices, in the quasistatic and dynamic domains. It reviews scale effects in materials, surveys available characterization techniques and describes the effects of surfaces and microscale contaminants. Recent applications of nano- and micro-materials in engineering systems will be discussed. |      |        |                |                         |
| Objective  | Learn the fundamental mechanical properties of nano- and micro-systems. Understand the effects of scales on the response of materials. Explore applications and devices exploiting the response of materials at small scales. |      |        |                |                         |
| Content    | follows soon                                                        |      |        |                |                         |
| Lecture notes | Slides and notes from the course will be provided.                |      |        |                |                         |
| Literature | Relevant articles and reading materials will be provided. Various books will be recommended pertaining to the topics covered. |      |        |                |                         |
The course addresses basic science and engineering principles governing the nano domain. We particularly work out the links between topics from atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles.

**Objective**
Familiarize students with basic science and engineering principles governing the nano domain. Special emphasis is placed on the emerging field of molecular electronic devices, ruling the nano domain. We particularly work out the links between topics that are traditionally taught separately.

Topics are treated in 2 blocks:

(I) From Quantum to Continuum
- From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles.
- Intermolecular forces, their macroscopic manifestations, and ways to control such interactions.
- Self-assembly and directed assembly of 2D and 3D structures.

(II) Interaction Forces on the Micro and Nano Scale

**Prerequisites / notice**
Lectures and Mini-Review presentations: Thursday 10-13, ML F 36

Homework: Mini-Reviews
Students select a paper (list distributed in class) and expand the topic into a Mini-Review that illuminates the particular field beyond the immediate results reported in the paper.
Since the fabrication and characterization of micro- and nanostructures is difficult, expensive, and time-consuming, numerical modelling drastically reduced the design process. Although many commercial software packages are available, it is important to know the drawbacks and difficulties of the numerical methods behind them and to be able to validate the results obtained with such packages. First, an introduction to the fundamental equations and effects of electromagnetics, mechanics, and thermodynamics is given. This is important for understanding the problems to be analyzed and for validating results obtained from software packages. After this, the main concepts of numerical methods and of the most widely used codes for physical modelling are outlined and compared, which is essential for the adequate selection of software for solving given problems. After this, prominent commercial software packages are applied to various types of problems, ranging from electrodynamic to multiphysics. For becoming able to select appropriate software and to validate the results obtained, different commercial software packages will be used and compared during the exercises in form of small projects.

### 263-5001-00L Introduction to Finite Elements and Sparse Linear System Solving

**W** 4 credits 2V+1U  P. Arbenz, T. Kaman

#### Abstract
The finite element (FE) method is the method of choice for (approximately) solving partial differential equations on complicated domains. In the first third of the lecture, we give an introduction to the method. The rest of the lecture will be devoted to methods for solving the large sparse linear systems of equation that a typical for the FE method. We will consider direct and iterative methods.

#### Objective
Students will know the most important direct and iterative solvers for sparse linear systems. They will be able to determine which solver to choose in particular situations.

### Content

#### I. THE FINITE ELEMENT METHOD

(1) Introduction, model problems.

(2) 1D problems. Piecewise polynomials in 1D.

(3) 2D problems. Triangulations. Piecewise polynomials in 2D.

(4) Variational formulations. Galerkin finite element method.

(5) Implementation aspects.

#### II. DIRECT SOLUTION METHODS

(6) LU and Cholesky decomposition.

(7) Sparse matrices.

(8) Fill-reducing orderings.

#### III. ITERATIVE SOLUTION METHODS

(9) Stationary iterative methods, preconditioning.

(10) Preconditioned conjugate gradient method (PCG).

(11) Incomplete factorization preconditioning.

(12) Multigrid preconditioning.

(13) Nonsymmetric problems (GMRES, BiCGstab).

#### Literature


### Prerequisites / notice

Prerequisites: Linear Algebra, Analysis, Computational Science. The exercises are made with Matlab.

### 376-1103-00L Frontiers in Nanotechnology

**W** 4 credits 4V  V. Vogel, further lecturers

#### Abstract
Many disciplines are meeting at the nanoscale, from physics, chemistry to engineering, from the life sciences to medicine. The course will prepare students to communicate more effectively across disciplinary boundaries, and will provide them with deep insights into the various frontiers.

#### Objective

Building upon advanced technologies to create, visualize, analyze and manipulate nano-structures, as well as to probe their nano-chemistry, nano-mechanics and other properties within manmade and living systems, many exciting discoveries are currently made. They change the way we do science and result in so many new technologies. The goal of the course is to give Master and Graduate students from all interested departments an overview of what nanotechnology is all about, from analytical techniques to nanosystems, from physics to biology. Students will start to appreciate the extent to which scientific communities are meeting at the nanoscale. They will learn about the specific challenges and what is currently sizzling in the respective fields, and learn the vocabulary that is necessary to communicate effectively across departmental boundaries.

Each lecturer will first give an overview of the state-of-the art in his/her field, and then describe the research highlights in his/her own research group. While preparing their Final Projects and discussing them in front of the class, the students will deepen their understanding of how to apply a range of new technologies to solve specific scientific problems and technical challenges. Exposure to the different frontiers will also improve their ability to conduct effective nanoscale research, recognize the broader significance of their work and to start collaborations.

#### Content

Starting with the fabrication and analysis of nanoparticles and nanostructured materials that enable a variety of scientific and technical applications, we will transition to discussing biological nanosystems, how they work and what bioinspired engineering principles can be derived, to finally discussing biomedical applications and potential health risk issues. Scientific aspects as well as the many of the emerging technologies will be covered that start impacting so many aspects of our lives. This includes new phenomena in physics, advanced materials, novel technologies and new methods to address major medical challenges.
<table>
<thead>
<tr>
<th>Lecture notes</th>
<th>All the enrolled students will get access to a password protected website where they can find pdf files of the lecture notes, and typically 1-2 journal articles per lecture that cover selected topics.</th>
</tr>
</thead>
</table>
| **376-1219-00L** Rehabilitation Engineering II: Rehabilitation of Sensory and Vegetative Functions | Rehabilitation of visual function
- Anatomy and physiology of the visual sense
- Technical aids (glasses, sensor substitution)
- Retina and cortex implants
Rehabilitation of hearing function
- Anatomy and physiology of the auditory sense
- Hearing aids
- Cochlea Implants
Rehabilitation and use of kinesthetic and tactile function
- Anatomy and physiology of the kinesthetic and tactile sense
- Tactile/haptic displays for motion therapy (incl. electrical stimulation)
- Role of displays in motor learning
Rehabilitation of vestibular function
- Anatomy and physiology of the vestibular sense
- Rehabilitation strategies and devices (e.g. BrainPort)
Rehabilitation of vegetative Functions
- Cardiac Pacemaker
- Phrenic stimulation, artificial breathing aids
- Bladder stimulation, artificial sphincter
Brain stimulation and recording
- Deep brain stimulation for patients with Parkinson, epilepsy, depression
- Brain-Computer Interfaces |
| Abstract | Rehab. Engineering is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system. |
| Objective | Provide knowledge on the anatomy and physiology of the human sensory system, related dysfunctions and pathologies, and how rehabilitation engineering can provide sensory restoration and substitution. |
| Content | Introduction, problem definition, overview
  - Rehabilitation of visual function
  - Anatomy and physiology of the visual sense
  - Technical aids (glasses, sensor substitution)
  - Retina and cortex implants
  Rehabilitation of hearing function
  - Anatomy and physiology of the auditory sense
  - Hearing aids
  - Cochlea Implants
  Rehabilitation and use of kinesthetic and tactile function
  - Anatomy and physiology of the kinesthetic and tactile sense
  - Tactile/haptic displays for motion therapy (incl. electrical stimulation)
  - Role of displays in motor learning
  Rehabilitation of vestibular function
  - Anatomy and physiology of the vestibular sense
  - Rehabilitation strategies and devices (e.g. BrainPort)
  Rehabilitation of vegetative Functions
  - Cardiac Pacemaker
  - Phrenic stimulation, artificial breathing aids
  - Bladder stimulation, artificial sphincter
  Brain stimulation and recording
  - Deep brain stimulation for patients with Parkinson, epilepsy, depression
  - Brain-Computer Interfaces |
Virtual Reality has the potential to support medical training and therapy. This lecture will derive the technical principles of multi-modal interaction and rendering techniques. Several examples are presented that are currently being developed or already applied for surgical training, intra-operative augmentation, and rehabilitation. The lecture is accompanied by practical courses and excursions.

Prerequisites / notice
Students of other departments, faculties, courses are also welcome!

Target Group:
- Biomedical Engineering/Movement Science and Sport
- Robotics, Systems and Control Master
- D-MAVT, D-ITET, D-INFK, D-HEST

Students of higher semesters and PhD students of
- D-MAVT, D-ITET, D-INFK, D-HEST
- Biomedical Engineering, Robotics, Systems and Control
- Medical Faculty, University of Zurich

376-1279-00L Virtual Reality in Medicine W 3 credits 2V R. Riener, M. Harders

Abstract
Virtual Reality has the potential to support medical training and therapy. This lecture will derive the technical principles of multi-modal (audiovisual, haptic, tactile etc.) input devices, displays and rendering techniques. Examples are presented in the fields of surgical training, intra-operative augmentation, and rehabilitation. The lecture is accompanied by practical courses and excursions.

Objective
Virtual Reality has the potential to provide descriptive and practical information for medical training and therapy while relieving the patient and/or the physician. Multi-modal interactions between the user and the virtual environment facilitate the generation of high-fidelity sensory impressions, by using not only visual and auditory modalities, but also kinesthetic, tactile, and even olfactory feedback. On the basis of the existing physiological constraints, this lecture will derive the technical requirements and principles of multi-modal input devices, displays, and rendering techniques. Several examples are presented that are currently being developed or already applied for surgical training, intra-operative augmentation, and rehabilitation. The lecture will be accompanied by several practical courses on graphical and haptic display devices as well as excursions to facilities equipped with large-scale VR equipment.

Target Group:
Students of higher semesters and PhD students of
- D-MAVT, D-ITET, D-INFK, D-HEST
- Biomedical Engineering, Robotics, Systems and Control
- Medical Faculty, University of Zurich

Students of other departments, faculties, courses are also welcome!

Literature

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 264 of 1434
**376-1714-00L** Biocompatible Materials  
**W** 4 credits 3G  
K. Maniura, J. Möller, M. Zenobi-Wong  

**Abstract**  
Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

**Objective**  
The class consists of three parts:  
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.  
2. The concept of biocompatibility.  
3. Introduction into methodology used in biomaterials research and application.

**Content**  
Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implanted or explanted implant are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

**Lecture notes / notice**  
Handouts can be accessed online.

**Literature**  
Literator  
Comprehensive Biomaterials, Ducheyne P. et al., 1st Edition, 2011 (available online via ETH library)

**376-1351-00L** Micro/Nanotechnology and Microfluidics for Biomedical Applications  
**W** 2 credits 2V  
E. Delamarche  

**Abstract**  
This course is an introduction to techniques in micro/nanotechnology and to microfluidics. It reviews how many familiar devices are built and can be used for research and biomedical applications. Transistors for DNA sequencing, bearers for patterning proteins, hard-disk technology for biosensing and scanning microfluidics for analyzing tissue sections are just a few examples of the covered topics.

**Objective**  
The main objective of the course is to introduce micro/nanotechnology and microfluidics to students having a background in the life sciences. The course should familiarize the students with the techniques used in micro/nanotechnology and show them how micro/nanotechnology pervades throughout life sciences. Microfluidics will be emphasized due to their increasing importance in research and medical applications. The second objective is to have life students less intimidated by micro/nanotechnology and make them able to link instruments and techniques to specific problems that they might have in their projects/studies. This will also help students getting access to the ETH/IBM Nanotech Center infrastructure if needed.

**Content**  
Mostly formal lectures (2 × 45 min), with a 2 hour visit and introduction to cleanroom and micro/nanotechnology instruments, last 3 sessions would be dedicated to the presentation and evaluation of projects by students (3 students per team).

**Prerequisites / notice**  
Nanotech center and lab visit at IBM would be mandatory, as well as attending the student project presentations.

**376-1720-00L** Application of MATLAB in the Human Movement Sciences  
**W** 2 credits 2G  
R. van de Langenberg  

**Abstract**  
Students will learn to import, process and graphically present experimental data using the MATLAB computing environment. Both the data and the methods of analysis will be typical for experiments in Human Movement Science (i.e. kinematics, kinetics and electromyography).

**Objective**  
Students will acquire the ability to independently load, plot, and process kinematic, kinetic and electromyographical data using the MATLAB computing environment.

**Content**  
Drawbacks of Excel: Possibilities in MATLAB; Import of several data formats: Plot of one and more signals; Removing of an offset and filtering of data based on self-written functions; Normalisation and parametrisation of data; Reliability; Interpolation, Differentiation and Integration in MATLAB.

**Literature**  
During the lecture, several electronically available MATLAB introductions are indicated. Course-specific scripts will be provided by the lecturer.

**Prerequisites / notice**  
A Laptop with MATLAB installed (v2009 or higher) and wireless internet access is mandatory. Two students can share a laptop if necessary. A MATLAB student version can be obtained at Stud-IDES for free.

**376-1974-00L** Colloquium in Biomechanics  
**W** 2 credits 2K  
B. Holgason, S. J. Ferguson, R. Müller, J. G. Snedeker, B. Taylor, M. Zenobi-Wong

**Abstract**  
Current topics in biomechanics presented by speakers from academia and industry.

**Objective**  
Getting insight into actual areas and problems of biomechanics.

**376-2017-00L** Biomechanics of Sports Injuries and Rehabilitation  
**W** 3 credits 2V  
K.U. Schmitt, J. Goldhahn

**Abstract**  
This lectures introduces the basic principles of injury mechanics and rehabilitation focussing on sports injuries.

**Objective**  
Within the scope of this lecture you will learn the basic principles of trauma biomechanics. Based on examples from sports, you will get to know different mechanisms that can possibly result in injury. Investigating the background and cause of injury should allow you to assess the injury risk for sports activities. Furthermore you should be able to develop measures to prevent such injury.

**Content**  
This lecture deals with the basic principles of injury mechanics and rehabilitation. Mechanisms that can result in injury are presented. Furthermore possibilities to prevent injuries are discussed. Thereby the lecture focuses on sports injuries.

**Lecture notes / notice**  
Handouts can be downloaded.

**Literature**  

**Prerequisites / notice**  
A course work is required. The mark of this course work contributes to the final credits for this lecture. Details will be given during the first lecture.

**402-0341-00L** Medical Physics I  
**W** 6 credits 2V+1U  
P. Manser

**Abstract**  
Introduction to the fundamentals of medical radiation physics. Functional chain due to radiation exposure from the primary physical effect to the radiobiological and medically manifest secondary effects. Dosimetric concepts of radiation protection in medicine. Mode of action of radiation sources used in medicine and its illustration by means of Monte Carlo simulations.

**Objective**  
Understanding the functional chain from primary physical effects of ionizing radiation to clinical radiation effects. Dealing with dose as a quantitative measure of medical exposure. Getting familiar with methods to generate ionizing radiation in medicine and learn how they are applied for medical purposes. Eventually, the lecture aims to show the students that medical physics is a fascinating and evolving discipline where physics can directly be used for the benefits of patients and the society.
Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background

Biostatistics

The course deals with simple quantitative and graphical as well as more complex methods of biostatistics. Contents: Descriptive statistics, probability theory and design of experiments, testing hypotheses, confidence intervals, correlation, simple and multiple linear regression, analysis of variance, logistic regression, survival analysis (Kaplan-Meier curves and Cox-regression).

551-1295-00L

Introduction to Bioinformatics: Concepts and Applications

Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.

Objective

Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

Content

Bioinformatics I will cover the following topics:

From genes to databases and information
BLAST searches
Prediction of gene function and regulation
RNA structure prediction
Gene expression analysis using microarrays
Protein sequence and structure databases
WWW for bioinformatics
Protein sequence comparisons
Proteomics and de novo protein sequencing
Protein structure prediction
Cellular and protein interaction networks
Molecular dynamics simulation

A script will be provided.

402-0674-00L

Physics in Medical Research: From Atoms to Cells

Scanning probe and diffraction techniques allow studying activated atomic processes during early stages of epitaxial growth. For quantitative description, rate equation analysis, mean-field nucleation and scaling theories are applied on systems ranging from simple metallic to complex organic materials. The knowledge is expanded to optical and electronic properties as well as to proteins and cells.

Objective

The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocyte behaviour.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxidic and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure's shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.
### Biology Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0399-10L</td>
<td>Physiology and Anatomy for Biomedical Engineers I</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>H. Niemann</td>
</tr>
</tbody>
</table>

**Abstract**
This course offers an introduction into the structure and function of the human body, and how these are interlinked with one another. Focusing on physiology, the visualization of anatomy is supported by 3D-animation, Computed Tomography and Magnetic Resonance Imaging.

**Objective**
To understand basic principles and structure of the human body in consideration of the clinical relevance and the medical terminology used in medical work and research.

**Content**
- The human body: nomenclature, axes, planes, orientations
- Musculoskeletal system, Muscle contraction
- Blood, Blood vessels
- Immune system and lymphoid organs
- Heart
- Cardiovascular system
- Respiratory system
- Acid-Base-Homeostasis
- Physical work

**Lecture notes**
Lecture notes and handouts

**Literature**
Silbernagl S., Despopoulos A. Color Atlas of Physiology; Thieme 2008
Fallen A., Schuenke M. The Human Body; Thieme 2004
Netter F. Atlas of human anatomy; Elsevier 2014

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>227-0945-00L</td>
<td>Cell and Molecular Biology for Engineers I</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>C. Frei</td>
</tr>
</tbody>
</table>

**Abstract**
The course gives an introduction into cellular and molecular biology, specifically for students with a background in engineering. The focus will be on the basic organization of eukaryotic cells, molecular mechanisms and cellular functions. Textbook knowledge will be combined with results from recent research and technological innovations in biology.

**Objective**
After completing this course, engineering students will be able to apply their previous training in the quantitative and physical sciences to modern biology. Students will also learn the principles how biological models are established, and how these models can be tested.

**Content**
Lectures will include the following topics: DNA, chromosomes, RNA, protein, genetics, gene expression, membrane structure and function, vesicular traffic, cellular communication, energy conversion, cytokskeleton, cell cycle, cellular growth, apoptosis, autophagy, cancer, development and stem cells.

In addition, three journal clubs will be held, where one/two publications will be discussed. For each journal club, students (alone or in groups of up to three students) have to write a summary and discussion of the publication. These written documents will be graded, and count as 25% for the final grade.

**Lecture notes**
Scripts of all lectures will be available.

**Literature**

<table>
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<tr>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0949-00L</td>
<td>Biological Methods for Engineers (Basic Lab)</td>
<td>W</td>
<td>2</td>
<td>4P</td>
<td>C. Frei</td>
</tr>
</tbody>
</table>

**Abstract**
The course during 4 afternoons covers basic laboratory skills and safety, cell culture, protein analysis, RNA/DNA isolation and RT-PCR. Each topic will be introduced, followed by practical work at the bench. Presence during the course is mandatory.

**Objective**
The goal of this laboratory course is to give students practical exposure to basic techniques of cell and molecular biology.

**Content**
The goal of this laboratory course is to give students practical exposure to basic techniques of cell and molecular biology.

**Prerequisites / notice**
Enrollment is limited and given only to students in the Masters of Biomedical Engineering program.

### Medical Physics

#### Track Core Courses

**During the Master program, a minimum of 12 CP must be obtained from track core courses.**

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>227-0385-10L</td>
<td>Biomedical Imaging</td>
<td>W</td>
<td>6</td>
<td>5G</td>
<td>S. Kozerke, U. Moser, K. P. Prüssmann, M. Rudin</td>
</tr>
</tbody>
</table>

**Abstract**
Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.

**Objective**
To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

**Content**
- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

**Lecture notes**
Lecture notes and handouts

**Literature**
Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011
Netter F. Atlas of human anatomy; Elsevier 2014

**Prerequisites / notice**
Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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</tr>
</thead>
<tbody>
<tr>
<td>402-0341-00L</td>
<td>Medical Physics I</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>P. Manser</td>
</tr>
</tbody>
</table>

**Abstract**
Introduction to the fundamentals of medical radiation physics. Functional chain due to radiation exposure from the primary physical effects to the radiobiological and medically manifest secondary effects. Dosimetric concepts of radiation protection in medicine. Mode of action of radiation sources used in medicine and its illustration by means of Monte Carlo simulations.

**Objective**
Understanding the functional chain from primary physical effects of ionizing radiation to clinical radiation effects. Dealing with dose as a quantitative measure of medical exposure. Getting familiar with methods to generate ionizing radiation in medicine and learn how they are applied for medical purposes. Eventually, the lecture aims to show the students that medical physics is a fascinating and evolving discipline where physics can directly be used for the benefits of patients and the society.
The lecture series will begin with a short historical overview of medical physics and an overview of the lecture series (lecture 1). This will be followed by two lectures on the physics of medical imaging. Medical imaging is one of the most important areas of preventive medicine and diagnostics, and in these two lectures, we will summarise the physics aspects of all the most important medical imaging modalities (X-ray, nuclear medicine, CT, MRI, Ultrasound imaging etc.). With lectures 4 and 5, we will move onto one of the other major areas of physics applied to medicine, radiotherapy. As the name implies, this is a physics ‘heavy’ discipline, being dependent as it is on both accelerator and particle physics. However, what is less well known is that this is also the second most successful treatment of cancer after surgery and a great success story for the application of physics to medicine. In lectures 6 and 7 will then move on to a very different area, that of bio-photonics and bio-physics. Here we will look into the applications of lasers in medicine, from therapy to their use in particle acceleration for medical applications, as well as a variety of optical techniques for studying biological tissues, cells and structures.

In the second half of the lecture series (lectures 8-13) the style changes somewhat, and we will concentrate on professional aspects of medical physics and the role of the medical physicist in various professional scenarios. As such, lectures 8-11 will cover the role of the clinical medical physicist in diagnostic radiology, MRI, nuclear medicine and radiotherapy, whilst the last two lectures will concentrate on their role in industry and research. For many of this second set of lectures, external experts in the various areas will be invited in order to give the student the best possible insight into the life of a professional medical physicist.

### Recommended Elective Courses

These courses are particularly recommended for the Medical Physics track. Please consult your track advisor if you wish to select other subjects.

<table>
<thead>
<tr>
<th>Number</th>
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</tr>
</thead>
<tbody>
<tr>
<td>402-0674-00L</td>
<td>Physics in Medical Research: From Atoms to Cells</td>
<td>W</td>
<td>6 credits</td>
<td>2+1U</td>
<td>B. K. R. Müller</td>
</tr>
</tbody>
</table>

Scanning probe and diffraction techniques allow studying activated atomic processes during early stages of epitaxial growth. For quantitative description, rate equation analysis, mean-field nucleation and scaling theories are applied on systems ranging from simple metallic to complex organic materials. The knowledge is expanded to optical and electronic properties as well as to proteins and cells.
### Other Elective Courses

These courses may be suitable for the Medical Physics track. Please consult your track advisor.

<table>
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<th>Number</th>
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<tbody>
<tr>
<td>227-0447-00L</td>
<td>Image Analysis and Computer Vision</td>
<td>W</td>
<td>6</td>
<td>3V+1U</td>
<td>G. Székely, O. Göksel, L. Van Gool</td>
</tr>
<tr>
<td>Objective</td>
<td>Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.</td>
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<tr>
<td>Content</td>
<td>The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.</td>
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</table>

- Lecture notes: Course material Script, computer demonstrations, exercises and problem solutions
- Prerequisites: Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C. The course language is English.

### Biology Courses

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<td>Abstract</td>
<td>This course offers an introduction into the structure and function of the human body, and how these are interlinked with one another. Focusing on physiology, the visualization of anatomy is supported by 3D-animation, Computed Tomography and Magnetic Resonance imaging.</td>
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<td>Objective</td>
<td>To understand basic principles and structure of the human body in consideration of the clinical relevance and the medical terminology used in medical work and research.</td>
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</table>
| Content      | - The human body: nomenclature, axes, planes, orientations  
- Musculoskeletal system, Muscle contraction  
- Blood, Blood vessels  
- Immune system and lymphoid organs  
- Heart  
- Cardiovascular system  
- Respiratory system  
- Acid-Base-Homeostasis  
- Physical work |      |      |       |                    |
| Lecture notes | Lecture notes and handouts |      |      |       |                    |
| Literature   | Silbernagl S., Despopoulos A. Color Atlas of Physiology; Thieme 2008  
Faller A., Schuenke M. The Human Body; Thieme 2004  
Netter F. Atlas of human anatomy; Elsevier 2014 |      |      |       |                    |
| 227-0945-00L | Cell and Molecular Biology for Engineers I | W    | 3    | 3G    | C. Frei           |
| Abstract     | This course is part I of a two-semester course. |      |      |       |                    |
| Objective    | |      |      |       |                    |
The course gives an introduction into cellular and molecular biology, specifically for students with a background in engineering. The focus will be on the basic organization of eukaryotic cells, molecular mechanisms and cellular functions. Textbook knowledge will be combined with results from recent research and technological innovations in biology.

After completing this course, engineering students will be able to apply their previous training in the quantitative and physical sciences to modern biology. Students will also learn the principles how biological models are established, and how these models can be tested. Lectures will include the following topics: DNA, chromosomes, RNA, protein, genetics, gene expression, membrane structure and function, vesicular traffic, cellular communication, energy conversion, cytoskeleton, cell cycle, cellular growth, apoptosis, autophagy, cancer, development and stem cells.

In addition, three journal clubs will be held, where one/two publications will be discussed. For each journal club, students (alone or in groups of up to three students) have to write a summary and discussion of the publication. These written documents will be graded, and count as 25% for the final grade.

Scripts of all lectures will be available.


### Molecular Bioengineering

### Track Core Courses

*During the Master program, a minimum of 12 CP must be obtained from track core courses.*

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<tr>
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<tbody>
<tr>
<td>376-1103-00L</td>
<td>Frontiers in Nanotechnology</td>
<td>W</td>
<td>4</td>
<td>4V</td>
<td>V. Vogel, further lecturers</td>
</tr>
</tbody>
</table>

**Abstract**

Many disciplines are meeting at the nanoscale, from physics, chemistry to engineering, from the life sciences to medicine. The course will prepare students to communicate more effectively across disciplinary boundaries, and will provide them with deep insights into the various frontiers.

**Objective**

Building upon advanced technologies to create, visualize, analyze and manipulate nano-structures, as well as to probe their nano-chemistry, nano-mechanics and other properties within mammal and living systems, many exciting discoveries are currently made. They change the way we do science and result in so many new technologies.

The goal of the course is to give Master and Graduate students from all interested departments an overview of what nanotechnology is all about, from analytical techniques to nanosystems, from physics to biology. Students will start to appreciate the extent to which scientific communities are meeting at the nanoscale. They will learn about the specific challenges and what is currently sizzling in the respective fields, and learn the vocabulary that is necessary to communicate effectively across departmental boundaries.

Each lecturer will first give an overview of the state-of-the art in his/her field, and then describe the research highlights in his/her own research group. While preparing their Final Projects and discussing them in front of the class, the students will deepen their understanding of how to apply a range of new technologies to solve specific scientific problems and technical challenges. Exposure to the different frontiers will also improve their ability to conduct effective nanoscale research, recognize the broader significance of their work and to start collaborations.

**Content**

Starting with the fabrication and analysis of nanoparticles and nanostructured materials that enable a variety of scientific and technical applications, we will transition to discussing biological nanosystems, how they work and what bioinspired engineering principles can be derived, to finally discussing biomedical applications and potential health risk issues. Scientific aspects as well as the many of the emerging technologies will be covered that start impacting so many aspects of our lives. This includes new phenomena in physics, advanced materials, novel technologies and new methods to address major medical challenges.

All the enrolled students will get access to a password protected website where they can find pdf files of the lecture notes, and typically 1-2 journal articles per lecture that cover selected topics.

<table>
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<tbody>
<tr>
<td>376-1714-00L</td>
<td>Biocompatible Materials</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>K. Maniura, J. Möller, M. Zenobi-Wong</td>
</tr>
</tbody>
</table>

**Abstract**

Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

**Objective**

The class consists of three parts:

1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

**Content**

Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

Handouts can be accessed online.

Literature


(available online via ETH library)

Handouts provided during the classes and references therin.

<table>
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<tr>
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<td>Physics in Medical Research: From Atoms to Cells</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>B. K. R. Müller</td>
</tr>
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**Abstract**

Scanning probe and diffraction techniques allow studying activated atomic processes during early stages of epitaxial growth. For quantitative description, rate equation analysis, mean-field nucleation and scaling theories are applied on systems ranging from simple metallic to complex organic materials. The knowledge is expanded to optical and electronic properties as well as to proteins and cells.
Objective

The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocyte behaviour.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxidic and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure’s shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

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Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

<table>
<thead>
<tr>
<th>465-0953-00L</th>
<th>Biostatistics</th>
<th>W</th>
<th>2 credits</th>
<th>2V+1U</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>The course deals with simple quantitative and graphical as well as more complex methods of biostatistics. Contents: Descriptive statistics, probability theory and design of experiments, testing hypotheses, confidence intervals, correlation, simple and multiple linear regression, analysis of variance, logistic regression, survival analysis (Kaplan-Meier curves and Cox-regression).</td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>E. Hafen, U. Kutay, J. Matos, G. Schertler, U. Suter, S. Werner</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
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<table>
<thead>
<tr>
<th>551-0103-00L</th>
<th>Fundamentals of Biology II: Cell Biology</th>
<th>W</th>
<th>5 credits</th>
<th>5V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>The goal of this course is to provide students with a wide general understanding in cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.</td>
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<tr>
<td>Content</td>
<td>The focus is animal cells and the development of multicellular organisms with a clear emphasis on the molecular basis of cellular structures and phenomena. The topics include biological membranes, the cytoskeleton, protein sorting, energy metabolism, cell cycle and division, viruses, extracellular matrix, cell signaling, embryonic development and cancer research.</td>
<td></td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>The lectures are presented in the Powerpoint format. These are available on the WEB for ETH students over the nethz (Moodle). Some lectures are available on the ETH WEB site in a live format (Livestream) at the above WEB site.</td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Some of the lectures are given in the English language. Certain sections of the text-book must be studied by self-instruction.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>551-1295-00L</th>
<th>Introduction to Bioinformatics: Concepts and Applications</th>
<th>W</th>
<th>6 credits</th>
<th>4G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.</td>
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<tr>
<td>Abstract</td>
<td>Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.</td>
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</table>

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.
Main topics of the course include:

- BLAST searches
- Prediction of gene function and regulation
- RNA structure prediction
- Gene expression analysis using microarrays
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

**636-0003-00L**

**Biological Engineering and Biotechnology**

<table>
<thead>
<tr>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>6</td>
<td>3G</td>
<td>M. Fusseegeger</td>
</tr>
</tbody>
</table>

**Objective**

1. Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical Manufacturing.
2. The Licence To Kill. Apoptosis Regulatory Networks - Engineering of Survival Pathways To Increase Robustness of Production Cell Lines.
5. From Target To Market. An Antibody's Journey From Cell Culture to The Clinic.
6. Biology and Malign Applications. Do Life Sciences Enable the Development of Biological Weapons?
7. Functional Food. Enjoy your Meal!

**Lecture notes**

Handsout during the course.

---

**Recommended Elective Courses**

*These courses are particularly recommended for the Molecular Bioengineering track. Please consult your track advisor if you wish to select other subjects.*

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
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</thead>
<tbody>
<tr>
<td>151-0604-00L</td>
<td>Microrobotics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>B. Nelson</td>
</tr>
</tbody>
</table>

**Abstract**

Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.

**Objective**

The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.

**Content**

- Scaling laws at micro/nano scales
- Electrostatics
- Electromagnetism
- Low Reynolds number flows
- Observation tools
- Materials and fabrication methods
- Applications of biomedical microrobots

**Lecture notes**

The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

**Prerequisites / notice**

The lecture will be taught in English.

**227-0385-10L**

**Biomedical Imaging**

*New course. Not to be confused with 227-0385-00L of fall 2014.*

<table>
<thead>
<tr>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>W</td>
<td>6</td>
<td>5G</td>
<td>S. Kozerke, U. Moser, K. P. Prüssmann, M. Rudin</td>
</tr>
</tbody>
</table>

**Abstract**

Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.

**Objective**

To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

**Content**

- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

**Lecture notes**

Lecture notes and handouts

**Literature**

Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011

**Prerequisites / notice**

Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

**227-0386-00L**

**Biomedical Engineering**

<table>
<thead>
<tr>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

**Abstract**

Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.
### 227-0965-00L Micro and Nano-Tomography of Biological Tissues

**Objective**
Introduction into micro- and nano-tomography as a powerful technique for non-destructive, high-resolution investigations of a broad range of materials. The high-brilliance and high-coherence of third generation synchrotron radiation facilities allow quantitative, threedimensional imaging at the micro and nanometer scale and extend the traditional absorption imaging technique to edge-enhanced and phase-sensitive measurements, which are particularly suited for investigating biological samples.

**Abstract**
The lecture introduces the basic concepts of X-ray tomographic imaging, image analysis and data quantification at the micro and nano scale with particular emphasis on biological applications.

**Content**
- **Objective:** Introduction to the basic concepts of X-ray tomographic imaging, image analysis and data quantification at the micro and nano scale with particular emphasis on biological applications.
- **Prerequisites:** General undergraduate physics including basic chemical kinetics and thermodynamics.
- **Prerequisites:** General undergraduate chemistry.

**Literature**
- Lecture notes: Available online
- Literature: Will be indicated during the lecture.

### 327-0505-00L Surfaces, Interfaces and their Applications I

**Objective**
To gain an understanding of the physical and chemical principles, as well as the tools and applications of surface science, and to be able to choose appropriate surface-analytical approaches for solving problems.

**Abstract**
After being introduced to the physical/chemical principles and importance of surfaces and interfaces, the student is introduced to the most important techniques that can be used to characterize surfaces. Later, liquid interfaces are treated, followed by an introduction to the fields of tribology (friction, lubrication, and wear) and corrosion.

**Content**
- **Objective:** Introduction to Surface Science
- **Prerequisites:** Introductory chemistry and physics.
- **Prerequisites:** Introductory calculus and basic trigonometry.
- **Prerequisites:** Introductory calculus and basic trigonometry.

**Literature**
- Lecture notes: Available online
- Literature: Will be indicated during the lecture.

### 327-1101-00L Biomineralization

**Objective**
The course aims to introduce the basic concepts of biomineralization and the underlying principles, such as supersaturation, nucleation and growth of minerals, the interaction of biomolecules with mineral surfaces, and cell biology of inorganic materials creation. An important part of this class is the independent study and the presentation of original literature from the field.

**Abstract**
The course addresses undergraduate and graduate students interested in getting introduced into the basic concepts of biomineralization.

**Content**
- **Objective:** Introduction into biomineralization. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.
- **Prerequisites:** Introductory chemistry and physics.
- **Prerequisites:** Introductory calculus and basic trigonometry.
- **Prerequisites:** Introductory calculus and basic trigonometry.

**Literature**
- Lecture notes: Available online
- Literature: Will be indicated during the lecture.
Content

Biominerallization is a multidisciplinary field. Topics dealing with biology, molecular and cell biology, solid state physics, mineralogy, crystallography, organic and physical chemistry, biochemistry, dentistry, oceanography, geology, etc. are addressed. The course covers definition and general concepts of biominerallization (BM)/types of biominerals and their function / crystal nucleation and growth / biological induction of BM / control of crystal morphology, habit, shape and orientation by organisms / strategies of compartmentalization / the interface between biomolecules (peptides, polysaccharides) and the mineral phases / modern experimental methods for studying BM phenomena / inter-, intra, extra- and epicellular BM / organic templates and matrices for BM / structure of bone, teeth (vertebrates and invertebrates) and mollusk shells / calcification / silification in diatoms, radiolarians and plants / calcium and iron storage / impact of BM on lithosphere and atmosphere/ evolution / taxonomy of organisms.

1. Introduction and overview
2. Biominerals and their functions
3. Chemical control of biominerallization
4. Control of morphology: Organic templates and additives
5. Modern methods of investigation of BM
6. BM in matrices: bone and nacre
7. Vertebrate teeth
8. Invertebrate teeth
9. BM within vesicles: calcite of coccoliths
10. Silica
11. Iron storage and mineralization

Lecture notes
Script with more than 600 pages with many illustrations will be distributed free of charge.

Literature
3) P. M. Dove, J. J. DeYoreo, S. Weiner (Eds.), Biominerallization, Reviews in Mineralogy & Geochemistry Vol. 54, 2003

Prerequisites / notice
Each attendee is required to present a publication from the field. The selection of key papers is provided by the lecturer.

No special requirements are needed for attending. Basic knowledge in chemistry and cell biology is expected.

376-1622-00L Practical Methods in Tissue Engineering W 5 credits 4P K. Würzt-Kozak, M. Zenobi-Wong
Number of participants limited to 12.

Abstract
The goal of this course is to teach MSc students the necessary skills for doing research in the fields of tissue engineering and regenerative medicine.

Objective
Practical exercises and demonstrations on topics including sterile cell culture, light microscopy and histology, protein and gene expression analysis, and viability assays are covered. The advantages of 3D cell cultures will be discussed and practical work on manufacturing and evaluating hydrogels and scaffolds for tissue engineering will be performed in small groups. In addition to practical lab work, the course will teach skills in data acquisition/analysis.

402-0341-00L Medical Physics I W 6 credits 2V+1U P. Manser

Abstract
Introduction to the fundamentals of medical radiation physics. Functional chain due to radiation exposure from the primary physical effect to the radiobiological and medically manifest secondary effects. Dosimetric concepts of radiation protection in medicine. Mode of action of radiation sources used in medicine and its illustration by means of Monte Carlo simulations.

Objective
Understanding the functional chain from primary physical effects of ionizing radiation to clinical radiation effects. Dealing with dose as a quantitative measure of medical exposure. Getting familiar with methods to generate ionizing radiation in medicine and learn how they are applied for medical purposes. Eventually, the lecture aims to show how physical and biological effects of ionizing radiation can directly be used for the benefits of patients and the society.

Content
The lecture is covering the basic principles of ionizing radiation and its physical and biological effects. The physical interactions of photons as well as of charged particles will be reviewed and their consequences for medical applications will be discussed. The concept of Monte Carlo simulation will be introduced in the exercises and will help the student to understand the characteristics of ionizing radiation in simple and complex situations. Fundamentals in dosimetry will be provided in order to understand the physical and biological effects of ionizing radiation. Deterministic as well as stochastic effects will be discussed and fundamental knowledge about radiation protection will be provided. In the second part of the lecture series, we will cover the generation of ionizing radiation. By this means, the x-ray tube, the clinical linear accelerator, and different radioactive sources in radiology, radiotherapy and nuclear medicine will be addressed. Applications in radiology, nuclear medicine and radiotherapy will be described with a special focus on the physics underlying these applications.

Lecture notes
A script will be provided.

535-0423-00L Drug Delivery and Drug Targeting W 2 credits 2V J.C. Leroux, D. Brambilla

Abstract
The students gain an overview on current principles, methodologies and systems for controlled delivery and targeting of drugs. This enables the students to understand the field in terms of scientific criteria.

Objective
The students dispose of an overview on current principles and systems for the controlled delivery and targeting of drugs. This covers the course lies on developing a capacity to understand the involved technologies and methods, as well as an appreciation of the chances and constraints of their therapeutic usage, with prime attention on anticancer drugs, therapeutic peptides, proteins, nucleic acids and vaccines.

Content
The course covers the following topics: drug targeting and delivery principles, radiopharmaceuticals, macromolecular drug carriers, liposomes, micelles, micro/nanoparticles, gels and implants, administration of vaccines, delivery of active agents in tissue engineering, targeting at the gastrointestinal level, synthetic carriers for nucleic acid drugs, ophthalmic devices and novel trends in transdermal and nasal drug delivery.

Lecture notes
Selected lecture notes, documents and supporting material will be directly provided or may be downloaded using http://www.galenik.ethz.ch/teaching/drug_del_drug_targ

The website also displays additional information on peroral delivery systems, transdermal systems and systems for alternative routes (nasal, pulmonary) of delivery. These fields are covered in detail in the course Galenische Pharmazie II (Galenical Pharmacy II).

Literature

Further references will be provided in the course.

636-0507-00L Synthetic Biology II W 4 credits 4A S. Panke, Y. Benenson, J. Stelling

Abstract
7 months biological design project, during which the students are required to give presentations on advanced topics in synthetic biology (specifically genetic circuit design) and then select their own biological system to design. The system is subsequently modeled, analyzed, and experimentally implemented. Results are presented at an international student competition at the MIT (Cambridge).

Objective
The students are supposed to acquire a deep understanding of the process of biological design including model representation of a biological system, its thorough analysis, and the subsequent experimental implementation of the system and the related problems. Presentations on advanced synthetic biology topics (e.g. genetic circuit design, adaptation of systems dynamics, analytical concepts, large scale de novo DNA synthesis), project selection, modeling of selected biological system, design space exploration, sensitivity analysis, conversion into DNA sequence, (DNA synthesis external) implementation and analysis of design, summary of results in form of scientific presentation and poster, presentation of results at the iGEM international student competition (www.igem.org).

Data: 06.02.2019 13:00 
Autumn Semester 2015 
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The final presentation of the project is typically at the MIT (Cambridge, US). Other competing schools include regularly Imperial College, Cambridge University, Harvard University, UC Berkeley, Princeton University, CalTech, etc.

This project takes place between end of Spring Semester and beginning of Autumn Semester. Registration in April.

Please note that the number of ECTS credits and the actual work load are disconnected.

### Other Elective Courses

These courses may be suitable for the Molecular Bioengineering track. Please consult your track advisor.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0313-00L</td>
<td>Microbiology (Part I)</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>W.D. Hardt, L. Eberl, H.M. Fischer, J. Piel, M. Pihler</td>
</tr>
<tr>
<td>Abstract</td>
<td>Advanced lecture class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.</td>
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<tr>
<td>Objective</td>
<td>This concept class will be based on common concepts (Grundlagen der Biologie IIb, Teil Mikrobiologie) and introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.</td>
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<tr>
<td>Content</td>
<td>Advanced class covering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.</td>
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<tr>
<td>Literature</td>
<td>Current literature references will be provided during the lectures.</td>
<td></td>
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<tr>
<td>Prerequisites / notice</td>
<td>The lecture &quot;Grundlagen der Biologie II: Mikrobiologie&quot; is the basis for this advanced lecture.</td>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>551-1103-00L</td>
<td>Microbial Biochemistry</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>J. Vorholt-Zambelli, T. J. Erb, J. Piel</td>
</tr>
<tr>
<td>Abstract</td>
<td>The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms. Emphasis is on processes that are specific to bacteria and archaea and that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest.</td>
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<tr>
<td>Objective</td>
<td>The lecture course aims at providing an advanced understanding of the physiology and metabolism of microorganisms.</td>
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<tr>
<td>Content</td>
<td>Important biochemical processes specific to bacteria and archaea will be presented that contribute to the widespread occurrence of prokaryotes. Applied aspects of microbial biochemistry will be pointed out as well as research fields of current scientific interest. Emphasis is on concepts of energy generation and assimilation.</td>
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<tr>
<td>Lecture notes</td>
<td>A script will be provided during the course.</td>
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</table>

### Biology Courses

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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0399-10L</td>
<td>Physiology and Anatomy for Biomedical Engineers I</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>H. Niemann</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course offers an introduction into the structure and function of the human body, and how these are interlinked with one another. Focusing on physiology, the visualization of anatomy is supported by 3D-animation, Computed Tomography and Magnetic Resonance imaging.</td>
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<tr>
<td>Objective</td>
<td>To understand basic principles and structure of the human body in consideration of the clinical relevance and the medical terminology used in medical work and research.</td>
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<tr>
<td>Content</td>
<td>- The human body: nomenclature, axes, planes, orientations - Musculoskeletal system, Muscle contraction - Blood, Blood vessels - Immune system and lymphoid organs - Heart - Cardiovascular system - Respiratory system - Acid-Base-Homeostasis - Physical work</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Lecture notes and handouts</td>
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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0945-00L</td>
<td>Cell and Molecular Biology for Engineers I</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>C. Frei</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course is part I of a two-semester course. The course gives an introduction into cellular and molecular biology, specifically for students with a background in engineering. The focus will be on the basic organization of eukaryotic cells, molecular mechanisms and cellular functions. Textbook knowledge will be combined with results from recent research and technological innovations in biology.</td>
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<tr>
<td>Objective</td>
<td>After completing this course, engineering students will be able to apply their previous training in the quantitative and physical sciences to modern biology. Students will also learn the principles how biological models are established, and how these models can be tested.</td>
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</tbody>
</table>
**ETH "Citation Etiquette", see www.plagiate.ethz.ch.**

**Biological Methods for Engineers (Basic Lab)**

The course during 4 afternoons covers basic laboratory skills and safety, cell culture, protein analysis, RNA/DNA Isolation and RT-PCR. 

**Type**

How to Write Scientific Texts in Engineering Sciences

**Hours**

* Topic 1: Structure of a Scientific Text (The Title, the author list, the abstract, State-of-the Art, the "in this paper" paragraph, the scientific part, the summary, Equations, Figures).

* Topic 2: Power Point Presentations.

* Topic 3: Citation Rules and Citation Software.

* Topic 4: Guidelines for Research Integrity.

**Literature**

ETH "Citation Etiquette", see www.plagiate.ethz.ch.


**Prerequisites / notice**

Students should already have a Bachelor degree and plan to do either a semester project or a master thesis in the immediate future.

**Semester Project**

**Number**

227-1101-00L

**Title**

How to Write Scientific Texts in Engineering Sciences 

Strangely recommended prerequisite for Semester Projects and Master Theses at D-ITET (MSc BME, MSc EEIT, MSc EST).

**ECTS**

0 credits

**Hours**

8 credits

**Lecturers**

J. Leuthold

**Abstract**

The 4 hour lecture covers the basics of writing & presenting a scientific text. The focus will be on the structure and elements of a scientific text and not on the language. Citation rules, good practice of scientific writing and an overview on software tools will be part of the training. The lecture will be thought on two afternoons. Some exercises will be lected into the lecture.

**Objective**

Knowledge on structure and content of a scientific text. The course further is arranged to stimulate a discussion on how to properly write a legible scientific text versus writing an interesting novel. We will further discuss the practice of properly citing and critically reflect on recent plagiarism allegations.

**Content**

* Topic 1: Structure of a Scientific Text (The Title, the author list, the abstract, State-of-the Art, the "in this paper" paragraph, the scientific part, the summary, Equations, Figures).

* Topic 2: Power Point Presentations.

* Topic 3: Citation Rules and Citation Software.

* Topic 4: Guidelines for Research Integrity.

**Literature**

ETH "Citation Etiquette", see www.plagiate.ethz.ch.


**Prerequisites / notice**

Students should already have a Bachelor degree and plan to do either a semester project or a master thesis in the immediate future.

**Master Thesis**

**Number**

227-1101-00L

**Title**

How to Write Scientific Texts in Engineering Sciences 

Strangely recommended prerequisite for Semester Projects and Master Theses at D-ITET (MSc BME, MSc EEIT, MSc EST).

**ECTS**

0 credits

**Hours**

8 credits

**Lecturers**

J. Leuthold

**Abstract**

The 4 hour lecture covers the basics of writing & presenting a scientific text. The focus will be on the structure and elements of a scientific text and not on the language. Citation rules, good practice of scientific writing and an overview on software tools will be part of the training. The lecture will be thought on two afternoons. Some exercises will be lected into the lecture.

**Objective**

Knowledge on structure and content of a scientific text. The course further is arranged to stimulate a discussion on how to properly write a legible scientific text versus writing an interesting novel. We will further discuss the practice of properly citing and critically reflect on recent plagiarism allegations.

**Content**

* Topic 1: Structure of a Scientific Text (The Title, the author list, the abstract, State-of-the Art, the "in this paper" paragraph, the scientific part, the summary, Equations, Figures).

* Topic 2: Power Point Presentations.

* Topic 3: Citation Rules and Citation Software.

* Topic 4: Guidelines for Research Integrity.

**Literature**

ETH "Citation Etiquette", see www.plagiate.ethz.ch.


**Prerequisites / notice**

Students should already have a Bachelor degree and plan to do either a semester project or a master thesis in the immediate future.
Admission only if all of the following apply:
a. bachelor program successfully completed;
b. successful completion of the track core courses, the biology laboratory and the seminar project;
c. acquired (if applicable) all credits from additional requirements for admission to master program.

Registration in mystudies required!

The masters program culminates in a six months research project which addresses a scientific research questions on one's chosen area of specialization. The masters thesis is supervised by a program-affiliated faculty member and the topic must be approved by the track advisor.

### Compulsory Electives in Humanities, Social and Political Sciences

- Recommended GESS compulsory elective courses (Type B) for D-ITET.
- see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability
- see GESS Compulsory Electives: Language Courses ETH/UZH

### Generally Accessible Seminars and Colloquia

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0970-00L</td>
<td>Research Topics in Biomedical Engineering</td>
<td>Z</td>
<td>0</td>
<td>2K</td>
<td>M. Rudin, S. Kozerke, K. P. Prüssmann, M. Stampanoni, K. Stephan, J. Vörds</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Current topics in Biomedical Engineering presented by speakers from academia and industry.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>Getting insight into actual areas and problems of Biomedical Engineering an Health Care.</td>
</tr>
<tr>
<td>227-0980-00L</td>
<td>Seminar on Biomedical Magnetic Resonance</td>
<td>Z</td>
<td>0</td>
<td>2K</td>
<td>K. P. Prüssmann, S. Kozerke, M. Rudin</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Actual developments and problems of magnetic resonance imaging (MRI)</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>Getting insight to advanced topics in Magnetic Resonance Imaging</td>
</tr>
</tbody>
</table>

### Biomedical Engineering Master - Key for Type

<table>
<thead>
<tr>
<th>Key for Type</th>
<th>Courses outside the curriculum</th>
<th>Suitable for doctorate</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Eligible for credits and recommended</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Suitable for doctorate</td>
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</table>

### Key for Hours

<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS** European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Bioinformatics Bachelor

#### Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>626-0002-00L</td>
<td>Bioinformatics</td>
<td>W+</td>
<td>6 credits</td>
<td>3G</td>
<td>J. Stelling, N. Beerenwinkel</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course introduces concepts of bioinformatics starting from first principles: DNA sequence alignment, phylogenetic tree inference, genome annotation, protein structure and function prediction. Key methods and algorithms are covered, including dynamic programming, Markov and Hidden Markov models, and molecular dynamics simulations. Practical applications and limitations are discussed.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>The course aims at introducing the fundamental concepts and methods of bioinformatics. Emphasis is given to a deep understanding of the methods' foundations and limitations to enable critical evaluations and applications of bioinformatics tools in areas such as biotechnology and systems biology.</td>
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</tr>
<tr>
<td>Content</td>
<td>Lecture topics: (1) Background: DNA, proteins, databases; (2-4) Sequence alignments, dynamic programming; (5-7) Evolutionary processes, Markov models, phylogenetic trees; (8-9) Genome characteristics, Hidden Markov models, genome annotation; (10-12) Protein structure and function, molecular modeling; (13) Outlook: genomics and proteomics.</td>
<td></td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Course material will be made available at: <a href="http://www.csb.ethz.ch">http://www.csb.ethz.ch</a></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literature</td>
<td>M. Zvelebil &amp; J.O. Baum, Understanding bioinformatics, Garland Science Textbooks, 2007</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td><a href="http://www.csb.ethz.ch/teaching">http://www.csb.ethz.ch/teaching</a></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>626-0005-00L</td>
<td>Mathematical Modelling in Systems Biology</td>
<td>W+</td>
<td>6 credits</td>
<td>3G</td>
<td>D. Iber</td>
</tr>
<tr>
<td>Abstract</td>
<td>Basic concepts and mathematical tools to explore biochemical reaction kinetics and biological network dynamics.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>The aim of the course is to provide an introductory overview of mathematical and computational methods to analyse biological network dynamics.</td>
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</tr>
</tbody>
</table>
| Content      | 1. Introduction to Mathematical Modeling  
2. Introduction to Biochemical Reaction Modeling  
3. Model Analysis: Phase Plane  
4. Model Analysis: Linear Stability Analysis  
5. Model Analysis: Bifurcation Analysis  
6. Regulatory Feedback: Switches  
7. Regulatory Feedback: Adaptation  
8. Regulatory Feedback: Oscillations and Delay Equations  
9. Receptor Signaling and Signaling Cascades  
10. Network Properties: Sensitivity and Robustness  
11. Introduction to Parameter Estimation |
- Keener and Sneyd, Mathematical Physiology, Springer  
- Klipp et al, Systems Biology in Practice, Wiley  
- Kreyszig, Engineering Mathematics, Wiley |
| Prerequisites / notice | Introductory courses in Mathematics (Linear Algebra, Differential Equations, Numerics) and basic concepts of programming. |
| 626-0007-00L | Microbial Biotechnology                     | W+   | 6 credits | 3V    | S. Panke |
| Abstract     | Introduction into the field of microbial biotechnology, covering possible products, fermentation and downstream technology. |
| Objective    | The student should be able to identify opportunities for microbial bioprocesses and to go through basic and advanced design procedures for microbial bioprocesses. |
| Content      | Students will obtain a thorough overview over microbial biotech products and the elements of bioprocess design: cellular growth and its modelling; mass transfer in fermentation; bioreaction engineering; bioreactors; downstream processing |
| Lecture notes| Handout in class |
| Literature   | eg Nielsen/Villadsen, Bioreaction Engineering Principles (Kluwer)  
ván’t Riet/Tramer: Basic bioreactor design  
Stephanopoulos/Aristidou/Nielsen: Metabolic Engineering  
Angeboten in: Biotech BSc, Biotech MSc, PE MSc |
| Prerequisites / notice | Prerequisites: Fundamentals in Chemistry and Biology (eg Bio-Engineering 151-0600-00) |
| 626-0001-00L | Microtechnology and Microelectronics       | W+   | 6 credits | 3G    | A. Hierlemann |
| Prerequisites: Physics I and Physics II highly recommended. |
| Abstract     | Students are introduced to the basics of semiconductors, microelectronics, microtechnology, and silicon process technology. They will get to know the fabrication of silicon-based microdevices and -systems by a sequence of defined batch processing steps as well as dedicated microfabrication processes. |
| Objective    | Students are introduced to the basics of semiconductors, microelectronics, microtechnology, and silicon process technology. They will get to know the different fabrication methods for various microdevices and systems. |
| Content      | Introduction to semiconductors, microelectronics, microtechnology, and micro electro mechanical systems (MEMS)  
Fundamentals of semiconductors  
Basics of microelectronics: transistor and diode.  
Silicon processing and fabrication steps  
Silicon crystal structure and manufacturing  
Thermal oxidation  
Doping via diffusion and ion implantation  
Photolithography  
Thin film deposition: dielectrics and metals  
Wet etching & bulk micromachining  
Dry etching & surface micromachining  
Micro electronics processing and fabrication sequence  
Packaging |
| Lecture notes| Handouts in English |
### Molecular Biology

**Abstract**
This lecture course gives an in-depth view into molecular mechanisms controlling basic biological processes, ranging from genetic regulatory networks to the internal functional organization of a cell to the signaling events controlling cells in their social context. In the tutorials and techniques used in molecular biology to solve problems in biotechnology and medicine are reviewed.

**Objective**
The goal is to achieve a high level knowledge of basic biological processes, to learn the methodology to tackle questions in molecular biology and to interpret experimental molecular data. Emphasis is given to cellular processes amenable to studies in systems and synthetic biology.

**Content**
The molecular biology of basic biological processes of a cell will be presented from the inside-out: in the nucleus the structure and function of the genetic material will be introduced, the compartmentalization of the cytoplasm and its ensuing specialization will be presented and the physiological activities of cellular populations through their signaling and interactions will be analyzed.

The course will be emphasize the logic of experimental design, the application of relevant methodology and equipment and of data analysis.

The following chapters will be discussed:

1. Chromosomes and Genomes
2. Control of gene expression
3. From gene sequence to biopharmaceuticals
4. Membrane structure and function
5. Intracellular compartments and protein sorting
6. Mechanisms of cell communication
7. The cytoskeleton, cell junctions and extracellular matrix
8. Cell cycle control
9. Development and apoptosis
10. Cancer
11. Tissue renewal and stem cells
12. Project planning and implementation

The tutorials are focused on state-of-the-art methods and techniques of molecular biology. Students are trained how to prepare an oral scientific presentation.

**Literature**

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### Interdisciplinary Biotechnology

**Abstract**
Interdisciplinary Biotechnology Seminar

**Objective**
To provide a common frame of reference for all novel biotechnology students who have come to Basel.

**Content**
An overview of the scope of the 3rd year Biotechnology BSc.

**Lecture notes**
Hands out during the course.

**Prerequisites / notice**
Block course (Tuesday afternoon to Friday evening) at the beginning of the fall semester.

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### Nanomachines of the Cell (Part I): Principles

**Abstract**
Molecular biotechnology students will combine basic knowledge in molecular cell biology, biochemistry, proteomics, biophysics, bioinformatics, bionanotechnology and engineering to learn how the nanomachines of the cell works and to use this knowledge to address future molecular biotechnological and bionanotechnological questions. Particularly it will be addressed how biomolecular units can be char

**Objective**
Gain of an interdisciplinary research and development competence, which qualifies for scientific work (master's or doctoral thesis) as well as for work in the research and development department of a biotechnological company. The module is of general use in nano- and biotechnological courses of study focusing modern biomolecular technologies.


**Content**

What are nanomachines of the cell? Understanding the cell as a complex factory. Are there engineering principles of the cell and if so what can we learn? Introducing new ways to understand and to apply engineering principles of cellular nanomachines in biotechnology and nanotechnology.


Designing molecular compounds that stabilize specific proteins. Designing molecular compounds that lead to protein destabilization, misfolding and denaturation.


Energy currencies of the cell. Energy conversion. Storable and transient forms of energy. Nature created a variety of light-driven ion pumps. How can we use this pumps, how can we modify them to our purpose? Employing light-driven ion pumps in biotechnology.

Employing light-driven proton pumps adsorbing different wavelengths to boost the membrane gradient. How to create a synthetic membrane that allows no diffusion of ions. Transforming a proton into a chloride pump. Tuning the adsorption spectra of a light-driven ion pump. Engineering proton pumps as safety standards for credit cards and ID cards. Engineering proton pumps for holographic devices. Natvie and artificial light-activated ion channels. Engineering light-activated channels for their use in neuroscience: Optogenetics. ATP synthases convert transient into storable energies. Experimental approaches to explore the nanoscopic rotary machinery of single ATP synthases. Are there ways to engineer and to exchange the building blocks of the ATP synthase? Ways to change to gear of ATP synthases and to tune its fuel consumption. Engineering an artificial vesicular system to convert light into ion gradients to synthetize ATP. Engineering ATP synthases as nanopropellers to move vesicles. Engineering a light-frequency tuned proton pumps to control the speed of nanopropelled vesicles. Engineering light-driven ion pumps to power the synthetic ATP propellers and to steer vesicles. Engineering and employing ATP synthases as molecular mixing devices. Principles of signal transduction. The family of G-protein coupled receptors (GPCRs). Structure and function of GPCRs. Engineering (and other) possibilities to manipulate the functional state of GPCRs.

Lecture notes

Hand out will be given to students at lecture.

Literature

Handouts will be given to students at lecture.

Prerequisites / notice

The module is composed of 3 SWS (3 hours/week): 2-hour lecture, 1-hour seminar. For the seminar, students prepare oral presentations on specific in-depth subjects with/under the guidance of the lecturer.

**Electives**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>626-0501-00L</td>
<td>Analytical Chemistry I: Structure Determination</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>external organisers</td>
</tr>
<tr>
<td>626-0503-00L</td>
<td>Biological Chemistry, Metabolism</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>external organisers</td>
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<tr>
<td>626-0505-00L</td>
<td>Macromolecules, Basics in Genetic and Gene-Expressions</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>external organisers</td>
</tr>
<tr>
<td>626-0509-00L</td>
<td>Introduction to Nano Sciences</td>
<td>W</td>
<td>1</td>
<td>1V</td>
<td>external organisers</td>
</tr>
<tr>
<td>626-0511-00L</td>
<td>Programming I</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>external organisers</td>
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</table>

**626-0513-00L Scientific Calculation**

<table>
<thead>
<tr>
<th>626-0011-00L</th>
<th>Linear Algebra with Applications to Systems Biology</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>W</strong></td>
<td>6 credits</td>
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<tr>
<td><strong>3G</strong></td>
<td></td>
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<tr>
<td><strong>6 credits</strong></td>
<td></td>
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<tr>
<td><strong>3G</strong></td>
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<tr>
<td>M. H. Khammash</td>
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</tbody>
</table>

**Abstract**

The course presents concepts and tools from linear algebra and linear programming together with applications to systems biology. The course builds on freshman courses Mathematical Foundations: Mathematical Analysis I and II.

**Objective**

To give the student a solid background in the theory and applications of linear algebra and linear programming with particular emphasis and motivating examples from systems biology.

**Content**

Matrices and inverses; LU factorization; subspaces; null space; independence; basis; dimension; rank; orthogonality and projections; eigenvalues and eigenvectors; diagonalization; positive definite matrices; SVD; linear programs; application to metabolic reaction networks will be integrated throughout the course.

**Literature**

Introduction to Linear Algebra, Fourth Edition, William Strang

Linear and nonlinear programming, David Leunberger

**Laboratory Courses**

The laboratory courses will be offered in spring semester only.

**Compulsory Electives in Humanities, Social and Political Sciences**

The Compulsory Electives in Humanities, Social and Political Sciences can be attended at the University of Basel (Faculty of Humanities as well as Faculty of Business and Economics) and/or at the University of Zürich.

**Biotechnology Bachelor - Key for Type**

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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</table>

**Key for Hours**

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
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<td>R</td>
<td>revision course / private study</td>
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</table>

**ECTS**

European Credit Transfer and Accumulation System

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**Biotechnology Master**

**Majors**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>636-0001-00L</td>
<td>Separations in Biotechnology and Bioprocess Economy</td>
<td>W+</td>
<td>6 credits</td>
<td>3G</td>
<td>S. Panke</td>
</tr>
</tbody>
</table>

**Abstract**

Separations play an integral part of any biotechnological process. This course aims at enabling students specifically with a chemistry/biology background to select & roughly design suitable separation processes for typical biotechnological products such as monoclonal antibodies, antibiotics, and fine chemicals and at providing a basic set of purification operations & judge on process economy.

**Objective**

Students should be able to select for a given biotechnological product a suitable set of purification operations and judge on process economy.

**Content**

Introduction membrane operations adsorption and chromatography crystallization overall process economics

**Lecture notes**

Handouts during course

<table>
<thead>
<tr>
<th>Number</th>
<th>Biological Engineering and Biotechnology</th>
<th>W+</th>
<th>6 credits</th>
<th>3V</th>
<th>M. Fussenegger</th>
</tr>
</thead>
</table>

**Abstract**

Biological Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutic from target to market.

**Objective**

1. Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical Manufacturing.
2. The Licence To Kill. Apoptosis Regulatory Networks - Engineering of Survival Pathways To Increase Robustness of Production Cell Lines.
5. From Target To Market. An Antibody's Journey From Cell Culture to The Clinics.
6. Biology and Malign Applications. Do Life Sciences Enable the Development of Biological Weapons?
7. Functional Food. Enjoy your Meal!

**Lecture notes**

Handouts during course.

<table>
<thead>
<tr>
<th>Number</th>
<th>Systems Biology</th>
<th>W+</th>
<th>6 credits</th>
<th>3G</th>
<th>R. Paro, N. Beerewinkel</th>
</tr>
</thead>
</table>

**Abstract**

This lecture course is an introduction to systems biology. It explores how complex biological networks are experimentally studied and how the resulting data is mathematically evaluated in order to derive predictive models. The biology of selected cellular processes, ranging from protein interaction networks to gene controlling systems and signaling cascades will be discussed in detail.

**Objective**

The goal of this course is to learn how a detailed quantitative description of complex biological processes can be employed for a better understanding of molecular interactions, the power and efficiency of regulatory networks, and the evolution of biological complexity. Students will learn how to identify techniques producing quantitative data and how to develop mathematical models and efficient statistical inference algorithms to recognize patterns, molecular interrelationships and systems behavior.

**Content**

Sessions will alternate between a thorough introduction into the basic biology of defined cellular processes and a corresponding mathematical and statistical analysis of the experimental data. Selected complex biological systems and the respective experimental tools for a quantitative analysis will be presented. Examples include the identification of protein interaction networks required for specific physiological processes in yeast based on graph theoretic methods, including the identification of network motifs and the global statistical analysis of graph properties (power laws); the comparative analysis of gene expressions data from cancer and normal cells involving data normalization techniques, multiple testing procedures, clustering algorithms, Bayesian networks, and linear dynamical systems; the definition of hierarchies of kinase signaling cascades employing Bayesian networks and their causal interpretation and nested effects models for the analysis of perturbed systems; analysis of deep sequencing data derived from studies of chromatin control and gene expression.

**Topics:**

- Control of Gene Expression: DNA binding proteins, gene activation in chromatin, posttranscriptional control
- Genetic Switches: combinatorial gene control, transcriptional circuits, transcriptional noise/robustness
- Analysis of Gene Expression Data: normalization, differential gene expression, multiple testing, PCA, clustering
- Large-scale Genomic Profiling: mapping genomes/epigenomes, high throughput sequencing technologies
- Analysis of Deep Sequencing Data: quality control, genome assembly, read mapping, RNA-seq, ChIP-seq
- Biological Networks: signaling networks and protein-protein interaction networks
- Network Biology: basic graph theory, motifs, dense subgraphs, power laws
- Boolean Network Dynamics: Boolean algebra, Boolean networks, random Boolean networks, yeast cell cycle
- Cellular Communication: signal transduction cascades, regulatory mechanisms
- Probabilistic Graphical Models: probabilities, statistical inference, Bayesian networks, nested effects models
- Evolutionary Mechanisms: RNA world, origin of life, ribozyme selection, genome evolution, SNP mapping, evolution & development
- Genome-wide association studies

**Lecture notes**

The Powerpoint presentations of the lectures as well as other course material relevant for an active participation will be made available online.

**Literature**


<table>
<thead>
<tr>
<th>Number</th>
<th>Introduction to Biological Computers</th>
<th>W+</th>
<th>6 credits</th>
<th>3G</th>
<th>Y. Benenson</th>
</tr>
</thead>
</table>

**Prerequisites:** Synthetic Biology I (636-0002-00 L). Basic knowledge of molecular biology is assumed.
Abstract

Biological computers are man-made biological networks that interrogate and control biological hosts-cells and organisms-in which they operate. Their key features, inspired by computer science, are programmability, modularity and versatility. The course will show how to rationally design, implement and test biological computers using molecular engineering, DNA nanothechnology and synthetic biology.

Objective

The course has the following objectives:

* Familiarize students with parallels between theories in computer science and engineering and information-processing in live cells and organisms

* Introduce basic theories of computation

* Introduce approaches to creating novel biological computing systems in non-living environment and in living cells including bacteria, yeast and mammalian/human cells.

The covered approaches will include
- Nucleic acids engineering
- DNA and RNA nanotechnology
- Synthetic biology and gene circuit engineering
- High-throughput genome engineering and gene circuit assembly

* Equip the students with computer-aided design (CAD) tools for biocomputing circuit engineering. A number of tutorials will introduce MATLAB SimBiology toolbox for circuit design and simulations

* Foster creativity, research and communication skills through semester-long "Design challenge" assignment in the broad field of biological computing and biological circuit engineering.
Note: the exact subjects can change, the details below should only serve for general orientation

Lecture 1. Introduction: what is molecular computation (part I)?

* What is computing in general?
* What is computing in the biological context (examples from development, chemotaxis and gene regulation)
* The difference between natural computing and engineered biocomputing systems

Lecture 2: What is molecular computation (part II) + State machines

1st hour

* Detailed definition of an engineered biocomputing system
* Basics of characterization
* Design challenge presentation

2nd hour

* Theories of computation: state machines (finite automata and Turing machines)

Lecture 3: Additional models of computation

* Logic circuits
* Analog circuits
* RAM machines

Basic approaches to computer science notions relevant to molecular computation. (i) State machines; (ii) Boolean networks; (iii) analog computing; (iv) distributed computing. Design Challenge presentation.

Lecture 4. Classical DNA computing

* Adleman experiment
* Maximal clique problem
* SAT problem

Lecture 5: Molecular State machines through self-assembly

* Tiling implementation of state machine
* DNA-based tiling system
* DNA/RNA origami as a spin-off of self-assembling state machines

Lecture 6: Molecular State machines that use DNA-encoded tapes

* Early theoretical work
* Tape extension system
* DNA and enzyme-based finite automata for diagnostic applications

Lecture 7: Introduction to cell-based logic and analog circuits

* Computing with (bio)chemical reaction networks
* Turing computation with ultrasensitivity and cooperativity
* Specific examples

Lecture 8: Transcriptional circuits I

* Introducing transcription-based circuits
* General features and considerations
* Guidelines for large circuit construction

Lecture 9: Transcriptional circuits II

* Large-scale distributed logic circuits in bacteria
* Toward large-scale circuits in mammalian cells

Lecture 10: RNA circuits I

* General principles of RNA-centered circuit design
* Riboswitches and sRNA regulation in bacteria
* Riboswitches in yeast and mammalian cells
* General approach to RNAi-based computing

Lecture 11: RNA circuits II

* RNAi logic circuits
* RNAi-based cell type classifiers
* Hybrid transcriptional/posttranscriptional approaches

Lecture 12: In vitro DNA-based logic circuits

* DNAzyme circuits playing tic-tac-toe against human opponents
* DNA brain

Lecture 13: Advanced topics

* Engineered cellular memory
* Counting and sequential logic
* The role of evolution
* Fail-safe design principles
The goal of this course is that the participants gain an understanding of data mining problems and algorithms to solve these problems, in particular in biological and medical applications. Data Mining, the search for statistical dependencies in large databases, is of utmost important in modern society, in particular in biological and medical research. This course provides an introduction to the key problems, concepts, and algorithms in data mining, and the applications of data mining in computational biology.

### Abstract

Data Mining, the search for statistical dependencies in large databases, is of utmost important in modern society, in particular in biological and medical research. This course provides an introduction to the key problems, concepts, and algorithms in data mining, and the applications of data mining in computational biology.

### Objective

The goal of this course is that the participants gain an understanding of data mining problems and algorithms to solve these problems, in particular in biological and medical applications.

### Content

The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology. The class covers separation techniques that are central in the purification and downstream processing of chemicals and biopharmaceuticals. Examples from both areas illustrate the utility of the methods: 1) Liquid-liquid extraction; 2) Adsorption and chromatography; 3) Membrane processes; 4) Crystallization and precipitation.

### Literature


### Prerequisites / notice

Compulsory attendance of (at least) 12 of 14 lectures. In addition, it is recommended that students take 636-0002-00 Synthetic Biology I prior to attending this course. Basic knowledge of molecular biology is assumed.

### Electives

The MSc Electives will be held in Zürich or Basel

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0927-00L</td>
<td>Rate-Controlled Separations in Fine Chemistry</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>M. Mazzotti</td>
</tr>
</tbody>
</table>

### Lecture notes

Handouts during the class

### Content

- Cells are central in tissue regeneration and repair, and hold great potential for therapy. We will discuss the role of stem cells in health and disease, and possibilities to manipulate their behavior for therapeutic application. Basic molecular and cell biology, engineering and novel technologies relevant for stem cell research and therapy will be discussed.

- Understanding of current knowledge, and lack thereof, in stem cell biology, regenerative medicine and required technologies. Theoretical preparation for the practical laboratory experimentation with stem cells.

- We will use different diseases to discuss how to potentially model, diagnose or heal them by stem cell based therapies. This will be used as a guiding framework to discuss relevant concepts and technologies in cell and molecular biology, engineering, imaging, bioinformatics, tissue engineering, that are required to manipulate stem cells for therapeutic application.

### Topics

- Embryonic and adult stem cells and their niches
- Induced stem cells by directed reprogramming
- Cancer stem cells
- Relevant basic cell biology and developmental biology
- Relevant molecular biology
- Cell culture systems
- Cell fates and their molecular control by transcription factors and signalling pathways
- Cell reprogramming
- Disease modelling
- Tissue engineering
- Bioimaging, Bioinformatics
- Single cell technologies

### Tentative list of topics:

1. Classification
2. Clustering
3. Feature Selection
4. Text Mining
5. Association Rule Mining
6. Transductive Learning
7. Graph Mining

### Lecture notes

Course material will be provided in form of slides.

### Literature

Will be provided during the course.

### Basic understanding of mathematics, as taught in basic mathematics courses at the Bachelor's level.
Literature Recommendations for textbook books will be covered in the class

<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirements: Thermal separation Processes I (151-0926-00) and Modelling and mathematical methods in process and chemical engineering (151-0940-00)</td>
</tr>
</tbody>
</table>

### 363-0389-00L Technology and Innovation Management

**W** 3 credits  **2G**  **S. Brusoni**

#### Abstract
This course focuses on the analysis of innovation as a pervasive process that cuts across organizational and functional boundaries. It looks at the sources of innovation, at the tools and techniques that organizations deploy to routinely innovate, and the strategic implications of technical change.

#### Objective
This course intends to enable all students to:
- understand the core concepts necessary to analyze how innovation happens
- master the most common methods and tools organizations deploy to innovate
- develop the ability to critically evaluate the innovation process, and act upon the main obstacles to innovation

#### Content
This course looks at technology and innovation management as a process. Continuously, organizations are faced with a fundamental decision: they have to allocate resources between well-known tasks that reliably generate positive results; or explore new ways of doing things, new technologies, products and services. The latter is a high risk choice. Its rewards can be high, but the chances of success is small.

How do firms organize to take these decisions? What kind of management skills are necessary to take them? What kind of tools and methods are deployed to sustain managerial decision-making in highly volatile environments? These are the central questions on which this course focuses, relying on a combination of lectures, case-based discussion, guest speakers, simulations and group work.

**Lecture notes** Slides will be available on the TIMGROUP website.
**Literature** Readings will be available on the TIMGROUP website.
**Prerequisites / notice** No specific background in economics or management is required.

### 376-1714-00L Biocompatible Materials

**W** 4 credits  **3G**  **K. Maniura, J. Möller, M. Zenobi-Wong**

#### Abstract
Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

#### Objective
The class consists of three parts:
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

#### Content
Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

**Lecture notes** Handouts can be accessed online.
**Literature**
  (available online via ETH library)

Handouts provided during the classes and references therein.

### 529-0733-00L Enzymes

**W** 7 credits  **3G**  **D. Hilvert**

#### Abstract
Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

#### Objective
Overview of enzymes, enzyme-catalyzed reactions and metabolic processes.

#### Content
Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

**Lecture notes** A script will not be handed out.
**Literature** General:

In addition, citations from the original literature relevant to the individual lectures will be assigned weekly.

### 529-0837-00L Microfluidics Engineering

**W** 7 credits  **3G**  **A. de Mello**

#### Abstract
Microfluidics describes the behaviour, control and manipulation of fluids that are geometrically constrained within sub-microliter environments. The use of microfluidic devices offers an opportunity to control physical and chemical processes with unrivalled precision, and in turn provides a route to performing chemistry and biology in an ultra-fast and high-efficiency manner.

#### Objective
In the course students will investigate the theoretical concepts behind microfluidic device operation, the methods of microfluidic device manufacture and the application of microfluidic architectures to important problems faced in modern day chemical and biological analysis. A design workshop will allow students to develop new microscale flow processes by appreciating the dominant physics at the microscale. The application of these basic ideas will primarily focus on biological problems and will include a treatment of diagnostic devices for use at the point-of-care, advanced functional material synthesis, DNA analysis, proteomics and cell-based assays. Lectures, assignments and the design workshop will acquaint students with the state-of-the-art in applied microfluidics.
Specific topics in the course include, but not limited to:

1. Theoretical Concepts
   - Features of mass and thermal transport on the microscale
   - Key scaling laws
2. Microfluidic Device Manufacture
3. Conventional lithographic processing of rigid materials
4. Soft lithographic processing of plastics and polymers
5. Mass fabrication of polymeric devices
6. Unit operations and functional components
7. Analytical separations (electrophoresis and chromatography)
8. Chemical and biological synthesis
9. Sample pre-treatment (filtration, SPE, pre-concentration)
10. Molecular detection

Design Workshop
- Design of microfluidic architectures for PCR, distillation & mixing
- Design of microfluidic devices for PCR, distillation & mixing
- Design of microfluidic devices for PCR, distillation & mixing

The students dispose of an overview on current principles and systems for the controlled delivery and targeting of drugs. The focus of the course lies on developing a capacity to understand the involved technologies and methods, as well as an appreciation of the chances and constraints of their therapeutic usage, with prime attention on anticancer drugs, therapeutic peptides, proteins, nucleic acids and vaccines.

- the role of glycans in infectious disease, 5) the role of glycans in infectious disease.
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The website also displays additional information on peroral delivery systems, transdermal systems and systems for alternative routes (nasal, pulmonary) of delivery. These fields are covered in detail in the course Galenische Pharmazie II (Galenical Pharmacy II).

Further references will be provided in the course.

Lecture notes
- Lecture handouts, background literature, problem sheets and notes will be provided electronically.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>Type</th>
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<tbody>
<tr>
<td>535-0030-00L</td>
<td>Therapeutic Proteins</td>
<td>3</td>
<td>G</td>
</tr>
<tr>
<td>535-0423-00L</td>
<td>Drug Delivery and Drug Targeting</td>
<td>2</td>
<td>V</td>
</tr>
<tr>
<td>551-1105-00L</td>
<td>Glycobiology</td>
<td>4</td>
<td>V</td>
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</table>

Abstract
- In this course, various topics related to the development, GMP production and application of therapeutic proteins will be discussed. Furthermore, students will expand their training in pharmaceutical immunology and will be introduced to the basic concepts of pharmaceutical product quality management.
- The course consists of two parts:
- The first part focuses on the development and application of therapeutic proteins, such as protein expression, protein engineering, reducing immunogenicity, and GMP production of therapeutic proteins. Furthermore, selected examples of approved therapeutic proteins will be discussed.

Objective
- Students know and understand:
  - basic mechanisms and regulation of the immune response
  - the pathogenic mechanisms of the most important immune-mediated disorders
  - the most frequently used expression systems for the production of therapeutic proteins
  - the use of protein engineering tools for modifying different features of therapeutic proteins
  - the mechanism of action of selected therapeutic proteins and their application
  - basic concepts in the GMP production of therapeutic proteins

Content
- The course covers the following topics:
  - drug targeting and delivery principles, radiopharmaceuticals, macromolecular drug carriers, liposomes, micelles, micro/nanoparticles, gels and implants, administration of vaccines, delivery of active agents in tissue engineering, targeting at the gastrointestinal level, synthetic carriers for nucleic acid drugs, ophthalmic devices and novel trends in transdermal and nasal drug delivery.

Literature
- Chapters 13-16 of the Immunobiology VIII book (Janeway et al.)
- Lecture Handouts
- Paper References provided in the Scripts
- EMEA Dossier for Humira

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<td>V</td>
</tr>
</tbody>
</table>

Abstract
- The students gain an overview on current principles, methodologies and systems for controlled delivery and targeting of drugs. This enables the students to understand and evaluate the field in terms of scientific criteria.
- The students dispose of an overview on current principles and systems for the controlled delivery and targeting of drugs. The focus of the course lies on developing a capacity to understand the involved technologies and methods, as well as an appreciation of the chances and constraints of their therapeutic usage, with prime attention on anticancer drugs, therapeutic peptides, proteins, nucleic acids and vaccines.

Objective
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  - drug targeting and delivery principles, radiopharmaceuticals, macromolecular drug carriers, liposomes, micelles, micro/nanoparticles, gels and implants, administration of vaccines, delivery of active agents in tissue engineering, targeting at the gastrointestinal level, synthetic carriers for nucleic acid drugs, ophthalmic devices and novel trends in transdermal and nasal drug delivery.

Content
- The course covers the following topics:
  - drug targeting and delivery principles, radiopharmaceuticals, macromolecular drug carriers, liposomes, micelles, micro/nanoparticles, gels and implants, administration of vaccines, delivery of active agents in tissue engineering, targeting at the gastrointestinal level, synthetic carriers for nucleic acid drugs, ophthalmic devices and novel trends in transdermal and nasal drug delivery.

Literature
- Selected lecture notes, documents and supporting material will be directly provided or may be downloaded using
  - The website also displays additional information on peroral delivery systems, transdermal systems and systems for alternative routes (nasal, pulmonary) of delivery. These fields are covered in detail in the course Galenische Pharmazie II (Galenical Pharmacy II).

Further references will be provided in the course.
The students are supposed to acquire a deep understanding of the process of biological design including model representation of a biological system, its thorough analysis, and the subsequent experimental implementation of the system and the related problems. Results are presented at an international student competition at the MIT (Cambridge).

Abstract
The goal of this course is to understand and to appreciate mathematical models and computational methods that provide insight into the evolutionary process. Evolution is the one theory that encompasses all of biology. It provides a single, unifying concept to understand the living systems that we observe today. We will introduce several types of mathematical models of evolution to describe gene frequency changes over time in the context of different biological systems, focusing on asexual populations. Viruses and cancer cells provide the most prominent examples of such systems and they are at the same time of great biomedical interest. The course will cover some classical mathematical population genetics and population dynamics, and also introduce several new approaches. This is reflected in a diverse set of mathematical concepts which make their appearance throughout the course, all of which are introduced from scratch. Topics covered include the quasispecies equation, evolution of HIV, evolutionary game theory, birth-death processes, evolutionary stability, evolutionary graph theory, somatic evolution of cancer, stochastic tunneling, cell differentiation, hematopoietic tumor stem cells, genetic progression of cancer and the speed of adaptation, diffusion theory, fitness landscapes, neutral networks, branching processes, evolutionary escape, and epistasis.

Objective
The final presentation of the project is typically at the MIT (Cambridge, US). Other competing schools include regularly Imperial College, Cambridge University, Harvard University, UC Berkeley, Princeton University, CalTech, etc.

This project takes place between end of Spring Semester and beginning of Autumn Semester. Registration in April.

Please note that the number of ECTS credits and the actual work load are disconnected.

The focus of this first part of the lecture will be on the organisms, but also on the factors which determine spoilage and foodborne disease. and spoilage organisms.

The students are supposed to acquire a deep understanding of the process of biological design including model representation of a biological system, its thorough analysis, and the subsequent experimental implementation of the system and the related problems. Results are presented at an international student competition at the MIT (Cambridge).

Abstract
Evolutionary dynamics is concerned with the mathematical principles according to which life has evolved. This course offers an introduction to mathematical modeling of evolution, including deterministic and stochastic models.

The goal of this course is to understand and to appreciate mathematical models and computational methods that provide insight into the evolutionary process.

Evolution is the one theory that encompasses all of biology. It provides a single, unifying concept to understand the living systems that we observe today. We will introduce several types of mathematical models of evolution to describe gene frequency changes over time in the context of different biological systems, focusing on asexual populations. Viruses and cancer cells provide the most prominent examples of such systems and they are at the same time of great biomedical interest. The course will cover some classical mathematical population genetics and population dynamics, and also introduce several new approaches. This is reflected in a diverse set of mathematical concepts which make their appearance throughout the course, all of which are introduced from scratch. Topics covered include the quasispecies equation, evolution of HIV, evolutionary game theory, birth-death processes, evolutionary stability, evolutionary graph theory, somatic evolution of cancer, stochastic tunneling, cell differentiation, hematopoietic tumor stem cells, genetic progression of cancer and the speed of adaptation, diffusion theory, fitness landscapes, neutral networks, branching processes, evolutionary escape, and epistasis.

The final presentation of the project is typically at the MIT (Cambridge, US). Other competing schools include regularly Imperial College, Cambridge University, Harvard University, UC Berkeley, Princeton University, CalTech, etc.

Please note that the number of ECTS credits and the actual work load are disconnected.

The focus of this first part of the lecture will be on the organisms, but also on the factors which determine spoilage and foodborne disease.
1. **History of Food Microbiology**
   - Short synopsis of foodborne microorganisms
   - Spoilage of Foods
   - Foodborne Disease
   - Food Preservation
   - VIPs of Food Microbiology

2. **Overview of Microorganisms in Foods**
   - Origin of foodborne Microorganisms
   - Bacteria
   - Yeasts
   - Molds
   - Microbial Spoilage of Foods

3. **Intrinsic and Extrinsic Parameters**
   - Intrinsic and Extrinsic Parameters
   - Meats, Seafoods, Eggs
   - Milk and Milk Products
   - Vegetable and Fruit Products
   - Miscellaneous (baked goods, nuts, spices, ready-to-eat products)
   - Drinks and Canned Foods

4. **Foodborne Disease**
   - Significance and Transmission of Foodborne pathogens
   - Staphylococcus aureus
   - Gram-positive Sporeformers (Bacillus & Clostridium)
   - Listeria monocytogenes
   - Salmonella, Shigella, Escherichia coli
   - Vibrio, Yersinia, Campylobacter
   - Brucella, Mycobacterium, Aeromonas, Plesiomonas
   - Parasites
   - Viruses and Bacteriophages
   - Mycotoxins
   - Bioactive Amines
   - Miscellaneous (Antibiotic-resistant Bacteria, Biofilms)

5. **Markov chains**
   - Transition functions and related computations
   - Classification of states and classification of chains

6. **Stochastic Processes**
   - Existence and Construction
   - Stationary Processes
   - Renewal Processes
   - Wiener Process
   - Ergodic Theorem

7. **Introduction to the theory of Martingales**
   - Basic definitions
   - Martingale differences
   - Hoeffding's inequality
   - Martingale Convergence Theorem
   - Crossings and convergence
   - Stopping times and conditional independence

**Literature**

- While no specific textbook will be followed, much of the material and homework problems will be taken from the following books:

**Prerequisites / notice**

The course will involve a healthy balance between mathematical rigor (theorem proving) and biological applications. Students are expected to have a good grasp of Linear Algebra and Multivariable Calculus. Basic knowledge of set theory will also be needed. Students should be prepared for abstract reasoning.

**Content**

1. The mathematical representation of random phenomena: The probability space, properties of the probability measure, Independence of events, Conditional probability and Bayes formula, applications to parameter inference.


3. Convergence of Random Variables: Modes of convergence, Laws of large numbers, the central limit theorem, the law of the iterated logarithm, Applications to the analysis of cell population data.


**Abstract**

Biology is becoming increasingly quantitative and mathematical modelling is now an integral part of biological research. In many biological processes, ranging from gene-expression to evolution, randomness plays an important role that can only be understood using stochastic models. This course will provide the students with a theoretical foundation for developing such stochastic models and analyzing reading based on their research interests.

The aim of this course is to introduce certain topics in Probability Theory and Stochastic Processes that have been specifically selected with an eye on biological applications. This course will teach students the tools and techniques for modeling and analyzing random phenomena. Throughout the course, several biological applications will be discussed and students will be encouraged to do additional reading based on their research interests.

The first half of the course will cover the basics of Probability Theory while the second half will delve into the theory of Stochastic Processes. Below is the list of topics that will be covered in the course.

1. The mathematical representation of random phenomena: The probability space, properties of the probability measure, Independence of events, Conditional probability and Bayes formula, applications to parameter inference.


3. Convergence of Random Variables: Modes of convergence, Laws of large numbers, the central limit theorem, the law of the iterated logarithm, Applications to the analysis of cell population data.


Objective
Attendees will learn what information is contained in genetic sequencing data and how this information is extracted from the sequencing data. The main concepts introduced are:
* models in molecular evolution
* phylogenetic & phylodynamic inference
* maximum likelihood and Bayesian statistics
* stochastic processes
Attendees will apply these concepts to a number of applications yielding biological insight into:
* epidemiology
* pathogen evolution
* macroevolution of species

Content
The course consists of three parts. We first introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Second, we employ these evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades.

Lecture notes
Slides of the lecture will be available online.

Literature
The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:
* Yang, Z. 2006. Computational Molecular Evolution.
* Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST.

Prerequisites / notice
Basic knowledge in linear algebra, analysis, and statistics.

Research Project

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>636-0801-00L</td>
<td>Research Project</td>
<td>O</td>
<td>20</td>
<td>46A</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Abstract
In a research project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic. Research projects are carried out in a core or optional subject area as chosen by the student.

Objective
Students get acquainted with scientific working methods and deepen their knowledge in a particular research area.

Master Thesis

<table>
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<tr>
<th>Number</th>
<th>Title</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>636-0900-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>40</td>
<td>91D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract
In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is carried out under the supervision of a professor in a research group of the D-BSSE, usually at the D-BSSE. Students are free to choose the area.

Objective
In the Master Thesis students prove their ability to independent, structured and scientific working.

Compulsory Electives in Humanities, Social and Political Sciences

The Compulsory Electives in Humanities, Social and Political Sciences can be attended at the University of Basel and/or at the University of Zürich.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Seminars, Colloquia and Additional Courses

The credit points of the here listed subjects won't be taken in account for the MSc programm.

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</table>

Abstract
This seminar will feature invited lectures about recent advances and developments in systems biology, including topics from biology, bioengineering, and computational biology.

Objective
To provide an overview of current systems biology research.

Content
The final list of topics will be available at http://www.bsse.ethz.ch/education/.

Biotechnology Master - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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</table>
### Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
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<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
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</table>

**ECTS**  European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
Certificate of Advanced Studies in Computer Science

Compulsory Major Courses

Neither credits can be obtained from entrance exams nor credited to the Certificate programme.

The lecture 151-0107-00L High Performance Computing for Science and Engineering I in the autumn semester can only together with the lecture 401-0886-10L High Performance Computing for Science and Engineering II in the spring semester be accredited as compulsory major course.

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<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>252-0206-00L</td>
<td>Visual Computing</td>
<td>W</td>
<td>8</td>
<td>4V+3U</td>
<td>M. Gross, M. Pollefeys</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course acquaints students with core knowledge in computer graphics, image processing, multimedia and computer vision. Topics include: Graphics pipeline, perception and camera models, transformation, shading, global illumination, texturing, sampling, filtering, image representations, image and video compression, edge detection and optical flow.</td>
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<tr>
<td>Objective</td>
<td>This course provides an in-depth introduction to the core concepts of computer graphics, image processing, multimedia and computer vision. The course forms a basis for the specialization track Visual Computing of the CS master program at ETH.</td>
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<tr>
<td>Content</td>
<td>Course topics will include: Graphics pipeline, perception and color models, camera models, transformations and projection, projections, image shading, global illumination, texture, sampling theory, image transforms, image representations, convolution, linear filtering, diffusion, nonlinear filtering, edge detection, optical flow, image and video compression.</td>
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<tr>
<td>Lecture notes</td>
<td>In theoretical and practical homework assignments students will learn to apply and implement the presented concepts and algorithms.</td>
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<tr>
<td>Literature</td>
<td>A scriptum will be handed out for a part of the course. Copies of the slides will be available for download. We will also provide a detailed list of references and textbooks.</td>
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<tr>
<td>252-0209-00L</td>
<td>Algorithms, Probability, and Computing</td>
<td>W</td>
<td>8</td>
<td>4V+2U+1A</td>
<td>E. Welzl, T. Holenstein, A. Steger</td>
</tr>
<tr>
<td>Abstract</td>
<td>Advanced design and analysis methods for algorithms and data structures: Random(ized) Search Trees, Point Location, Minimum Cut, Linear Programming, Randomized Algebraic Algorithms (matchings), Probabilistically Checkable Proofs (introduction).</td>
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<tr>
<td>Objective</td>
<td>Studying and understanding of fundamental advanced concepts in algorithms, data structures and complexity theory.</td>
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<td>Lecture notes</td>
<td>Will be handed out.</td>
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<tr>
<td>252-0210-00L</td>
<td>Compiler Design</td>
<td>W</td>
<td>8</td>
<td>4V+3U</td>
<td>T. Gross</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course uses compilers as example to expose modern software development techniques. Compiler organization. Lexical analysis. Top-down parsing via recursive descent, table-driven parsers, bottom-up parsing. Symboltables, semantic checking. Code generation for a simple RISC machine: conditionals, loops, procedure calls, simple register allocation techniques.</td>
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<tr>
<td>Objective</td>
<td>Learn principles of compiler design, gain practical experience designing and implementing a medium-scale software system.</td>
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<tr>
<td>Content</td>
<td>This course uses compilers as example to expose modern software development techniques. The course introduces the students to the fundamentals of compiler construction. Students will implement a simple yet complete compiler for an object-oriented programming language for a realistic target machine. Students will learn the use of appropriate tools (parser generators); the implementation language is Java. Throughout the course, students learn to apply their knowledge of theory (automata, grammars, stack machines, program transformation) and well-known programming techniques (module definitions, design patterns, frameworks, software reuse) in a software project. Specific topics: Compiler organization. Lexical analysis. Top-down parsing via recursive descent, table-driven parsers, bottom-up parsing. Symboltables, semantic checking. Code generation for a simple RISC machine: expression evaluation, straight line code, conditionals, loops, procedure calls, simple register allocation techniques. Storage allocation on the stack, parameter passing, runtime storage management, heaps. Special topics as time permits: introduction to global dataflow and its application to register allocation, instruction scheduling.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Muchnick, Advanced Compiler Design and Implementation, Morgan Kaufmann Publishers, 1997</td>
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<tr>
<td>252-0213-00L</td>
<td>Distributed Systems</td>
<td>W</td>
<td>8</td>
<td>6G+1A</td>
<td>F. Mattern, R. Wattenhofer</td>
</tr>
<tr>
<td>Abstract</td>
<td>Distributed control algorithms (mutual exclusion, logical clocks), communication models (RPC, synchronous/asynchronous communication, broadcast, events, tupel spaces), middleware, service- and resource-oriented architectures (SOAP, REST), security, fault-tolerance (failure models, consensus), replication (primary copy, 2PC, 3PC, Paxos, quorum systems), shared memory (spin locks, concurrency).</td>
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<tr>
<td>Objective</td>
<td>Become acquainted with pertinent technologies and architectures of distributed systems.</td>
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<tr>
<td>Content</td>
<td>We present the characteristics and concepts of distributed systems, and discuss distributed control algorithms (flooding, mutual exclusion, logical clocks), communications models (remote procedure call, client-server models, synchronous and asynchronous communication), abstraction communication principles (broadcast, events, tupel spaces), name services, communication middleware for open systems (e.g., REST, SOAP), infrastructure for ad hoc networking (IJIN), cloud computing, and mechanisms for security and safety. Having a distributed system may permit getting away with failures and malfunctions of parts of the system. We discuss fault-tolerance issues (models, consensus, agreement) as well as replication issues (primary copy, 2PC, 3PC, Paxos, quorum systems, distributed storage) and problems with asynchronous multiprocesssing (shared memory, spin locks, concurrency). To get familiar with message passing communication, some of the exercises will be devoted to a practical lab where participants will develop software for a mobile platform (smartphones).</td>
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<tr>
<td>Literature</td>
<td>Of the exercises will be devoted to a practical lab where participants will develop software for a mobile platform (smartphones).</td>
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<tbody>
<tr>
<td>Abstract</td>
<td>This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.</td>
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<tr>
<td>Objective</td>
<td>Introduction to HPC for scientists and engineers</td>
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Content

Programming models and languages:
1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)

Computers and methods:
1. Hardware and architectures
2. Libraries
3. Particles: N-body solvers
4. Fields: PDEs
5. Stochastics: Monte Carlo

Lecture notes
http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1

Class notes, handouts

► Focus Courses and Electives

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<tr>
<th>Number</th>
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<tr>
<td>252-0237-00L</td>
<td>Concepts of Object-Oriented Programming</td>
<td>W</td>
<td>6 credits</td>
<td>3V+2U</td>
<td>P. Müller</td>
</tr>
</tbody>
</table>

Abstract
Course that focuses on an in-depth understanding of object-oriented programming and compares designs of object-oriented programming languages. Topics include different flavors of type systems, inheritance models, encapsulation in the presence of aliasing, object and class initialization, program correctness, reflection

Objective
After this course, students will:
Have a deep understanding of advanced concepts of object-oriented programming and their support through various language features.
Be able to understand language concepts on a semantic level and be able to compare and evaluate language designs.
Be able to learn new languages more rapidly.
Be aware of many subtle problems of object-oriented programming and know how to avoid them.

Content
The main goal of this course is to convey a deep understanding of the key concepts of sequential object-oriented programming and their support in different programming languages. This is achieved by studying how important challenges are addressed through language features and programming idioms. In particular, the course discusses alternative language designs by contrasting solutions in languages such as C++, C#, Eiffel, Java, Python, and Scala. The course also introduces novel ideas from research languages that may influence the design of future mainstream languages.

The topics discussed in the course include among others:
The pros and cons of different flavors of type systems (for instance, static vs. dynamic typing, nominal vs. structural, syntactic vs. behavioral typing)
The key problems of single and multiple inheritance and how different languages address them
Generic type systems, in particular, Java generics, C# generics, and C++ templates
The situations in which object-oriented programming does not provide encapsulation, and how to avoid them
The pitfalls of object initialization, exemplified by a research type system that prevents null pointer dereferencing
How to maintain the consistency of data structures

Literature
Will be announced in the lecture.

Prerequisites / notice
Prerequisites:
Mastering at least one object-oriented programming language (this course will NOT provide an introduction to object-oriented programming); programming experience

252-0239-00L | Software Verification                                  | W    | 6 credits | 3V+2U | B. Meyer, C. A. Furia, S. Nanz |

Abstract
This course surveys some of the main approaches to software verification, including axiomatic semantics, abstract interpretation, model checking, and testing.

Objective
After successfully taking this course, students will have a theoretical and practical understanding of:
* The principles behind fundamental software verification techniques, including Hoare-style axiomatic semantics, abstract interpretation, model checking, and testing.
* Application of the principles to the construction of verification tools, in particular program provers.
* Research challenges in these areas.

Content
The idea of software verification has been around for decades, but only recently have the techniques become mature enough to be implemented and be applicable in practice. Progress has been made possible by the convergence of different techniques, originally developed in isolation.

This course embraces this diversity of approaches, by surveying some of the main ideas, techniques, and results in software verification. These include in particular:

* Axiomatic semantics, which provides a foundation of program correctness proofs by supplying a rigorous semantics of programs.
* Abstract interpretation, which provides a general framework to express and design static techniques for program analysis.
* Model checking, which provides efficient techniques for the exhaustive exploration of state-based models of programs and reactive systems.
* Testing, which provides the counterpart to exhaustive techniques by defining dynamic analyses to detect programming mistakes and correct them.

To demonstrate some of the techniques in practice, the course will offer a practical project requiring the application of verification tools to illustrative examples.
Literature

- Axiomatic semantics:

Abstract interpretation:

- Neil D. Jones, Flemming Nielson: Abstract Interpretation: a Semantic-Based Tool for Program Analysis

Model checking and real-time:


Testing:


252-0286-00L System Construction W 4 credits 2V+1U F. O. Friedrich

Abstract
Main goal is teaching knowledge and skills needed for building custom operating systems and runtime environments. Relevant topics are studied at the example of sufficiently simple systems that have been built at our Institute in the past, ranging from purpose-oriented single processor real-time systems up to generic system kernels on multi-core hardware.

Objective
The lecture's main goal is teaching of knowledge and skills needed for building custom operating systems and runtime environments.

Content
- Case Study 1: Embedded System
  - Safety-critical and fault-tolerant monitoring system
  - Based on an auto-pilot system for helicopters
- Case Study 2: Multi-Processor Operating System
  - Universal operating system for symmetric multiprocessors
  - Shared memory approach
  - Based on Language/System Codesign (Active Oberon / A2)
- Case Study 3: Custom designed Single-Processor System
  - RISC Single-processor system designed from scratch
  - Hardware on FPGA
  - Graphical workstation OS and compiler (Project Oberon)
- Case Study 4: Custom-designed Multi-Processor System
  - Special purpose heterogeneous system on a chip
  - Masssively parallel hard- and software architecture based on message passing
  - Focus: dataflow based applications

Lecture notes
Printed lecture notes will be delivered during the lecture. Slides will also be available from the lecture homepage.

252-0293-00L Wireless and Mobile Computing for Entertainment W 4 credits 2V+1U S. Mangold

Applications
- Focus: dataflow based applications
- Masssively parallel hard- and software architecture based on message passing

Objective
The lecture intends to supplement more abstract views of software construction, and to contribute to a better understanding of "how it really works" behind the scenes.

Content

Lecture notes
The script will be made available from the course webpage.

Literature


Prerequisites / notice
Students should have interest in wireless communication, and should be familiar with JAVA programming.

252-0341-01L Information Retrieval W 4 credits 2V+1U T. Hofmann

Abstract
Introduction to information retrieval with a focus on text documents and images. Main topics comprise extraction of characteristic features from documents, index structures, retrieval models, search algorithms, benchmarking, and feedback mechanisms. Searching the web, images and XML collections demonstrate recent applications of information retrieval and their implementation.
Objective
In depth understanding of managing, indexing, and retrieving documents with text, image and XML content. Knowledge about basic search algorithms on the web, benchmarking of search algorithms, and relevance feedback methods.

252-0373-00L
Mobile and Personal Information Systems
W
4 credits
2V+1U
M. Norrie

Abstract
The course examines how traditional information system architectures and technologies have been adapted to support various forms of mobile and personal information systems. Topics to be covered include: databases of mobile objects; context-aware services; opportunistic information sharing; ambient information; pervasive display systems.

Objective
Students will be introduced to a variety of novel information services and architectures developed for mobile environments in order to gain insight into the requirements and processes involved in designing and developing such systems and learning to think beyond traditional information systems.

Content
Advances in mobile devices and communication technologies have led to a rapid increase in demands for various forms of mobile information systems where the users, the applications and the databases themselves may be mobile. Based on both lectures and breakout sessions, this course examines the impact of the different forms of mobility and collaboration that systems require nowadays and how these influence the design of systems, at the database, the application and the user interface level. For example, traditional data management techniques have to be adapted to meet the requirements of such systems and cope with new connection, access and synchronisation issues. As mobile devices have increasingly become integrated into the users’ lives and are expected to support a range of activities in different environments, applications should be context-aware, adapting functionality, information delivery and the user interfaces to the current environment and task. Various forms of software and hardware sensors may be used to determine the current context, raising interesting issues for discussion. Finally, user mobility, and the varying and intermittent connectivity that it implies, gives rise to new forms of dynamic collaboration that require lightweight, but flexible, mechanisms for information synchronisation and consistency maintenance. Here, the interplay of mobile, personal and social context will receive special attention.

252-0417-00L
Randomized Algorithms and Probabilistic Methods
W
7 credits
3V+2U+1A
A. Steger

Abstract
Las Vegas & Monte Carlo algorithms; inequalities of Markov, Chebyshev, Chernoff; negative correlation; Markov chains: convergence, rapidly mixing; generating functions; Examples include: min cut, median, balls and bins, routing in hypercubes, SSAT, card shuffling, random walks

Objective
After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.

Content
Randomized Algorithms are algorithms that “flip coins” to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.

Lecture notes
Yes.

Literature

252-0437-00L
Distributed Algorithms
W
4 credits
3V
F. Mattern

Abstract
Models of distributed computations, time space diagrams, virtual time, logical clocks and causality, wave algorithms, parallel and distributed graph traversal, consistent snapshots, mutual exclusion, election and symmetry breaking, distributed termination detection, garbage collection in distributed systems, monitoring distributed systems, global predicates.

Objective
Become acquainted with models and algorithms for distributed systems.

Content
Verteilte Algorithmen sind Verfahren, die dadurch charakterisiert sind, dass mehrere autonome Prozesse gleichzeitig Teile eines gemeinsamen Problems in kooperativer Weise bearbeiten und der dabei erforderliche Informationsaustausch ausschliesslich über Nachrichten erfolgt. Derartige Algorithmen kommen im Rahmen verteilter Systeme zum Einsatz, bei denen kein gemeinsamer Speicher existiert und die Übertragungsgeschwindigkeit von Nachrichten i.a. nicht vernachlässigt werden kann. Da dabei kein Prozess eine aktuelle konsistente Sicht des globalen Zustands besitzt, führt dies zu interessanten Problemen. Im einzelnen werden u.a. folgende Themen behandelt:
- Modelle verteilter Berechnungen; Raum-Zeit-Diagramme; Virtuelle Zeit; Logische Uhren und Kausalität; Wellenalgorithmen; Verteilte und parallele Graphtraversierung; Berechnung konsistenten Schnappschusses; Wechselseitiger Ausschluss; Elektion und Symmetriebrechung; Verteilte Terminierung; Garbage-Collection in verteilen Systemen; Beobachten verteilter Systeme; Berechnung globaler Prädkate.

Literature
- F. Mattern: Verteilte Basisalgorithmen, Springer-Verlag
- G. Tel: Topics in Distributed Algorithms, Cambridge University Press
- G. Tel: Introduction to Distributed Algorithms, Cambridge University Press, 2nd edition
- N. Lynch: Distributed Algorithms, Morgan Kaufmann Publ

252-0463-00L
Security Engineering
W
5 credits
2V+2U
D. Basin

Abstract
Subject of the class are engineering techniques for developing secure systems. We examine concepts, methods and tools, applied within the different activities of the SW development process to improve security of the system. Topics: security requirements&risk analysis, system modeling&model-based development methods, implementation-level security, and evaluation criteria for secure systems

Objective
Security engineering is an evolving discipline that unifies two important areas: software engineering and security. Software Engineering addresses the development and application of methods for systematically developing, operating, and maintaining, complex, high-quality software. Security, on the other hand, is concerned with assuring and verifying properties of a system that relate to confidentiality, integrity, and availability of data.

The goal of this class is to survey engineering techniques for developing secure systems. We will examine concepts, methods, and tools that can be applied within the different activities of the software development process, in order to improve the security of the resulting systems.

Topics covered include
- security requirements & risk analysis,
- system modeling and model-based development methods,
- implementation-level security, and
- evaluation criteria for the development of secure systems

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Autumn Semester 2015
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Content

Security engineering is an evolving discipline that unifies two important areas: software engineering and security. Software Engineering addresses the development and application of methods for systematically developing, operating, and maintaining, complex, high-quality software. Security, on the other hand, is concerned with assuring and verifying properties of a system that relate to confidentiality, integrity, and availability of data.

The goal of this class is to survey engineering techniques for developing secure systems. We will examine concepts, methods, and tools that can be applied within different activities of the software development process, in order to improve the security of the resulting systems.

Topics covered include

* security requirements & risk analysis,
* system modeling and model-based development methods,
* implementation-level security, and
* evaluation criteria for the development of secure systems

Modules taught:

1. Introduction
   - Introduction of Infsec group and speakers
   - Security meets SW engineering: an introduction
   - The activities of SW engineering, and where security fits in
   - Overview of this class

2. Requirements Engineering: Security Requirements and some Analysis
   - overview: functional and non-functional requirements
   - use cases, misuse cases, sequence diagrams
   - safety and security
   - FMEA, FTA, attack trees

3. Modeling in the design activities
   - structure, behavior, and data flow
   - class diagrams, statecharts

4. Model-driven security for access control (design)
   - SecureUML as a language for access control
   - Combining Design Modeling Languages with SecureUML
   - Semantics, i.e., what does it all mean,
   - Generation
   - Examples and experience

5. Model-driven security (Part II)
   - Continuation of above topics

6. Security patterns (design and implementation)

7. Implementation-level security
   - Buffer overflows
   - Input checking
   - Injection attacks

8. Testing
   - overview
   - model-based testing
   - testing security properties

9. Risk analysis and management 1 (project management)
   - "risk": assets, threats, vulnerabilities, risk
   - risk assessment: quantitative and qualitative
   - safeguards
   - generic risk analysis procedure
   - The OCTAVE approach

10. Risk analysis: IT baseline protection
   - Overview
   - Example

11. Evaluation criteria
   - CMM
   - systems security engineering CMM
   - common criteria

12. Guest lecture
   - TBA

Literature

- Further relevant books and journal/conference articles will be announced in the lecture.

Prerequisites / notice

Prerequisite: Class on Information Security

252-0523-00L Computational Biology W 6 credits 3V+2U G. H. Gonnet

Abstract

Study of computational techniques, algorithms and data structures used to solve problems in computational biology. Topics: basic biology, string alignment, phylogeny (distance, character, parsimony), molecular evolution, multiple sequence alignment, probabilistic and statistical models, Markov models, microarrays, dynamic programming, maximum likelihood and specialized DNA and protein analysis.

Objective

Familiarize the students with the basic concepts of molecular biology and the models and algorithms used to understand, classify and predict behaviour of living organism. This course is at the most basic level, where the main issues, mostly of molecular sequences, are studied.

Content

This course lies in the intersection between Computer Science and Molecular Biology. The main purpose is to study computational techniques, algorithms and data structures which are usually applied to solve problems in Molecular Biology and Biochemistry. The following topics are likely to be covered: Introduction, mathematical models of evolution, protein and DNA sequence alignment and its meaning, phylogenetic tree construction, multiple sequence alignments, secondary structure prediction, molecular dynamics, threading, role of bioinformatics in drug design, etc. From the computer science point of view we concentrate our attention in practical solutions for the above problems. Biological knowledge is an asset but not a prerequisite.

252-0527-00L Probabilistic Graphical Models for Image Analysis W 4 credits 3G

Does not take place this semester.
This course will focus on the algorithms for inference and learning with statistical models. We use a framework called probabilistic graphical models which include Bayesian Networks and Markov Random Fields.

We will use examples from traditional vision problems such as image registration and image segmentation, as well as recent problems such as object recognition.

Students will be introduced to probabilistic graphical models and will learn how to apply them to problems in image analysis and understanding. The focus will be to study various algorithms for inference and parameter learning.

Will be announced during the lecture.

Machine Learning

Abstract

Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

Objective

Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.

Content

The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:

- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

Lecture notes

No lecture notes, but slides will be made available on the course webpage.

Literature


Prerequisites / notice

Solid basic knowledge in analysis, statistics and numerical methods for CSE. Experience in programming for solving the project tasks.
Content
The Internet is a typical example of a large-scale distributed computer system without central control, with users that are typically only interested in their own good. For instance, they are interested in getting high bandwidth for themselves, but don't care about others, and the same is true for computational load or download rates. Game theory provides a particularly well-suited model for the behaviour and interaction of such selfish users and programs. Classical game theory dates back to the 1930s and typically does not consider algorithmic aspects at all. Only a few years back, algorithms and game theory have been considered together, in an attempt to reconcile selfish behavior of independent agents with the common good.

This course discusses algorithmic aspects of game-theoretic models, with a focus on recent algorithmic and mathematical developments. Rather than giving an overview of such developments, the course aims to study selected important topics in depth.

Outline:
- Introduction to classical game theoretic concepts.
- Existence of stable solutions (equilibria), algorithms for computing equilibria, computational complexity.
- The cost difference between an optimum under central control and an equilibrium under selfish agents, known as the "price of anarchy".
- Auction-like mechanisms and algorithms that "direct" the actions of selfish agents into a certain desired equilibrium situation.
- Selected current research topics of Algorithmic Game Theory, such as Web-Search Based Keyword Auctions, or Information Cascading in Social Networks

Lecture notes
No lecture notes.

Literature
"Game Theory and Strategy", Philip D. Straffin, The Mathematical Association of America, 5th printing, 2004

Prerequisites / notice
Several copies of both books are available in the Computer Science library.

Audience: Although this is a Computer Science course, we encourage the participation from all students who are interested in this topic.

Requirements: You should enjoy precise mathematical reasoning. You need to have passed a course on algorithms and complexity. No knowledge of game theory is required.

252-1411-00L  Security of Wireless Networks  W  5 credits  2V+1U+1A  S. Capkun
Abstract
Core Elements: Wireless communication channel, Wireless network architectures and protocols, Attacks on wireless networks, Protection techniques.
Objective
After this course, the students should be able to: describe and classify security goals and attacks in wireless networks; describe security architectures of the following wireless systems and networks: 802.11, GSM/UMTS, RFID, ad hoc/sensor networks; reason about security protocols for wireless network; implement mechanisms to secure 802.11 networks.
Content

252-1414-00L  System Security  W  5 credits  2V+2U  S. Capkun, A. Perrig
Abstract
The first part of the lecture covers individual system's aspects starting with tamperproof or tamperresistant hardware in general over operating system related security mechanisms to application software systems, such as host based intrusion detection systems. In the second part, the focus is on system design and methodologies for large projects.
Objective
In this lecture, students learn about the security requirements and capabilities that are expected from modern hardware, operating systems and other software environments. An overview of available technologies, algorithms and standards is given, with which these requirements can be met.
Content
The first part of the lecture covers individual system's aspects starting with tamperproof or tamperresistant hardware in general over operating system related security mechanisms to application software systems such as host based intrusion detection systems. The main topics covered are: tamper resistant hardware, CPU support for security, protection mechanisms in the kernel, file system security (permissions / ACLs / network filesystem issues), IPC Security, mechanisms in more modern OS, such as Capabilities and Zones, Libraries and Software tools for security assurance, etc.

In the second part, the focus is on system design and methodologies for large projects. The main question answered is how to get a large secure system. Topics include: patch management, common software faults (buffer overflows, etc.), writing secure software (design, architecture, QA, testing), compiler-supported security, language-supported security (java...), logging and auditing (BSM audit, dtrace, ...), cryptographic support, TCG, secure file systems, dos/windows/ windowsXP security issues.

Along the lectures, model cases will be elaborated and evaluated in the exercises.

252-1425-00L  Geometry: Combinatorics and Algorithms  W  6 credits  2V+2U+1A  B. Gärtner, M. Hoffmann, E. Welzl
Abstract
Geometric structures are useful in many areas, and there is a need to understand their structural properties, and to work with them algorithmically. The lecture addresses theoretical foundations concerning geometric structures. Central objects of interest are triangulations. We study combinatorial (Does a certain object exist?) and algorithmic questions (Can we find a certain object efficiently?)
Objective
The goal is to make students familiar with fundamental concepts, techniques and results in combinatorial and computational geometry, so as to enable them to model, analyze, and solve theoretical and practical problems in the area and in various application domains. In particular, we want to prepare students for conducting independent research, for instance, within the scope of a thesis project.
Content
Planar and geometric graphs, embeddings and their representation (Whitney's Theorem, canonical orderings, DCEL), polygon triangulations and the art gallery theorem, convexity in R^d, planar convex hull algorithms (Jarvis Wrap, Graham Scan, Chan's Algorithm), point set triangulations, Delaunay triangulations (Lawson flips, lifting map, randomized incremental construction), Voronoi diagrams, the Crossing Lemma and incidence bounds, line arrangements (duality, Zone Theorem, ham-sandwich cuts), 3-SUM hardness, counting planar triangulations.

Lecture notes
yes

Literature

Prerequisites / notice
Prerequisites: The course assumes basic knowledge of discrete mathematics and algorithms, as supplied in the first semesters of Bachelor Studies at ETH.
Outlook: In the following spring semester there is a seminar "Geometry: Combinatorics and Algorithms" that builds on this course. There are ample possibilities for Semester-, Bachelor- and Master Thesis projects in the area.

252-3610-00L  Smart Energy  W  3 credits  2G  F. Mattern, V. Tiefenbeck
Abstract
The lecture covers the role of ICT for sustainable energy usage. Concepts of the emerging smart grid are outlined and approaches to motivate sustainable consumer choices are explained. The lecture combines technologies from ubiquitous computing and traditional ICT with insights from socio-psychological concepts and illustrates them with examples from actual applications.
<table>
<thead>
<tr>
<th>Code</th>
<th>Course Title</th>
<th>Type</th>
<th>Credits</th>
<th>Start/End</th>
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<tr>
<td>252-4050-00L</td>
<td>Complexity Theory</td>
<td>W</td>
<td>6</td>
<td>3V+2U</td>
<td>T. Holenstein</td>
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<tr>
<td>Abstract</td>
<td>Complexity Theory classifies problems according to resources required in order to solve them. In this course, we give an introduction to modern complexity theory. We introduce basic complexity classes (such as L, P, NP, AM, PH, PSPACE, IP, EXP), and study circuit complexity.</td>
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<tr>
<td>Objective</td>
<td>The student learns the fundamentals of Complexity Theory, as well as some of the more recent techniques. He not only understands the basic results and techniques used to prove them, but also has insight in some of the technically more advanced theorems.</td>
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<tr>
<td>Content</td>
<td>Complexity Theory classifies problems according to the difficulty of solving them. In this course, we give an introduction to modern complexity theory. We introduce basic complexity classes (such as L, P, NP, PH, PSPACE, IP, EXP), and study the known relationship to uniform complexity. We study circuit complexity, and its relationship to uniform complexity. We will also study some circuit lower bounds for constant depth circuits, as well as results which explain why it is difficult to improve these results.</td>
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<tr>
<td>Literature</td>
<td>Will be provided during the course, though a good starting point is &quot;ICT for Green: how computers can help us to conserve energy&quot; from Friedemann Mattern, Thosten Staake, and Markus Weiss (available at <a href="http://www.vs.inf.ethz.ch/publ/papers/ICT-for-Green.pdf">http://www.vs.inf.ethz.ch/publ/papers/ICT-for-Green.pdf</a>).</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The lecture includes interactive exercises, case studies and practical examples.</td>
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<tr>
<td>252-5703-00L</td>
<td>Multimedia Communications</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>A. Smolic</td>
</tr>
<tr>
<td>Abstract</td>
<td>After a summary of fundamentals in signal processing and information theory, an introduction to processing and coding of different types of multimedia is given.</td>
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<tr>
<td>Objective</td>
<td>Understanding principles of multimedia communications and getting an illustrative overview of available and emerging technology.</td>
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<tr>
<td>Content</td>
<td>After a summary of fundamentals in signal processing and information theory, an introduction to processing and coding of different types of multimedia is given. This starts with speech (PCM, vocoder, CELP etc.), continues over audio (MP3, AAC etc.), still images (JPEG etc.), video (MPEG-2, MPEG-4, H.264/AVC, HEVC etc.), and interactive graphics (MPEG-4), to emerging and future multimedia content such as 3D video, free viewpoint video, high dynamic range video. Algorithms as well as human perception will be addressed.</td>
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<tr>
<td>Literature</td>
<td>Papers from scientific conferences and journals. References will be given as part of the course material during the semester.</td>
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<tr>
<td>263-2800-00L</td>
<td>Design of Parallel and High-Performance Computing</td>
<td>W</td>
<td>7</td>
<td>3V+2U+1A</td>
<td>T. Hoeffler, M. Püschel</td>
</tr>
<tr>
<td>Abstract</td>
<td>Advanced topics in parallel / concurrent programming.</td>
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<tr>
<td>Objective</td>
<td>Understand concurrency paradigms and models from a higher perspective and acquire skills for designing, structuring and developing possibly large concurrent software systems. Become able to distinguish parallelism in problem space and in machine space. Become familiar with important technical concepts and with concurrency folklore.</td>
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<tr>
<td>Content</td>
<td>The goal of this course is to give an overview of Big Data technologies. All aspects are covered: data formats and models, programming languages, optimization techniques, systems, and applications.</td>
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<tr>
<td>Literature</td>
<td>Papers from scientific conferences and journals. References will be given as part of the course material during the semester.</td>
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<tr>
<td>263-3010-00L</td>
<td>Big Data</td>
<td>W</td>
<td>6</td>
<td>3V+1U+1A</td>
<td>T. Hofmann</td>
</tr>
<tr>
<td>Abstract</td>
<td>Does not take place this semester.</td>
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<tr>
<td>Objective</td>
<td>One of the key challenges of the information society is to turn data into information, information into knowledge, and knowledge into value. To turn data into value in this way involves collecting large volumes of data, possibly from many and diverse data sources, processing the data fast, and applying complex operations to the data.</td>
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<tr>
<td>Content</td>
<td>One of the key challenges of the information society is to turn data into information, information into knowledge, and knowledge into value. To turn data into value in this way involves collecting large volumes of data, possibly from many and diverse data sources, processing the data fast, and applying complex operations to the data. This combination of requirements is typically referred to as Big Data and it has led to a completely new way to do business (e.g., develop new products and business models) and do science (sometimes referred to as data-driven science or the &quot;fourth paradigm&quot;). Unfortunately, big data grows faster than our ability to process the data so that new architectures and approaches for processing Big Data are needed.</td>
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<tr>
<td>Literature</td>
<td>Papers from scientific conferences and journals. References will be given as part of the course material during the semester.</td>
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<tr>
<td>263-3800-00L</td>
<td>Advanced Operating Systems</td>
<td>W</td>
<td>6</td>
<td>2V+2U+1A</td>
<td>T. Roscoe</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course is intended to give students a thorough understanding of design and implementation issues for modern operating systems. We will cover key design issues in implementing an operating system, such as memory management, scheduling, protection, inter-process communication, device drivers, and file systems.</td>
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<tr>
<td>Objective</td>
<td>The goals of the course are, firstly, to give students a broader perspective on OS design than that provided by knowledge of Unix or Windows, building on the material in a standard undergraduate operating systems class, and secondly, to provide them with practical experience in dealing directly with the concurrency, resource management, and abstraction problems confronting OS designers and implementers.</td>
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<tr>
<td>Content</td>
<td>This course is intended to give students a thorough understanding of design and implementation issues for modern operating systems. We will cover key design issues in implementing an operating system, such as memory management, scheduling, protection, inter-process communication, device drivers, and file systems. We will pay particular attention to system structures that differ from traditional monolithic arrangements of Unix/Linux and Windows.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The course consists of lectures, project work, and a written examination. Project work will be performed in small groups, where students will implement major components of a microkernel-based operating system. The final assessment will be a combination of project and examination grades.</td>
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<tr>
<td>263-4640-00L</td>
<td>Network Security</td>
<td>W</td>
<td>6</td>
<td>2V+1U+2P</td>
<td>A. Perrig, T. P. Dümbendorfer, S. Frei</td>
</tr>
<tr>
<td>Abstract</td>
<td>This lecture discusses fundamental concepts and technologies in the area of network security. Several case studies illustrate the dark side of the Internet and explain how to protect against such threats. A hands-on computer lab that accompanies the lecture gives a deep dive on firewalls, penetration testing and intrusion detection.</td>
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</table>
Objective

Students are aware of current threats that Internet services and networked devices face and can explain appropriate countermeasures.
Students know fundamental network security concepts.
Students have an in-depth understanding of important security technologies.
Students know how to configure a real firewall and know some penetration testing tools from their own experience.

Content

Risk management and the vulnerability lifecycle of software and networked services are discussed. Threats like denial of service, spam, worms, and viruses are studied in-depth. Fundamental security related concepts like identity, availability, authentication and secure channels are introduced. State of the art technologies like secure shell, network and transport layer security, intrusion detection and prevention systems, cross-site scripting, secure implementation techniques and more for securing the Internet and web applications are presented. Several case studies illustrate the dark side of the Internet and explain how to protect against current threats. A hands-on computer lab that accompanies the lecture gives a deep dive on firewalls, penetration testing and intrusion detection.

This lecture is intended for students with an interest in securing Internet services and networked devices. Students are assumed to have knowledge in networking as taught in the Communication Networks lecture. This lecture and the exam are held in English.

Prerequisites / notice

Due to recent changes in the Swiss law, ETH requires each student of this course to sign a written declaration that he/she will not use the information given in this for illegal purposes. This declaration will have to be signed and submitted no later than at the beginning of the second lesson.

263-5001-00L  Introduction to Finite Elements and Sparse Linear System Solving

Abstract

The finite element (FE) method is the method of choice for (approximately) solving partial differential equations on complicated domains. In the first third of the lecture, we give an introduction to the method. The rest of the lecture will be devoted to methods for solving the large sparse linear systems of equation that a typical for the FE method. We will consider direct and iterative methods.

Objective

Students will know the most important direct and iterative solvers for sparse linear systems. They will be able to determine which solver to choose in particular situations.

Content

I. THE FINITE ELEMENT METHOD

(1) Introduction, model problems.
(2) 1D problems. Piecewise polynomials in 1D.
(3) 2D problems. Triangulations. Piecewise polynomials in 2D.
(4) Variational formulations. Galerkin finite element method.
(5) Implementation aspects.

II. DIRECT SOLUTION METHODS

(6) LU and Cholesky decomposition.
(7) Sparse matrices.
(8) Fill-reducing orderings.

III. ITERATIVE SOLUTION METHODS

(9) Stationary iterative methods, preconditioning.
(10) Preconditioned conjugate gradient method (PCG).
(11) Incomplete factorization preconditioning.
(12) Multigrid preconditioning.
(13) Nonsymmetric problems (GMRES, BiCGstab).
(14) Indefinite problems (SYMMLQ, MINRES).

Literature


Prerequisites / notice

Prerequisites: Linear Algebra, Analysis, Computational Science.
The exercises are made with Matlab.

263-5150-00L  Scientific Databases

Abstract

Scientific databases share many aspects with classical DBs, but have additional specific aspects. We will review Relational DBs, Object Oriented DBs, Knowledge DBs, textual DBs and the Semantic Web. All these topics will be studied from the point of view of the scientific applications (Bioinformatics, Physics, Chemistry, Health, Engineering) A toy SDB will be used for exercises.

Objective

The goals of this course are to:
(a) Familiarize the students with how existing DBs can be used for scientific applications.
(b) Recognize the areas where SciDBs differ and require additional features compared to classical DBs.
(c) Be able to understand more easily SciDBs, improve existing ones or design/create new ones.
(d) Familiarize the students with at least two examples of SciDBs.
Content

1) - Introduction, Statement of the problem, course structure, exercises, why Scientific DBs (SDBs) do not fit exactly the classical DB area. Efficiency issues and how they differ from classical DB.

2) - Relational DB used for scientific data, pros/cons Introduction to RDB, limitations of the model, basics of SQL, handling of metadata, examples of scientific use of RDBs.

3) - Object Oriented DB. Rich/structured objects are very appealing in SDB. OODB primitives and environments. OODB searching, Space and access time efficiency of OODBs.

4) - Knowledge bases, key-value stores, ontologies, workflow-based architectures. WASA.

5) - MapReduce / Hadoop

6) - Storing and sharing mathematical objects, Open Math, its relation with OODB and Knowledge bases. Also the problem of chemical formula representation.

7) - SGML and XML, human-readable databases, genomic databases. Advantages of human-readable databases (the huge initial success of genomic databases).

8) - Semantic web, Resource Description Framework (RDF) triples, SparQL. An example of very flexible database for knowledge storage. Goals of the Semantic Web, discussion about its future.

9) - An ideal scenario (and the design of a toy system with most of the desired features for exploration and exercises).


11) - Functional testing, Verifiers, Consistency, Short-circuit testing. Recovery and Automatic recovery, Backup (incremental) methods.

12) - Performance and space issues, various uses of compression, concurrency control. Hardware issues, clusters, Cloud computing, Crowd-sourcing.

13) - Guest speaker: Ioannis Xenarios (UniProtKB/Swiss-Prot).

Literature

Several papers and online articles will be made available. There is no single textbook for this course. A significant amount of material will be delivered in the lectures making lecture attendance highly recommended.

263-5200-00L Data Mining: Learning from Large Data Sets W 4 credits 2V+1U A. Krause

Abstract

Many scientific and commercial applications require insights from massive, high-dimensional data sets. This courses introduces principled, state-of-the-art techniques from statistics, algorithms and discrete and convex optimization for learning from such large data sets. The course both covers theoretical foundations and practical applications.

Objective

Many scientific and commercial applications require us to obtain insights from massive, high-dimensional data sets. In this graduate-level course, we will study principled, state-of-the-art techniques from statistics, algorithms and discrete and convex optimization for learning from such large data sets. The course will both cover theoretical foundations and practical applications.

Content

Topics covered:
- Dealing with large data (Data centers; Map-Reduce/Hadoop; Amazon Mechanical Turk)
- Fast nearest neighbor methods (Shingling, locality sensitive hashing)
- Online learning (Online optimization and regret minimization, online convex programming, applications to large-scale Support Vector Machines)
- Multi-armed bandits (exploration-exploitation tradeoffs, applications to online advertising and relevance feedback)
- Active learning (uncertainty sampling, pool-based methods, label complexity)
- Dimension reduction (random projections, nonlinear methods)
- Data streams (Sketches, coresets, applications to online clustering)
- Recommender systems

Prerequisites / notice

Prerequisites: Solid basic knowledge in statistics, algorithms and programming. Background in machine learning is helpful but not required.

263-5210-00L Probabilistic Artificial Intelligence W 4 credits 2V+1U A. Krause

Abstract

This course introduces core modeling techniques and algorithms from statistics, optimization, planning, and control and study applications in areas such as sensor networks, robotics, and the Internet.

Objective

How can we build systems that perform well in uncertain environments and unforeseen situations? How can we develop systems that exhibit "intelligent" behavior, without prescribing explicit rules? How can we build systems that learn from experience in order to improve their performance? We will study core modeling techniques and algorithms from statistics, optimization, planning, and control and study applications in areas such as sensor networks, robotics, and the Internet. The course is designed for upper-level undergraduate and graduate students.

Content

Topics covered:
- Search (BFS, DFS, A*), constraint satisfaction and optimization
- Tutorial in logic (propositional, first-order)
- Probability
- Bayesian Networks (models, exact and approximate inference, learning) - Temporal models (Hidden Markov Models, Dynamic Bayesian Networks)
- Probabilistic planning (MDPs, POMDPs)
- Reinforcement learning
- Combining logic and probability

Prerequisites / notice

Solid basic knowledge in statistics, algorithms and programming
The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related computational systems biology.

6 credits

Topics covered in this course include:

1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

Prerequisites / notice

It is recommended that students have taken the Visual Computing lecture or a similar course introducing basic image processing concepts before taking this course.

151-0104-00L Uncertainty Quantification for Engineering & Life Sciences

Number of participants limited to 60.

Abstract

Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

Objective

The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicoarse architectures.

Content

Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Lecture notes

The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

Literature

1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

Prerequisites / notice

Fundamentals of Probability, Fundamentals of Computational Modeling

227-0778-00L Hardware/Software Codesign

Abstract

The course provides advanced knowledge in the design of complex computer systems, in particular embedded systems. Models and methods are discussed that are fundamental for systems that consist of software and hardware components.

Objective

The course provides advanced knowledge in the design of complex computer systems, in particular embedded systems. Models and methods are discussed that are fundamental for systems that consist of software and hardware components.

Content

The course covers the following subjects: (a) Models for describing hardware and software components (specification), (b) Hardware-Software Interfaces (instruction set, hardware and software components, reconfigurable computing, heterogeneous computer architectures, System-on-Chip), (c) Application specific instruction sets, code generation and reconfigurable compilation, (d) Performance analysis and estimation techniques, (e) System design (hardware-software partitioning and design space exploration).

Lecture notes

Material for exercises, copies of transparencies.

Literature


G. DeMicheli, R. Ernst and W. Wolf, Readings in Hw/Sw Co-design, M. Kaufmann, 2003.

Prerequisites / notice

Prerequisites for the course is a basic knowledge in the following areas: computer architecture, digital design, software design, embedded systems.

401-0647-00L Introduction to Mathematical Optimization

Abstract

Introduction to basic techniques and problems of mathematical optimization.

Objective

The goal is to get a good understanding of some of the most important mathematical optimization techniques used to solve linear programs and basic combinatorial optimization problems.

Content

Topics covered in this course include:

- Linear programming (simplex method, duality theory, shadow prices, ...).
- Basic combinatorial optimization problems (spanning trees, network flows, knapsack problem, ...).

Literature

Information about relevant literature will be given in the lecture.

Prerequisites / notice

This course is meant for students who did not already attend the course "Mathematical Optimization", which is a more advance lecture covering similar topics and more.

636-0007-00L Computational Systems Biology

Abstract

Study of fundamental concepts, models and computational methods for the analysis of complex biological networks. Topics: Systems approaches in biology, biology and bioinformatics, fundamental principles, modeling and simulation approaches (topological, probabilistic, stoichiometric, qualitative, linear / nonlinear ODEs, stochastic), and systems analysis (complexity reduction, stability, identification).

Objective

The aim of this course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.

Content

Biology has witnessed an unprecedented increase in experimental data and, correspondingly, an increased need for computational methods to analyze this data. The explosion of sequenced genomes, and subsequently, of bioinformatics methods for the storage, analysis and comparison of genetic sequences provides a prominent example. Recently, however, an additional area of research, captured by the label "Systems Biology", focuses on how networks, which are more than the mere sum of their parts' properties, establish biological functions. This is essentially a task of reverse engineering. The aim of this course is to provide an introductory overview of corresponding computational methods for the modeling, simulation and analysis of biological networks. We will start with an introduction into the basic units, functions and design principles that are relevant for biology at the level of individual cells. Making extensive use of example systems, the course will then focus on methods and algorithms that allow for the investigation of biological networks with increasing detail. These include (i) graph theoretical approaches for revealing large-scale network organization, (ii) probabilistic (Bayesian) network representations, (iii) structural network analysis based on reaction stoichiometries, (iv) qualitative methods for dynamic modeling and simulation (Boolean and piece-wise linear approaches), (v) mechanistic modeling using ordinary differential equations (ODEs) and finally (vi) stochastic simulation methods.
### Seminars

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>252-3001-00L</td>
<td>Advanced Topics in Information Systems</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>M. Norrie</td>
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<td></td>
<td>Number of participants limited to 16.</td>
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<tr>
<td>Abstract</td>
<td>This seminar course will discuss research topics in the area of information systems. We will read recent research papers on a selected topic, and present/discuss them in class.</td>
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<tr>
<td>Objective</td>
<td>The goal is to introduce students to current research, and to enable them to read, understand, and present scientific papers.</td>
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<tr>
<td>Content</td>
<td>Each participant will be required to give a presentation of about 30 mins followed by a discussion on an assigned topic. In addition, each participant will be assigned as a buddy on another paper which means that they must read the paper and be prepared to start of the discussion on the paper with some comments and questions. Students also have to submit a 2-page summary of the paper that they present. Grading will depend on the quality of the talk, the report, and also active participation during the seminar.</td>
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<tr>
<td>252-4202-00L</td>
<td>Seminar in Theoretical Computer Science</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>E. Welzl, B. Gärtner, M. Hoffmann, J. Lengler, A. Steger, B. Sudakov</td>
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<tr>
<td>Abstract</td>
<td>Presentation of recent publications in theoretical computer science, including results by diploma, masters and doctoral candidates.</td>
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<tr>
<td>Objective</td>
<td>The goal is to introduce students to current research, and to enable them to read, understand, and present scientific papers.</td>
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<tr>
<td>Content</td>
<td>The seminar covers various topics in information security: security protocols (models, specification &amp; verification), trust management, access control, non-interference, side-channel attacks, identity-based cryptography, host-based attack detection, anomaly detection in backbone networks, key-management for sensor networks.</td>
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<tr>
<td>Literature</td>
<td>The reading list will be published on the course web site.</td>
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<tr>
<td>252-4601-00L</td>
<td>Current Topics in Information Security</td>
<td>W</td>
<td>2 credits</td>
<td>3S</td>
<td>D. Basin, S. Capkun, A. Perrig</td>
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<tr>
<td>Abstract</td>
<td>The seminar covers various topics in information security: security protocols (models, specification &amp; verification), trust management, access control, non-interference, side-channel attacks, identity-based cryptography, host-based attack detection, anomaly detection in backbone networks, key-management for sensor networks.</td>
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<tr>
<td>Objective</td>
<td>The main goals of the seminar are the independent study of scientific literature and assessment of its contributions as well as learning and practicing presentation techniques.</td>
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<tr>
<td>Content</td>
<td>The seminar covers various topics in information security, including network security, cryptography and security protocols. The participants are expected to read a scientific paper and present it in a 35-40 min talk. At the beginning of the semester a short introduction to presentation techniques will be given.</td>
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<tr>
<td>Literature</td>
<td>The reading list will be published on the course web site.</td>
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<tr>
<td>252-5051-00L</td>
<td>Advanced Topics in Machine Learning</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>J. M. Buhmann, T. Hofmann, A. Krause</td>
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<tr>
<td>Abstract</td>
<td>In this seminar, recent papers of the pattern recognition and machine learning literature are presented and discussed. Possible topics cover statistical models in computer vision, graphical models and machine learning.</td>
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<tr>
<td>Objective</td>
<td>The seminar “Advanced Topics in Machine Learning” familiarizes students with recent developments in pattern recognition and machine learning. Original articles have to be presented and critically reviewed. The students will learn how to structure a scientific presentation in English which covers the key ideas of a scientific paper. An important goal of the seminar presentation is to summarize the essential ideas of the paper in sufficient depth while omitting details which are not essential for the understanding of the work. The presentation style will play an important role and should reach the level of professional scientific presentations.</td>
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<tr>
<td>Content</td>
<td>The seminar will cover a number of recent papers which have emerged as important contributions to the pattern recognition and machine learning literature. The topics will vary from year to year but they are centered on methodological issues in machine learning like new learning algorithms, ensemble methods or new statistical models for machine learning applications. Frequently, papers are selected from computer vision or bioinformatics - two fields, which relies more and more on machine learning methodology and statistical models.</td>
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<tr>
<td>Literature</td>
<td>The reading list will be published on the course web site.</td>
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<tr>
<td>252-5701-00L</td>
<td>Advanced Topics in Computer Graphics and Vision</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>M. Gross, M. Pollefeys, O. Sorkine Hornung</td>
</tr>
<tr>
<td>Abstract</td>
<td>This seminar covers advanced topics in computer graphics, such as modeling, rendering, animation, real-time graphics, physical simulation, and computational photography. Each time the course is offered, a collection of research papers is selected and each student presents one paper to the class and leads a discussion about the paper and related topics.</td>
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<tr>
<td>Objective</td>
<td>The goal is to get an in-depth understanding of actual problems and research topics in the field of computer graphics as well as improve presentations and critical analysis skills.</td>
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</tr>
<tr>
<td>Content</td>
<td>This seminar covers advanced topics in computer graphics, including both seminal research papers as well as the latest research results. Each time the course is offered, a collection of research papers are selected covering topics such as modeling, rendering, animation, real-time graphics, physical simulation, and computational photography. Each student presents one paper to the class and leads a discussion about the paper and related topics. All students read the papers and participate in the discussion.</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>no script</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>Individual research papers are selected each term. See <a href="http://graphics.ethz.ch/">http://graphics.ethz.ch/</a> for the current list.</td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: The courses “Computer Graphics I and II” (GDV I &amp; II) are recommended, but not mandatory.</td>
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</tbody>
</table>

### Research Topics in Software Engineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>263-2100-00L</td>
<td>Research Topics in Software Engineering</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>P. Müller</td>
</tr>
<tr>
<td>Abstract</td>
<td>This seminar is an opportunity to become familiar with current research in software engineering and more generally with the methods and challenges of scientific research.</td>
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</tr>
<tr>
<td>Objective</td>
<td>Each student will be asked to study some papers from the recent software engineering literature and review them. This is an exercise in critical review and analysis. Active participation is required (a presentation of a paper as well as participation in discussions).</td>
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</tbody>
</table>
Content

The aim of this seminar is to introduce students to recent research results in the area of programming languages and software engineering. To accomplish that, students will study and present research papers in the area as well as participate in paper discussions. The papers will span topics in both theory and practice, including papers on program verification, program analysis, testing, programming language design, and development tools.

Literature

The publications to be presented will be announced on the seminar homepage at least one week before the first session.

Prerequisites / notice

Organizational note: the seminar will meet only when there is a scheduled presentation. Please consult the seminar’s home page for information.

263-4200-00L Seminar SAT

Abstract

Study and presentation of research papers from the literature on “Boolean Satisfiability-Combinatorics and Algorithms”.

Objective

The goal of this seminar is to study and present, in continuation of the course “Boolean Satisfiability-Combinatorics and Algorithms”, research papers from the literature.

Literature

A list of papers for presentations will be distributed at the beginning of the seminar.

263-4203-00L Geometry: Combinatorics and Algorithms

Abstract

This seminar is held once a year and complements the courses Computational Geometry and Geometric Graphs: Combinatorics & Algorithms. Students of the seminar will present original research papers, some classic and some of them very recent. The seminar is a good preparation for a master, diploma, or semester thesis in the area.

Objective

Each student is expected to read, understand, and elaborate on a selected research paper. To this end, (s)he should give a 45-min. presentation about the paper. The process includes:

- getting an overview of the related literature;
- understanding and working out the background/motivation: why and where are the questions addressed relevant?
- understanding the contents of the paper in all details;
- selecting parts suitable for the presentation;
- presenting the selected parts in such a way that an audience with some basic background in geometry and graph theory can easily understand and appreciate it.

Prerequisites / notice

To attend the seminar, some basic knowledge in (discrete and computational) geometry and graphs and algorithms is required. Thus, previous participation in some of the courses “Graphs and Algorithms”, “Computational Geometry”, “Geometric Graphs: Combinatorics & Algorithms”, or similar courses is strongly encouraged. It is also possible to take this seminar in parallel to the lecture “Computational Geometry”.

Certificate of Advanced Studies in Computer Science - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Code</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td></td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td></td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
<td></td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
<td></td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
<td></td>
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</table>

Key for Hours

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Nutrition and Chronic Disease (HS)

**Number:** 752-6101-00L  
**Title:** Nutrition and Chronic Disease (HS)  
**Type:** W  
**ECTS:** 3 credits  
**Hours:** 2V  
**Lecturers:** M. B. Zimmermann

**Abstract:**
To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

**Objective:**
To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.

**Content:**
The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

**Lecture notes:**
There is no script. Powerpoint presentations will be made available on-line to students.

**Literature:**
To be provided by the individual lecturers, at their discretion.

**Prerequisites / notice:**
No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.

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### Nutrition and Performance

**Number:** 752-6403-00L  
**Title:** Nutrition and Performance  
**Type:** W  
**ECTS:** 2 credits  
**Hours:** 2V  
**Lecturers:** S. Mettler, M. B. Zimmermann

**Abstract:**
The course introduces basic concepts of the interaction between nutrition and exercise and cognitive performance.

**Objective:**
To understand the potential effects of nutrition on exercise performance, with a focus on concepts and principles of nutrition before, during and after exercise.

**Content:**
The course will cover elementary aspects of sports nutrition physiology, including carbohydrate, glycogen, fat, protein and energy metabolism. A main focus will be to understand nutritional aspects before exercise to be prepared for intensive exercise bouts, how exercise performance can be supported by nutrition during exercise and how recovery can be assisted by nutrition after exercise.

Although this is a scientific course, it is a goal of the course to translate basic sports nutrition science into practical sports nutrition examples.

**Lecture notes:**
Lecture slides and required handouts will be available on the ETH website.

**Literature:**
Information on further reading will be announced during the lecture. There will be some mandatory as well as voluntary readings.

**Prerequisites / notice:**
General knowledge about nutrition, human biology, physiology and biochemistry is a prerequisite for this course. The course builds on basic nutrition and biochemistry knowledge to address exercise and performance related aspects of nutrition.

The course is designed for 3rd year Bachelor students, Master students and postgraduate students (MAS/CAS).

**Language:** English

It is strongly recommended to attend the lectures. The lecture (including the handouts) is not designed for distance education.

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### Epidemiology and Prevention

**Number:** 752-6105-00L  
**Title:** Epidemiology and Prevention  
**Type:** W  
**ECTS:** 3 credits  
**Hours:** 2V  
**Lecturers:** M. Eichholzer

**Abstract:**
The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented.

**Objective:**
Students are able
- to evaluate the scientific evidence on the effects of diet on human health
- to describe the role of nutritional factors in the prevention of chronic diseases
- to assess the nutritional status of a population (Switzerland taken as an example)
- to put forward preventive measures addressing individuals but also our society in relation to the obesity epidemic

**Content:**
The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented. Switzerland taken as an example, the health risks associated with our nutritional habits will be evaluated. Finally, examples of preventive measures addressing individuals but also the society in relation to the obesity epidemic and other threats to health are discussed.

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**CAS in Nutrition for Disease Prevention and Health - Key for Type**

<table>
<thead>
<tr>
<th>Key for Type</th>
<th>Description</th>
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<tbody>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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</table>

**Key for Hours**

<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
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**ECTS**
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Chemistry (General Courses)

### General Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0073-00L</td>
<td>Radiochemistry</td>
<td>E-</td>
<td>2 credits</td>
<td>2V</td>
<td>M. Badertscher</td>
</tr>
<tr>
<td>Abstract</td>
<td>Principles and phenomena around radioactivity.</td>
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<tr>
<td>Objective</td>
<td>Knowledge of the most important phenomena in relation with radioactivity. Knowledge of the principles of radiation protection. Ability to judge dangerous situations in handling radioactive materials, geopolitically as well as locally at ones own working place.</td>
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<tr>
<td>Content</td>
<td>Structure and properties of atomic nuclei, mathematical description of the radioactive decay, decay types, interaction of radiation with matter, detectors for ionizing radiation, radiation protection, principles of isotope separation, nuclear power plants, major nuclear accidents. Additional topics may be suggested by the students.</td>
<td></td>
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<tr>
<td>Lecture notes</td>
<td>A script is available free of charge.</td>
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<tr>
<td></td>
<td>Weitere Literaturangaben werden nach Bedarf in der Vorlesung abgegeben.</td>
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<tr>
<td>529-0075-00L</td>
<td>Radiochemistry (Practical Training)</td>
<td>E-</td>
<td>4 credits</td>
<td>4P</td>
<td>M. Badertscher</td>
</tr>
<tr>
<td>Objective</td>
<td>Knowledge of the most important phenomena in relation with radioactivity. Knowledge of the principles of radiation protection. Ability to handle radioactive material.</td>
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<tr>
<td>Content</td>
<td>Handling open and closed radioactive sources. Getting accustomed to a variety of instruments and detectors for various kinds of ionizing radiation. Acquisition of working techniques under consideration of radiation protection. Comprehensive material is available online.</td>
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<tr>
<td>Lecture notes</td>
<td>This Praktikum is also an integral part of the Praktikum 529-0057-01L &quot;Analytische Chemie&quot;.</td>
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<tr>
<td>Abstract</td>
<td>Institute-Seminar covering current research Topics in Physical Chemistry</td>
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<tr>
<td>529-1100-00L</td>
<td>Fragrance Chemistry</td>
<td>E-</td>
<td>1 credit</td>
<td>1V</td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>Does not take place this semester.</td>
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<tr>
<td>Objective</td>
<td>The lecture provides a journey into the molecular world of scents from the chemical secrets behind Chanel N°5 to structure-odor relationships, industrial processes, and total synthesis of terpenoids. Each subunit is centered on one odorant family and highlights a certain class of chemical reactions, illustrated by prominent perfumery examples.</td>
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<tr>
<td>Content</td>
<td>After completion of this lecture module the students know all the major perfumery materials of the important odor families with their academic and industrial syntheses, their olfactory properties, their usage, their historic perspective, and today's economic importance. The students can explain the significance of important building blocks and industrial transformations, and can estimate how attractive chemical processes are on large scale. They can retrosynthetically plan academic and industrial syntheses of fragrant compounds and terpenoids, and the acquired knowledge on structure-odor relationships enables them to predict and design new odorants. The students can approximate the conformational space of odorants and especially macrocycles on the basis of simple rules, and know how olfactophore models are used. The students understand and can explain the molecular mechanism of smell, the biosynthesis of terpenes, and the basics of perfumery composition. The latter enables them to further their education in perfumery at specialized Universities such as the ISIPCA in Versailles; yet, the student also knows about the links of Fragrance Chemistry with Pharmaceutical Chemistry and the Specialty Chemicals business in general.</td>
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<tr>
<td>529-0688-00L</td>
<td>Safety Lecture for Assistants</td>
<td>Z</td>
<td>0 credits</td>
<td></td>
<td>T. Máder</td>
</tr>
<tr>
<td>Abstract</td>
<td>Safety-Praxis und Riskmanagement in Laboratorien</td>
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<tr>
<td>Objective</td>
<td>Gute Safety-Praxis</td>
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<tr>
<td>Content</td>
<td>Safety-Regeln, Riskmanagement im Labor, Safety-Parcours</td>
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</tbody>
</table>

### Chemistry (General Courses) - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Type Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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</table>

### Key for Hours

<table>
<thead>
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<th>Symbol</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<td>G</td>
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</tr>
</tbody>
</table>

ECTS | European Credit Transfer and Accumulation System |

Special students and auditors need special permission from the lecturers.
### 1. Semester

**Compulsory Subjects First Year Examinations**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tbody>
<tr>
<td>529-0011-02L</td>
<td>General Chemistry (Inorganic Chemistry) I</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>A. Togni</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Introduction to the chemistry of ionic equilibria; Acids and bases, redox reactions, formation of coordination complexes and precipitation reactions</td>
<td></td>
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<tr>
<td><strong>Objective</strong></td>
<td>Understanding and describing ionic equilibria from both a qualitative and a quantitative perspective</td>
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</tr>
<tr>
<td><strong>Content</strong></td>
<td>Chemical equilibrium and equilibrium constants, mono- and polyprotic acids and bases in aqueous solution, calculation of equilibrium concentrations, acidity functions, Lewis acids, acids in non-aqueous solvents, redox reactions and equilibria, Galvanic cells, electrode potentials, Nernst equation, coordination chemistry, stepwise formation of metal complexes, solubility</td>
<td></td>
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</tr>
<tr>
<td><strong>Lecture notes</strong></td>
<td>Copies of the course slides as well as other documents will be provided as pdf files via the ILIAS platform (myStudies)</td>
<td></td>
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<tr>
<td>529-0011-03L</td>
<td>General Chemistry (Organic Chemistry) I</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>H. Wennemers</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Introduction to Organic Chemistry. Classical structure theory, stereochemistry, chemical bonds and bonding, symmetry, nomenclature, organic thermochemistry, conformational analysis, basics of chemical reactions.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Introduction to the structures of organic compounds as well as the structural and energetic basis of organic chemistry.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Introduction to the history of organic chemistry, introduction to nomenclature, learning of classical structures and stereochemistry: isomerism, Fischer projections, CIP rules, point groups, molecular symmetry and chirality, topicity, chemical bonding; Lewis bonding model and resonance theory in organic chemistry, description of linear and cyclic conjugated molecules, aromaticity, Huckel rules, organic thermochemistry, learning of organic chemistry reactions, intermolecular interactions.</td>
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</tr>
<tr>
<td><strong>Lecture notes</strong></td>
<td>Underlagen werden als PDF über die ILIAS-Plattform zur Verfügung gestellt</td>
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<td></td>
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</tr>
<tr>
<td>529-0011-01L</td>
<td>General Chemistry (Physical Chemistry) I</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>F. Merkt</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Atomic structure and structure of matter; Atomic orbitals and energy levels; Quantum mechanical atom model; Chemical bonding; Equations of state.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Introduction to Physical Chemistry</td>
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</tr>
<tr>
<td><strong>Content</strong></td>
<td>Atomic structure and structure of matter: atomic theory, elementary particles, atomic nuclei, radioactivity, nuclear reactions. Atomic orbitals and energy levels: ionisation energies, atomic spectroscopy, term values and symbols. Quantum mechanical atom model: wave-particle duality, the uncertainty principle, Schrödinger’s equation, the hydrogen atom, construction of the periodic table of the elements.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>See homepage of the lecture.</td>
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<tr>
<td><strong>Literature</strong></td>
<td>See homepage of the lecture.</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Voraussetzungen: Maturastoff. Insbesondere Integral- und Differentialrechnung.</td>
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<tr>
<td>551-0015-00L</td>
<td>Biology I</td>
<td>O</td>
<td>2 credits</td>
<td>2V</td>
<td>R. Glockshuber, E. Hafen</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>The lecture Biology I, together with the lecture Biology II in the following summer semester, is a basic, introductory course into Biology for Students of Materials Sciences and other students with biology as subsidiary subject.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>The goal of this course is to give the students a basic understanding of the molecules that build a cell and make it function, and the basic principles of metabolism and molecular genetics.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Die folgenden Kapitelnummern beziehen sich auf das Vorlesungsprogramm der Lehrbuch &quot;Biology&quot; (Campbell &amp; Rees, 7th edition, 2005) Kapitel 1-4 des Lehrbuchs werden als Grundwissen vorausgesetzt</td>
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<tr>
<td>1. <strong>Aufbau der Zelle</strong></td>
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<tr>
<td>Kapitel 5: Struktur und Funktion biologischer Makromoleküle</td>
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<td>Kapitel 6: Eine Tour durch die Zelle</td>
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<td>Kapitel 7: Membranstruktur und-funktion</td>
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<tr>
<td>Kapitel 8: Einführung in den Stoffwechsel</td>
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<tr>
<td>Kapitel 9: Zelluläre Atmung und Speicherung chemischer Energie</td>
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<td>Kapitel 10: Photosynthese</td>
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<td>Kapitel 12: Der Zellzyklus</td>
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<td>Kapitel 17: Vom Gen zum Protein</td>
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<td>2. <strong>Allgemeine Genetik</strong></td>
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<td>Kapitel 13: Meiose und Reproduktionszyklen</td>
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<tr>
<td>Kapitel 14: Mendel'sche Genetik</td>
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<td>Kapitel 15: Die chromosomale Basis der Vererbung</td>
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<tr>
<td>Kapitel 16: Die molekulare Grundlage der Vererbung</td>
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<tr>
<td>Kapitel 18: Genetik von Bakterien und Viren</td>
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<tr>
<td>Kapitel 46: Tierische Reproduktion</td>
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<tr>
<td>Grundlagen des Stoffwechsels und eines Überblicks über molekulare Genetik</td>
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<tr>
<td>Der Vorlesungsstoff ist sehr nahe am Lehrbuch gehalten, Skripte werden ggf. durch die Dozenten zur Verfügung gestellt.</td>
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<tr>
<td>Das folgende Lehrbuch ist Grundlage für die Vorlesungen Biologie I und II:</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Zur Vorlesung Biologie I gibt es während der Prüfungsphasen eine einstündige, schriftliche Prüfung. Die Vorlesung Biologie II wird separat geprüft.</td>
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<tr>
<td>401-0271-00L</td>
<td>Mathematical Foundations I: Analysis A</td>
<td>O</td>
<td>5 credits</td>
<td>3V+2U</td>
<td>T. Bühler</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Introduction to calculus in one dimension. Building simple models and analysing them mathematically. Functions of one variable: the notion of a function, of the derivative, the idea of a differential equation, complex numbers, Taylor polynomials and Taylor series. The integral of a function of one variable.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Introduction to calculus in one dimension. Building simple models and analysing them mathematically.</td>
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</tbody>
</table>
Content
Functions of one variable: the notion of a function, of the derivative, the idea of a differential equation, complex numbers, Taylor polynomials and Taylor series. The integral of a function of one variable.

Literature
D. W. Jordan, P. Smith: Mathematische Methoden für die Praxis, Spektrum Akademischer Verlag
R. Spéry/M. Akvedal: Analysis I (vdf)
L. Papula: Mathematik für Ingenieure und Naturwissenschaftler (3 Bände), Vieweg

529-0001-00L
Introduction to Computer Science
O
4 credits
2V+2U
P. H. Hünenberger

Abstract
Introduction to UNIX, data representation, introduction to C++ programming, errors, algorithms, computer architecture, sorting and searching, databases, numerical algorithms, types of algorithms, simulation, data communication & networks, chemical structures, operating systems, programming languages, software engineering.

For more information: www.csms.ethz.ch/education/infol

Objective
Discuss fundamentals of computer architecture, languages, algorithms and programming with an eye to their application in the area of chemistry, biology and material science.

Content
Minimal introduction to UNIX, Data representation and processing, algorithms and programming in C++, Errors, programming guidelines, efficiency, computer architecture, algorithms for sorting and searching, databases, numerical algorithms, types of algorithms, simulation, data communication & networks, chemical structures, operating systems, programming languages, style, software engineering.

Lecture notes
Available (in English), distributed at first lecture

Literature
See: www.csms.ethz.ch/education/infol

Prerequisites / notice
Since the exercises on the computer do convey and test essentially different skills as those being conveyed during the lectures and tested at the written exam, the results of the exercises are taken into account when evaluating the results of the exam.

For more information about the lecture: www.csms.ethz.ch/education/infol

Laboratory Courses

Number Title Type ECTS Hours Lecturers
529-0011-04L Practical Course General Chemistry ■ O 8 credits 12P H. V. Schönberg, E. C. Meister

Information about the practical course will be given on the first day.

Abstract
Qualitative analysis (determination of cations and anions), acid-base-equilibria (pH-values, titrations, buffer), precipitation equilibria (gravimetry, potentiometry, conductivity), redox reactions (syntheses, redox-titrations, galvanic elements), metal complexes (syntheses, complexometric titration) analysis of measured values, states of aggregation (vapour pressure, conductivity, calorimetry)

Objective
Qualitative analysis (simple cation and anion separation process, determination of cations and anions), acid-base-equilibria (strengths of acids and bases, pH- and pKa-values, titrations, buffer systems, Kjeldahl determination), precipitation equilibria (gravimetry, potentiometry, conductivity), oxidation state and redox behaviour (syntheses), redox-titrations, galvanic elements), metal complexes (syntheses of complexes, ligand exchange reactions, complexometric titration) analysis of measured values (measuring error, average value, error analysis), states of aggregation (vapour pressure), characteristics of electrolytes (conductivity measurements), thermodynamics (calorimetry)

Content
The general aim for the students of the practical course in general chemistry is an introduction in the scientific work and to get familiar with simple experimental procedures in a chemical laboratory. In general, first experiences with the principal reaction behaviour of a variety of different substances will be made. The chemical characteristics of these will be elucidated by a series of quantitative experiments alongside with the corresponding qualitative analyses. In order to get an overview of classes of substances as well as some general phenomena in chemistry suitable experiments have been chosen. In the second part of the practical course, i.e. physical chemistry, the behaviour of substances in their states of aggregation as well as changes of selected physical values will be recorded and discussed.

Lecture notes
http://www.gruetzmacher.ethz.ch/education/labcourses

Prerequisites / notice
Compulsory: online enrolment latest one week prior start of the semester

3. Semester

Compulsory Subjects Examination Block I

Number Title Type ECTS Hours Lecturers
529-0121-00L Inorganic Chemistry I O 3 credits 2V+1U A. Mezzetti

Abstract
Complexes of the transition metals: structure, bonding, spectroscopic properties, and synthesis.

Objective
Introduction to the binding theory in complexes of the transition metals. Interpretation of structure, bonding, and spectroscopic properties. General synthetic strategies.

Content
The chemical bond (overview). Symmetry and group theory. The chemical bond of coordination compounds (Valence Bond Theory, Crystal Field Theory, Molecular Orbital Theory (sigma- and pi-bonding), pi-Accepting ligands (CO, NO, olefins, dioxygen, dihydrogen, phosphines and phosphites). Electronic spectra of coordination compounds (Tanabe-Sugano diagrams). Coordination numbers and isomers in complexes. Dynamic phenomena (stereochemical nonrigidity). Complexes and kinetics.

Lecture notes
Can be bought at the HSCI-shop

Literature

529-0221-00L Organic Chemistry I O 3 credits 2V+1U F. Diederich, C. Schaack

Abstract
Chemical reactivity and classes of compounds. Eliminations, fragments, chemistry of aldehydes and ketones (hydrates, acetals, imines, enamines, nucleophilic addition of organometalloc compounds, reactions with phosphorus and sulfur ylides; reactions of enolates as nucleophiles) and of carboxylic acid derivatives. Aldol reactions.

Objective
Acquisition of a basic repertoire of synthetic methods including important reactions of aldehydes, ketones, carboxylic acids and carboxylic acid derivatives, as well as eliminations and fragmentations. Particular emphasis is placed on the understanding of reaction mechanisms and the correlation between structure and reactivity. A deeper understanding of the concepts presented during the lecture is reached by solving the problems handed out each time and discussed one week later in the exercise class.

Content
Chemical reactivity and classes of compounds. Eliminations, fragmentations, chemistry of aldehydes and ketones (hydrates, acetals, imines, enamines, nucleophilic addition of organometalloc compounds, reactions with phosphorus and sulfur ylides; reactions of enolates as nucleophiles) and of carboxylic acid derivatives. Aldol reactions.

Lecture notes
A pdf file of the printed lecture notes is provided online. Supplementary material may be provided online.

Literature
No set textbooks. Optional literature will be proposed at the beginning of the class and in the lecture notes.

529-0422-00L Physical Chemistry II: Introduction to Chemical Reaction Kinetics O 4 credits 3V+1U H. J. Wörner
Abstract

Objective
Introduction to Chemical Reaction Kinetics

Content

Lecture notes

Literature

Prerequisites / notice
Voraussetzungen:
- Mathematik I und II
- Allgemeine Chemie I und II
- Physikalische Chemie I

402-0043-00L Physics I

Objective
Introduction to the concepts and tools in physics with the help of demonstration experiments: mechanics of point-like and ridged bodies, periodic motion and mechanical waves.

Content
Mechanics (motion, Newton's laws, work and energy, conservation of momentum, rotation, gravitation, fluids)

Lecture notes
The lecture follows the book "Physics" by Paul A. Tipler.

Literature

Prerequisites / notice
Prerequisites: Mathematics I & II

529-0051-00L Analytical Chemistry I

Objective
Knowledge about the necessary theoretical background of spectroscopical methods and their practical applications

Content
Application oriented basics of organic and inorganic instrumental analysis and of the empirical employment of structure elucidation methods:
- Mass spectrometry: Ionization methods, mass separation, isotope signals, rules of fragmentation, rearrangements.
- NMR spectroscopy: Experimental basics, chemical shift, spin-spin coupling.
- IR spectroscopy: Revisiting topics like harmonic oscillator, normal vibrations, coupled oscillating systems (in accordance to the basics of the related lecture in physical chemistry); sample preparation, acquisition techniques, law of Lambert and Beer, interpretation of IR spectra; Raman spectroscopy.

Lecture notes
Script will be for the production price

Literature
- M. Hesse, H. Meier, B. Zeeh, Spektroskopische Methoden in der organischen Chemie, 5. überarbeitete Auflage, Thieme, Stuttgart, 1995

Prerequisites / notice
Exercises are integrated in the lectures. In addition, attendance in the lecture 529-0289-00 "Instrumental analysis of organic compounds" (4th semester) is recommended.

401-0373-00L Mathematics III: Partial Differential Equations

Objective
The main objective is that the students get a basic knowledge of the classical tools to solve explicitly linear partial differential equations.
## Examples of partial differential equations
- Classification of PDEs
- Superposition principle

## One-dimensional wave equation
- D'Alembert's formula
- Duhamel's principle

## Fourier series
- Representation of piecewise continuous functions via Fourier series
- Examples and applications

## Separation of variables
- Resolution of wave and heat equation
- Homogeneous and inhomogeneous boundary conditions, Dirichlet and Neumann boundary conditions

## Laplace equation
- Resolution of the Laplace equation on rectangle, disk and annulus
- Poisson formula
- Mean value theorem and maximum principle

## Fourier transform
- Derivation and Definition
- Inverse Fourier transformation and inversion formula
- Interpretation and properties of the Fourier transform
- Resolution of the heat equation

## Laplace transform
- Definition, motivation and properties
- Inverse Laplace transform of rational functions
- Application to ordinary differential equations

Lecture notes
There are available some Lecture Notes in English and also in German of the Professor. These can be found following the links provided under the tab 'Lernmaterialien'.

Literature
2) Y. Pinchover and J. Rubinstein, An Introduction to Partial Differential Equations, Cambridge University Press
3) E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons (only Chapters 1,2,6,11)

Prerequisites / notice
Prerequisites:
- Practical Course General Chemistry (1. Semester, 529-0011-04)
- Practical Course Inorg. and Org. Chemistry I (2. Sem., 529-0230)
- Attendance of Course Inorg. Chemistry 1 (3. Sem., 529-0121)

5. Semester

### Compulsory Subjects Examination Block II

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>529-0132-00L</td>
<td>Inorganic Chemistry III: Organometallic</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>A. Togni, A. Mezzetti</td>
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<td>Chemistry and Homogeneous Catalysis</td>
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<td>Abstract</td>
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<td>Fundamental aspects of the organometallic</td>
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<td>chemistry of the transition elements.</td>
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<td>Mechanistic homogeneous catalysis</td>
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<td>Towards an understanding of the</td>
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<td>fundamental coordination-chemical and</td>
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<td>mechanistic aspects of transition-metal</td>
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<td>chemistry relevant to homogeneous</td>
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<td>Fundamental aspects of the organometallic</td>
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<td>Mechanistic homogeneous catalysis</td>
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<td>including oxidative additions, reductive</td>
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<td>eliminations and insertion reactions.</td>
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<td>Catalytic hydrogenation, carbylation,</td>
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<td>C-C bond-forming and related reactions.</td>
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<td>529-0231-00L</td>
<td>Organic Chemistry III: Introduction to</td>
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<td>3G</td>
<td>E. M. Carreira</td>
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<td>Asymmetric Synthesis</td>
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<td>Abstract</td>
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<td>Methods of Asymmetric Synthesis</td>
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<td>Understanding of the basic principles of</td>
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<td>diastereoselective synthesis</td>
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Content

- Conformational analysis: acyclic and cyclic systems; Diastereoselective sigmatropic rearrangements; Diastereoselective Carbonyl addition reactions: Cram- and Felkin-Anh models, carbonyl Lewis acid interactions, chelate controlled reactions; chemistry of enolates, selective formation; asymmetric enolate alkylation; aldol reactions, allyl- and crotyl-metal chemistry; cyclisations, Baldwin rules; Diastereoselective olefin functionalization: hydroboration, dihydroxylation, epoxidation.

Literature


<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>529-0449-00L</td>
<td>Spectroscopy</td>
<td>O</td>
<td>13</td>
<td>13P</td>
<td>E. Meister, G. Jeschke, B. H. Meier, F. Merkt, R. Riek, R. Signorell, H. J. Wörner</td>
</tr>
<tr>
<td>529-0141-00L</td>
<td>Physical Methods for Inorganic Chemistry</td>
<td>W</td>
<td>6</td>
<td>3G</td>
<td>D. Günther, J. Koch, R. Verel, M. D. Wörle</td>
</tr>
<tr>
<td>529-0041-00L</td>
<td>Signal Processing</td>
<td>W</td>
<td>6</td>
<td>3G</td>
<td>M. Jeschke, M. Yulikov</td>
</tr>
<tr>
<td>529-0041-00L</td>
<td>Modern Mass Spectrometry, Hyphenated Methods, and Chemometrics</td>
<td>W</td>
<td>6</td>
<td>3G</td>
<td>R. Ženobi, M. Badertscher, B. Hattendorf, P. Martínez-Lozano, Sinues</td>
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</table>
### Biological Chemistry

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0731-00L</td>
<td>Nucleic Acids and Carbohydrates</td>
<td>W</td>
<td>6</td>
<td>3G</td>
<td>D. Hilvert, P. A. Kast, S. J. Sturla, H. Wennemers</td>
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</tbody>
</table>

**Abstract**
Structure, function and chemistry of nucleic acids and carbohydrates. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genetics; antisense approach and RNAi; polymersases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

**Objective**
Structure, function, and chemical behavior of DNA/RNA. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genetics; antisense approach and RNAi; polymersases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

**Content**
Structure, function, and chemical behavior of DNA/RNA. DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genetics; antisense approach and RNAi; polymersases and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines

**Lecture notes**
no script

**Literature**
Mainly based on recent original literature, a detailed list will be distributed during the first lecture

### Chemical Aspects of Energy

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0659-00L</td>
<td>Electrochemistry</td>
<td>W</td>
<td>6</td>
<td>3G</td>
<td>P. Novák</td>
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</tbody>
</table>

**Abstract**

**Objective**
Toward the end of the course the students will understand the basics of electrochemistry and will be able to describe and calculate electrochemistry-related matters in industrial processes and products.

**Content**

### Chemical Crystallography

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<tr>
<th>Number</th>
<th>Title</th>
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<tbody>
<tr>
<td>529-0039-00L</td>
<td>Principles of Crystal Structure Determination</td>
<td>W</td>
<td>6</td>
<td>3G</td>
<td>M. D. Wörle, N. Trapp</td>
</tr>
</tbody>
</table>

**Abstract**
An introduction to the principles of X-ray diffraction and crystal structure determination as it relates to Chemistry

**Objective**
To gain an understanding of the principles of crystal structure determination by X-ray diffraction.

**Content**
Basic crystallographic concepts: Unit cells, Bravais lattices, Laue symmetry, crystal classes (point groups), space groups, crystal growth, instrumentation, diffraction of X-rays by crystals: physical and geometric basics, powder and single crystal methods, structure solution and modelling, interpretation of crystal structure data; internal coordinates for structure description: atom spacing, co-ordination polyhedra, bond angles, torsion angles; intermolecular interactions, absolute configuration determination. Overview of inorganic, organic and macromolecular databases.

**Lecture notes**
The script and exercises will be distributed weekly in loose form

**Literature**
Main reference


### Computational Chemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0002-00L</td>
<td>Algorithms and Programming in C++</td>
<td>W</td>
<td>6</td>
<td>3G</td>
<td>S. Riniker</td>
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</tbody>
</table>

**Abstract**
Introduction to algorithms (special focus on chemistry); Design of algorithms, data structures, search and sort algorithms, graphs, numerical algorithms, algorithms in cheminformatics; Computer language: C++

**Objective**
Development of programming skills and craftsmanship in order to be able to deal with the complexity of computer applications in chemistry.
Introduction to algorithms (special focus chemistry):
Design of algorithms, data structures, search and sort algorithms, graphs, numerical algorithms, algorithms in cheminformatics

Computer language: C++

Lecture notes
Script (in English) will be available

Literature

C++ programming:

Prerequisites / notice
Since the exercises on the computer do convey and test essentially different skills as those being conveyed during the lectures and tested at the oral exam, the results of the exercises are taken into account when evaluating the results of the exam.

Materials Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0947-00L</td>
<td>Basic Polymer Synthesis</td>
<td>W</td>
<td>6</td>
<td>3G</td>
<td>A. D. Schlüter</td>
</tr>
</tbody>
</table>

Abstract
Chain-growth polymerizations (anionic, cationic, Ziegler/Natta, ROMP, radical, NMP, ATRP, RAFT), mechanistic details including how to render a polymerization "living", recent developments, and important examples.

Objective
The students should gain an overview of important polymerization procedures, learn how to deal with chemical structures and reactivities, and be able to suggest reasonable synthetic pathways to a given polymer structure. Aspects like achievable molar masses in dependence of the method used and structure perfection play a role throughout.

Content
I. Anionic polymerization
1. General
2. Living polymerization
3. Group transfer polymerization (GTP)
4. Some recent developments

II. Cationic polymerization
1. General
2. Some applications (macromonomer and telechelics)

III. Ziegler/Natta- and metallocene polymerization
1. General
2. Mechanism
3. Some applications

IV. Ring-opening metathesis polymerization
1. Comments on history
2. Monomers, catalysts, polymer structures
3. Mechanism, direct NMR monitoring
4. Termination
5. Examples

V. Controlled radical polymerization
1. Nitroxide mediated polymerization (NMP)
2. Atom transfer radical polymerization (ATRP)
3. Reversible addition fragmentation chain transfer polymerization (RAFT)

For step-growth procedures and other topics (dendrimers, bottle-brushes, macrocycles, polyrotaxanes, topochemical polymerizations etc.) see Advanced Polymer Synthesis

Lecture notes
A script will not be provided. For all projections shown, however, paper copies will be distributed.

Literature
There is no specific literature recommendation. Numerous references will be provided for an easy access to the original literature.

Prerequisites / notice
The course will be taught in English. Complicated expressions will be explained in German. Questions can be asked in both languages. The examination will be in English; answers are acceptable in both languages.

Environmental Chemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0037-01L</td>
<td>Introduction to Environmental Chemistry and Ecotoxicology</td>
<td>W</td>
<td>6</td>
<td>3G</td>
<td>K. Fenner, C. Bogdal, J. Hollender</td>
</tr>
</tbody>
</table>

Abstract
Production and use of chemicals also introduces them into the environment. This course introduces chemistry students to environmental chemistry, ecotoxicology and trace analysis.
Partitioning behavior and reactions of organic pollutants in the environment. Biodegradation, bioavailability and bioaccumulation. Ecotoxicological effects at the molecular level. Aspects of chemical trace analysis.

Objective
Goals:
* The students develop an understanding of the processes that govern the fate and effects of chemicals in the environment.
* The students know a number of methods for estimating the fate and effect of environmental pollutants. They recognize the relevant processes affecting a given compound and know how to use appropriate estimation methods for their quantification.
Part I: Fate of Chemicals in the Environment:
Overview on partitioning and transformation processes of chemicals in the environment.
Partitioning in the environment:
- Meaning of vapor pressure, water solubility and air-water partition coefficient for environmental behavior
- Octanol-water partition coefficient as surrogate for partitioning into biological systems
- Influence of temperature and pH on partitioning
- Global distribution of semi-volatile chemicals
- Molecular interactions that govern partitioning
- Sorption to natural surfaces, partitioning into natural organic matter

Chemical and photochemical transformation reactions
Microbial transformation processes in the environment

Part II: Effects of chemicals in the environment
Biological test systems for assessing ecotoxicological effects
Endpoints of toxicity assessment:
- Acute and chronic toxicity, effects on reproduction
- Dose-response modeling
Bioavailability and bioaccumulation:
- Bioconcentration, biomagnification, food chain accumulation
- Active and passive uptake mechanisms

Biokinetics and toxicodynamics:
- Metabolism and transformation reactions of pollutants in organisms, phase I and II transformations
- Detoxification, active excretion
Molecular mechanisms of toxicity in cells:
- Baseline toxicity
- Specific toxicity (Examples: Inhibition of photosynthesis, neurotoxicity, including AchEsterase, ion channels etc.)
- Oxidative stress
- Genotoxicity

Part III: Specific aspects of trace analysis in the environment (soil, water, air)
Planning of analytical strategy and sampling
Enrichment procedures
Separation and detection
Quantification, screening for unknowns

Lecture notes
Copies of the slides and some articles are distributed

Literature

701-1233-00L Stratospheric Chemistry

4 credits
2V+1U
T. Peter, A. Stenke

Abstract

Objective
The lecture gives an overview on the manifold reactions which occur in the gas phase, in stratospheric aerosol droplets and in polar cloud particles. The focus is on the chemistry of stratospheric ozone and its influence through natural and anthropogenic effects. Especially the intercontinental air traffic and the ozone depletion caused by FCKW CFC in the mid-latitude and the polar regions as well as coupling with the greenhouse effect.

Content
Short presentation of thermodynamical and kinetic basics of chemical reactions: bi- and thermo rmolecular reactions, photo-dissociation. Introduction to the chemical family concept: active species, their source gases and reservoir gases. Detailed treatment of the pure oxygen family (odd oxygen) according to the Chapman chemistry. Radical reactions of the oxygen species with nitric oxide, active halogens (chlorine and bromine) and odd hydrogen. Ozone depletion cycles. Methane depletion and ozone production in the lower stratosphere (photo-smog reactions). Heterogeneous chemistry on the background aerosol and its significance for heavy air traffic. Chemistry and dynamics of the ozone hole: Formation of polar stratospheric clouds and chlorine activation.

Lecture notes
Documents are provided in the contact hours.

Literature

Prerequisites / notice
Prerequisites: Basics in physical chemistry are required and an overview equivalent to the bachelor course in atmospheric chemistry (lecture 701-0471-01) is expected.

701-1233-00 V starts in the first week of the semester. The exercises 701-1233-00 U will start only in the 2nd week of the semester.

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-CHAB:
see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability
see GESS Compulsory Electives: Language Courses

Chemistry Bachelor - Key for Type

<table>
<thead>
<tr>
<th>Compulsory</th>
<th>Eligible for credits and recommended</th>
<th>Eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Z</td>
<td>Suitable for doctorate</td>
<td></td>
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</table>

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 314 of 1434
## Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

### ECTS

- European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
Student Research Projects: Practical Research on

Understanding of research methods used in the empirical human sciences

The course is targeted at advanced students who have taken an interest in gathering practical research experience in the field of Learning & Instruction. In teams of two, students conduct their own research projects (planning, conducting, analyzing, interpreting, and presenting research); thus, the course requires a high amount of self-directed working. Students are personally advised, and supported in their research projects, by one of the researchers serving as lecturers in this course. During the first half the semester, relevant methodological issues are the topic of a series of plenary meetings; however, the major part of the work is done in small-group meetings with the advising researcher, and in self-directed research projects.

The successful completion of both course no. 851-0240-00L "Menschliches Lernen (EW 1)" and course no. 851-0238-01L "Unterstützung und Diagnose von Wissenserwerbsprozessen (EW 3)" is a necessary prerequisite for this course.

In teams of two, participants in this seminar conduct their own research project. Each team is advised by one of the researchers serving as lecturers in this course. Basic conceptual and methodological issues are the topic of a series of plenary meetings; however, the major part of the work is done in small-group meetings with the advising researcher, and in self-directed research projects.

The course is targeted at advanced students who have taken an interest in gathering practical research experience in the field of Learning & Instruction. In teams of two, students conduct their own research projects (planning, conducting, analyzing, interpreting, and presenting research); thus, the course requires a high amount of self-directed working. Students are personally advised, and supported in their research project, by one of the researchers serving as lecturers in this course. During the first half the semester, relevant methodological knowledge and skills are practiced during plenary meetings and in students’ independent reading (e.g. generating and testing research questions, designing experiments, and analyzing data in the field of Learning and Instruction)

Learning goals include:
- Participants can illustrate and explain basic methods and concepts for research in the fields of Learning and Instruction, e.g. with the help of practical examples.
- Participants can generate testable research questions for a topic relevant in the fields of Learning and Instruction.
- Participants can design and conduct a study that is relevant for answering their research question.
- Participants can summarize and evaluate the main results from a study in the field of learning and Instruction, with regard to the research question being asked.

see Educational Science Teaching Diploma

Important: You can only enrol in the courses of this category if you have not more than 12 CP left for possible additional requirements.
### 529-0950-00L Subject Didactics Chemistry I

**Abstract**
Implementing findings from research into teaching and learning for chemistry lessons and coverage of subject-specific teaching and learning specialities.

**Objective**
- Among other things, students are put in a position where they can
  - divide up the subject matter into contents that can be learned by heart or accessed intellectually, and communicate these contents.
  - break down technically complex contents to the right level for a class and still present these in a stringent, error-free manner in their simplified form.
  - establish which subject matter can be presented with which teaching techniques and methods that have been recognised as efficient in teaching terms, and adapt these tools to the learning content in question.
  - plan school experiments, incorporate them in lessons, perform them in accordance with all the rules of the art, and also evaluate them in a beneficial manner.
  - assess pupils' prior knowledge, clarify it in greater detail and take it into account for planning lessons.
  - design a sequential curriculum suitable for the levels in question and put it into practice.
  - reliably identify stumbling blocks in the contents and get round these.

**Content**
Schwerpunkte im ersten Studiensemester bilden die folgenden Themen:

- Auswahl gymnasiumsrelevanter Lerninhalte
- Modellbegriff in den Naturwissenschaften, insbesondere der Chemie
- Sprache und Fachsprache im Chemieunterricht
- Wechselspiel zwischen Beobachtungen in der realen Welt und Deutungsversuchen auf der Modell-Ebene
- Interdisziplinarität mit Biologie, Mathematik und Physik
- Leistungserhebung und -beurteilung im Theorie- und Laborunterricht
- Atommodelle und chemische Bindung
- Mathematische Beschreibung chemischer Systeme (z.B. Stöchiometrie und Gleichgewichtssysteme)
- Auswahl, Konzeption, Einbettung, Vorbereitung, Durchführung, Nachbereitung und Auswertung von Demonstrations- und Schüler-Experimenten

**Lecture notes**

**Literature**
Professional Training in Chemistry

**Important:** You can only enrol in the courses of this category if you have not more than 12 CP left for possible additional requirements.

<table>
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<tr>
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<th>Lecturers</th>
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<tr>
<td>529-0966-00L</td>
<td>Introductory Internship Chemistry I</td>
<td>O</td>
<td>3</td>
<td>6P</td>
<td>A. Baertsch</td>
</tr>
<tr>
<td></td>
<td><em>Simultaneous enrolment in Subject Didactics Chemistry I</em> - course 529-0950-00L - is compulsory.</td>
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</tr>
<tr>
<td>Abstract</td>
<td>During the introductory teaching practice, the students sit in on five lessons given by the teacher responsible for their teaching practice, and teach five lessons themselves. The students are given observation and reflection assignments by the teacher responsible for their teaching practice.</td>
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<tr>
<td>Objective</td>
<td>Right at the start of their training, students acquire initial experience with the observation of teaching, the establishment of concepts for teaching and the implementation of teaching. This early confrontation with the complexity of everything that teaching involves helps students decide whether they wish to and, indeed, ought to, continue with the training. It forms a basis for the subsequent pedagogical and subject didactics training.</td>
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</tr>
<tr>
<td>Literature</td>
<td>Wird von der Praktikumslehrperson bestimmt.</td>
<td></td>
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</tr>
<tr>
<td>Prerequisites</td>
<td>- Students use their specialist-subject, educational science and subject didactics training in the classroom. Students also conduct work assignments in parallel to their teaching practice.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>- Students use their specialist-subject, educational science and subject didactics training to draw up concepts for teaching.</td>
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<td></td>
<td>- They are able to assess the significance of tuition topics in their subject from different angles (including interdisciplinary angles) and impart these to their pupils.</td>
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<td>- They acquire the skills of the teaching trade.</td>
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<td>- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.</td>
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<td>- They learn to assess pupils’ work.</td>
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<td>- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.</td>
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</tr>
<tr>
<td>Literature</td>
<td>Wird von der Praktikumslehrperson bestimmt.</td>
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<tr>
<td>Prerequisites</td>
<td><em>Course 529-0950-00L - is compulsory.</em></td>
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<tr>
<td>529-0964-00L</td>
<td>Teaching Internship Chemistry II</td>
<td>W</td>
<td>4</td>
<td>9P</td>
<td>A. Baertsch</td>
</tr>
<tr>
<td>Abstract</td>
<td>This is a supplement to the Teaching Internship required to obtain a “Lehrdiplom” in the corresponding subject. It is aimed at enlarging the already acquired teaching experience. Students observe 10 lessons and teach 15 lessons independently.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>Findet in der Regel am Schluss der Ausbildung, vor Ablegung der Prüfungslektionen statt.</td>
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<tr>
<td>Prerequisites</td>
<td><em>Course 529-0950-00L - is compulsory.</em></td>
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<tr>
<td>529-0965-00L</td>
<td>Teaching Internship Chemistry II</td>
<td>W</td>
<td>4</td>
<td>9P</td>
<td>A. Baertsch</td>
</tr>
<tr>
<td>Abstract</td>
<td>This is a supplement to the Teaching Internship required to obtain a “Lehrdiplom” in the corresponding subject. It is aimed at enlarging the already acquired teaching experience. Students observe 10 lessons and teach 15 lessons independently.</td>
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</tr>
<tr>
<td>Objective</td>
<td>Die Studierenden können die Bedeutung von Unterrichtsthemen in ihrem Fach unter verschiedenen Blickwinkeln einschätzen. Sie kennen und beherrschen das Unterrichtsmittel. Sie können ein gegebenes Unterrichtsthema für eine Gruppe von Lernenden fachlich und didaktisch korrekt strukturieren und in eine adäquate Lernumgebung umsetzen. Gelingt ihnen, die Balance zwischen Anleitung und Offenheit zu finden, sodass die Lernenden sowohl über den nötigen Freiraum wie über ausreichend Orientierung verfügen, für aktiv und effektiv flexibel nutzbares (Fach-)Wissen zu erwerben.</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Literature</td>
<td><em>Course 529-0950-00L - is compulsory.</em></td>
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<tr>
<td>Prerequisites</td>
<td><em>Course 529-0950-00L - is compulsory.</em></td>
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</tr>
</tbody>
</table>
Amongst other things, students are put in a position to:
- appreciate whether experiments would make sense, or are even indispensable
- adapt experiments described in the literature to their own teaching situation
- develop experiments of their own
- plan and implement the incorporation of experiments in their tuition
- perform demonstration experiments in a technically correct and safe manner
- accompany pupils' experiments from the content, pedagogical and safety angles
- evaluate experiments together with the pupils
- observe the safety provisions

In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.

The candidates are required to:
- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.
- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle.
- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

Blockveranstaltung an einem Gymnasium in der Deutschschweiz.

Simultaneous enrolment in "Examination Lesson II Chemistry" (529-0968-02L) is compulsory.

Will mark the conclusion of the teacher training program in Chemistry.

In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.

On the basis of a specified topic, the candidate shows that they are in a position
- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle
- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.


Dokument: Schriftliche Vorbereitung für Prüfungslektionen.https://www.ethz.ch/content/dam/ethz/main/education/didaktische-ausbildung/Files/Diversen/schriftliche%20Unterrichtsvorb%C3%BCr%20Pr%C3%BCfung_04.11.2014..pdf

Nach Abschluss der Übrigen Ausbildung.

Simultaneous enrolment in "Examination Lesson II Chemistry" (529-0968-01L) is compulsory.

Will mark the conclusion of the teacher training program in Chemistry.

In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.

On the basis of a specified topic, the candidate shows that they are in a position
- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle
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Nach Abschluss der Übrigen Ausbildung.


<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0962-00L</td>
<td>Fundamental Aspects of Chemistry with an Educational Focus B</td>
<td>O</td>
<td>4</td>
<td>2V</td>
<td>A. Togni, R. Alberto</td>
</tr>
</tbody>
</table>
Abstract
Selected topics in general chemistry:
1) The language of chemistry
2) Chirality and stereochemistry
3) Oxidation of water
4) Chemistry of the atmosphere

Objective
In this course, participants acquire extended and more in-depth knowledge of selected chemistry topics. The selection is based to a large extent on the partial aspects of chemistry that are typically taught at high school. By gaining a broader understanding, teachers are put in a position where they can comprehend the topics that are to be taught in a wider and, to some extent, unconventional context and critically process these in respect of their teachability and learnability. At the same time, interrelationships between the classical sub-disciplines of chemistry are highlighted, along with the unique features of chemistry as one of the central natural sciences.

Content
Content of the four modules:
1) The language of chemistry: Concepts, formulas, aesthetics, and philosophical aspects
2) Chirality and stereochemistry: Selected aspects, origin of biomolecular chirality, inorganic chemistry
3) Cosmochemistry
4) Chemistry of the atmosphere

Lecture notes
Folien und ausgewählte Literatur werden zur Verfügung gestellt.

Literature
Ausgewählte Artikel aus der Primärliteratur werden vorgestellt, kommentiert und zur Lektüre empfohlen.

Prerequisites / notice
FV A (gelesen im Frühjahrsemester) und FV B (gelesen im Herbstsemester) bauen nicht aufeinander. Die Reihenfolge der Belegung ist somit indifferent.

529-0962-01L Mentored Work Specialised Courses in the Respective O 2 credits 4A R. Ciorciaro

Abstract
In the mentored work on their subject specialisation, students link high-school and university aspects of the subject, thus strengthening their teaching competence with regard to curriculum decisions and the future development of the tuition. They compile texts under supervision that are directly comprehensible to the targeted readers - generally specialist-subject teachers at high-school level.

Objective
The aim is for the students:
- to familiarise themselves with a new topic by obtaining material and studying the sources, so that they can selectively extend their specialist competence in this way;
- to independently develop a text on the topic, with special focus on its mathematical comprehensibility in respect of the level of knowledge of the targeted readership.
- To try out different options for specialist further training in their profession.

Content
Thematische Schwerpunkte:

Lernformen:

Lecture notes
Eine Anleitung zur mentorierten Arbeit in FV wird zur Verfügung gestellt.

Literature
Die Literatur ist themenspezifisch. Sie muss je nach Situation selber beschafft werden oder wird zur Verfügung gestellt.

Prerequisites / notice
Die Arbeit sollte vor Begin des Praktikums abgeschlossen werden.

Compulsory Elective Courses

Additional Requirements (ETH-Masterstudents in Chemical + Bioeng.)

Part 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>529-0200-00L</td>
<td>Research Project I</td>
<td>O</td>
<td>16 credits</td>
<td>16A</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract
In a research project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic. Research projects are carried out in a core or optional subject area as chosen by the student.

Objective
Students are accustomed to scientific work and they get to know one specific research field.

<table>
<thead>
<tr>
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<th>ECTS</th>
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<tbody>
<tr>
<td>529-0132-00L</td>
<td>Inorganic Chemistry III: Organometallic Chemistry and Homogeneous Catalysis</td>
<td>O</td>
<td>4 credits</td>
<td>3G</td>
<td>A. Togni, A. Mezzetti</td>
</tr>
</tbody>
</table>

Abstract
Fundamental aspects of the organometallic chemistry of the transition elements. Mechanistic homogeneous catalysis including oxidative additions, reductive eliminations and insertion reactions. Catalytic hydrogenation, carbynylation, C-C bond-forming and related reactions.

Objective
Towards an understanding of the fundamental coordination-chemical and mechanistic aspects of transition-metal chemistry relevant to homogeneous catalysis.

Content
Fundamental aspects of the organometallic chemistry of the transition elements. Mechanistic homogeneous catalysis including oxidative additions, reductive eliminations and insertion reactions. Catalytic hydrogenation, carbynylation, C-C bond-forming and related reactions.

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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>529-0231-00L</td>
<td>Organic Chemistry III: Introduction to Asymmetric Synthesis</td>
<td>O</td>
<td>4 credits</td>
<td>3G</td>
<td>E. M. Carreira</td>
</tr>
</tbody>
</table>

Abstract
Methods of Asymmetric Synthesis

Objective
Understanding the basic principles of diastereoselective synthesis

Content
Conformational analysis: acyclic and cyclic systems; Diastereoselective sigmatropic rearrangements; Diastereoselective Carbonyl addition reactions: Cram- and Felkin-Anh models, carbonyl Lewis acid interactions, chelate controlled reactions; chemistry of enolates, selective formation; asymmetric enolate alklylation; aldol reactions, allyl- and crotly-metal chemistry; cyclisations, Baldwin rules; Diastereoselective olefin functionalization: hydroboration, dihydroxylation, epoxidation.

Literature

529-0241-00L Advanced Methods and Strategies in Synthesis | O | 7 credits | 3G | J. W. Bode |

Abstract
Advanced Modern Methods and Strategies in Synthesis

Objective
Knowledge of modern methods in asymmetric stereocontrol, enantioselective catalysis, and organic reaction mechanisms.
Content
Current trends in methods for and approaches to synthesis of complex natural products, pharmaceuticals, and biological molecules; fragment coupling and protecting group strategies; chemical ligation and biomolecules synthesis; enantioselective catalysis including ligand design and optimization; cross coupling reactions from preactivated precursors; C-H activation and oxidation chemistry; building block synthesis with chiral auxiliaries and reagents; new concepts in asymmetric catalysis. Analysis of key primarily literature including identification of trends, key precendents, and emerging topics will be emphasized.

Lecture notes
will be provided in class and online

Literature
Suggesting Textbooks

see Chemistry Master > Electives

<table>
<thead>
<tr>
<th>Key for Type</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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Key for Hours

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<tr>
<td>V</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
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</table>

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
The basic principles of NMR in solids will be introduced. After the discussion of basic tools to describe NMR experiments, basic methods mathematical description of spin dynamics, important building blocks for multi-dimensional experiments are discussed to allow students a better understanding of modern solid-state NMR experiments.

### Organic Chemistry

#### 529-0241-00L Advanced Methods and Strategies in Synthesis

- **Abstract:** Advanced Modern Methods and Strategies in Synthesis
- **Objective:** Knowledge of modern methods in asymmetric stereocontrol, enantioselective catalysis, and organic reaction mechanisms.
- **Content:** Current trends in methods for and approaches to synthesis of complex natural products, pharmaceuticals, and biological molecules; fragment coupling and protecting group strategies; chemical ligation and biomolecules synthesis; enantioselective catalysis including ligand design and optimization; cross coupling reactions from preactivated precursors; C-H activation and oxidation chemistry; building block synthesis with chiral auxiliaries and reagents; new concepts in asymmetric catalysis. Analysis of key primarily literature including identification of trends, key precendents, and emerging topics will be emphasized.
- **Lecture notes:** will be provided in class and online
- **Literature:** Suggesting Textbooks

#### 529-0233-00L Organic Synthesis: Methods and Strategies

- **Abstract:** Organic Synthesis: Methods and Strategies
- **Objective:** Extension and deepening of the knowledge in organic synthesis.
- **Content:** Concepts of the planning of organic synthesis (strategy and tactics), retrosynthetic analysis. Structure-reactivity relation in the context of the synthesis of complex molecules.
- **Literature:**

### Physical Chemistry

#### 529-0433-00L Advanced Magnetic Resonance

- **Abstract:** The course is for advanced students and covers selected topics from magnetic resonance spectroscopy. This year, the lecture will introduce and discuss the theoretical foundation of high-resolution solid-state NMR under magic-angle spinning.
- **Objective:** The aim of the course is to familiarize the students with the basic concepts of high-resolution solid-state NMR. Starting from the mathematical description of spin dynamics, important building blocks for multi-dimensional experiments are discussed to allow students a better understanding of modern solid-state NMR experiments.
- **Content:** The basic principles of NMR in solids will be introduced. After the discussion of basic tools to describe NMR experiments, basic methods and experiments will be discussed, e.g., magic-angle spinning, cross polarization, decoupling, and recoupling experiments. Such basic building blocks allow a tailoring of the effective Hamiltonian to the needs of the experiment. These basic building blocks can then be combined in different ways to obtain spectra that contain the desired information.
- **Lecture notes:** A script which covers the topics will be distributed in the lecture and will be accessible through the web page http://www.ssnmr.ethz.ch/education/

### Compensatory Courses

#### 529-0445-00L Advanced Optics and Spectroscopy

- **Abstract:**
- **Objective:**
- **Content:**
- **Lecture notes:** A script which covers the topics will be distributed in the lecture and will be accessible through the web page http://www.ssnmr.ethz.ch/education/
### Abstract
This course provides an introduction to the interaction of light with nano- and microparticles followed by an overview of applications of current interest. Examples range from nanoparticles for medical applications and sensing to the role of the interaction of solar radiation with aerosol particles and cloud droplets for the climate.

### Objective
The students will be introduced to the basic concepts of the interaction of light with nano- and microparticles. The combination of basic concepts with different applications will enable students to apply their knowledge to new problems in various fields where nanoscale objects play a role.

### Content
Light interacts surprisingly differently with small particles than with bulk or with gas phase materials. The first part of the course provides a basic but rigorous introduction into the interaction of light with nano- and microparticles. The emphasis is on the classical treatment of absorption and scattering of light by small particles. The strengths and limits of this conventional approach will be discussed. The second part of the course is devoted to a broad range of applications. Here, topics include: Plasmon resonances in metallic systems, metallic dielectric nanoparticles for medical applications, the use of lasers for optical trapping and characterization of single particles, vibrational excitons in dielectric nanoparticles, interaction of light with aerosol particles and cloud droplets for remote sensing applications and climate predictions, characterization of ultralight aerosol particles by photoemission using velocity mapping imaging.

### Literature
Basics: Absorption and Scattering of Light by Small Particles, C. F. Bohren and D. R. Huffman, John Wiley & Sons, Inc.

### Electives

#### Inorganic Chemistry

<table>
<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
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<tr>
<td>529-0143-00L</td>
<td>Inorganic and Organometallic Polymers</td>
<td>O</td>
<td>7</td>
<td>3G</td>
<td>H. Grützmacher, J. Grützmacher</td>
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<tr>
<td>Abstract</td>
<td>1. Introduction: What are Inorganic Polymers</td>
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<td></td>
<td>2. Polyporphazenes</td>
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<tr>
<td></td>
<td>3. Polysiloxanes</td>
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<tr>
<td></td>
<td>4. Organometallic Polymers</td>
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<td>5. Dendritic Molecules</td>
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<td></td>
<td>6. Introduction to Inorganic Materials</td>
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#### Organic Chemistry

<table>
<thead>
<tr>
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<tr>
<td>529-0241-00L</td>
<td>Advanced Methods and Strategies in Synthesis</td>
<td>W</td>
<td>7</td>
<td>3G</td>
<td>J. W. Bode</td>
</tr>
<tr>
<td>Abstract</td>
<td>Advanced Modern Methods and Strategies in Synthesis</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Objective</td>
<td>Knowledge of modern methods in asymmetric stereoccontrol, enantioselective catalysis, and organic reaction mechanisms.</td>
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<tr>
<td>Content</td>
<td>Current trends in methods for and approaches to synthesis of complex natural products, pharmaceuticals, and biological molecules; fragment coupling and protecting group strategies; chemical ligation and biomolecules synthesis; enantioselective catalysis including ligand design and optimization; cross coupling reactions from preactivated precursors; C-H activation and oxidation chemistry; building block synthesis with chiral auxiliaries and reagents; new concepts in asymmetric catalysis. Analysis of key primarily literature including identification of trends, key precendents, and emerging topics will be emphasized.</td>
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#### Physical Chemistry

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<tr>
<td>529-0443-00L</td>
<td>Advanced Magnetic Resonance</td>
<td>W</td>
<td>7</td>
<td>3G</td>
<td>B. H. Meier, M. Ernst</td>
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### Analytical Chemistry

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<tbody>
<tr>
<td>529-0043-00L</td>
<td>Analytical Strategy</td>
<td>W</td>
<td>7</td>
<td>3G</td>
<td>R. Zenobi, M. Badertscher, P. S. Dittrich, D. Günther</td>
</tr>
</tbody>
</table>

**Abstract**
Problem-oriented development of analytical strategies and solutions.

**Objective**
Ability to create solutions for particular analytical problems.

**Content**
Individual development of strategies for the optimal application of chemical, biochemical, and physico-chemical methods in analytical chemistry solving predefined problems. Experts from industry and administration present particular problems in their field of activity.

**Prerequisites / notice**
Copies of problem sets and solutions will be distributed free of charge

**Lecture notes**
Prerequisites: 529-0051-00 "Analytical Chemistry I (3. Semester)“, 529-0058-00 "Analytical Chemistry II (4. Semester)“ (or equivalent)

### Biological Chemistry

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<tr>
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<tr>
<td>529-073-00L</td>
<td>Enzymes</td>
<td>W</td>
<td>7</td>
<td>3G</td>
<td>D. Hilvert</td>
</tr>
</tbody>
</table>

**Abstract**
Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

**Objective**
Overview of enzymes, enzyme-catalyzed reactions and metabolic processes.

**Content**
Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.

**Lecture notes**
A script will not be handed out.

**Literature**

In addition, citations from the original literature relevant to the individual lectures will be assigned weekly.
### Chemical Aspects of Energy

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>529-0193-00L</td>
<td>Renewable Energy Technologies I</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>A. Wokaun, A. Steinfeld</td>
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<tr>
<td></td>
<td>The lectures Renewable Energy Technologies I (529-0193-00L) and Renewable Energy Technologies II (529-0191-00L) can be taken independently from one another.</td>
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</table>

**Abstract**

Scenarios for world energy demand and CO2 emissions, implications for climate. Methods for the assessment of energy chains. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaic electricity, solar chemistry), Wind and ocean energy, heat pumps, geothermal energy, energy from waste. CO2 sequestration.

**Objective**

Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals.

**Content**


**Lecture notes**

Lecture notes will be distributed during the course.

**Literature**


**Prerequisites / notice**

Topics are available to carry out a Project Work (Semesterarbeit) on the contents of this course.

### Chemical Crystallography

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0029-00L</td>
<td>Structure Determination</td>
<td>W</td>
<td>7 credits</td>
<td>3G</td>
<td>M. D. Wörle, N. Trapp</td>
</tr>
</tbody>
</table>

**Abstract**

Advanced X-ray crystal structure analysis

**Objective**

To gain a deeper understanding of crystal structure determination principles and practice by X-ray diffraction and the evaluation of results.

**Content**

Review of principles of diffraction and instrumentation, unit cells, lattices, and symmetry. Inorganic structural chemistry: sphere packings, ionic crystals, covalent networks, intermetallic compounds. Overview of powder diffraction and application of crystal chemistry for structure analysis of polycrystalline phases. Working safely with X-rays, crystal growth, selection and mounting, data collection strategies, data reduction, corrections for absorption, extinction and Lp, advanced structure solution theory and techniques: Patterson function, heavy atom technique, Fourier methods, direct methods. Structure modeling and refinement, disorder, twinning, false symmetry, interpretation of anisotropic shift parameters. Determination of absolute configuration, interpretation of results and scope of chemically useful information, validation and publication of results, critical evaluation of published crystal structures.

**Lecture notes**

Information and exercise sheets will be distributed in loose form.

**Literature**

Main references


**Additional literature**


**Prerequisites / notice**

Students will conduct the computational exercises and examples of structure solution and refinement on personal computers.

**Prerequisite:** Principles of Crystal Structure Determination (529-0039-00L).

### Chemical Technology

<table>
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<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
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<tbody>
<tr>
<td>636-0003-00L</td>
<td>Biological Engineering and Biotechnology</td>
<td>W</td>
<td>6 credits</td>
<td>3V</td>
<td>M. Fussenegger</td>
</tr>
</tbody>
</table>

Biological Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutic from target to market.
Objective

Introduction to computer simulation of (bio)molecular systems, development of skills to carry out and interpret computer simulations of molecular systems.

Content

1. Molecular models, Force fields, Boundary conditions, Electrostatic interactions, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

Literature

Note also the standard textbooks:
A) Schröter, N.S. Oxtund. Verlag, Dover Publications
B) I. N. Levine. Quantum Chemistry. Pearson

Prerequisites / notice

Strongly recommended (preparatory) courses are: quantum mechanics and quantum chemistry

Objective

Introduction to computer simulation of (bio)molecular systems, development of skills to carry out and interpret computer simulations of biomolecular systems.

Content

Molecular models, Force fields, Spatial boundary conditions, Calculation of Coulomb forces, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

Lecture notes

Available (copies of powerpoint slides distributed before each lecture)

Literature

See: www.csm.ethz.ch/education/SCSBP
Materials Science

course: Introduction to Macromolecular Chemistry (529-0941-00L) will be given in spring semester

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
</table>

Abstract
A comprehensive understanding of the interaction of electrons with condensed matter and details on the instrumentation and methods designed to use these probes in the structural and chemical analysis of various materials.

Objective
A comprehensive understanding of the interaction of electrons with condensed matter and details on the instrumentation and methods designed to use these probes in the structural and chemical analysis of various materials.

Content
This course provides a general introduction into electron microscopy of organic and inorganic materials. In the first part, the basics of transmission- and scanning electron microscopy are presented. The second part includes the most important aspects of specimen preparation, imaging and image processing. In the third part, recent applications in materials science, solid state physics, structural biology, structural geology and structural chemistry will be reported.

Lecture notes
Englisch

Literature
- Williams, Hawkes, Valdèr:
- Erni: Aberration-corrected imaging in transmission electron microscopy, Imperial College Press (2010, and 2nd ed. 2015)

Environmental Chemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0745-00L</td>
<td>General and Environmental Toxicology</td>
<td>W</td>
<td>7</td>
<td>3V</td>
<td>M. Arand, H. Nägeli, B. B. Steiger, I. Werner</td>
</tr>
</tbody>
</table>

Abstract
Toxicokinetic and toxicodynamic aspects of xenobiotic interactions with cellular structures and mechanisms. Toxic responses at the level of organs (immune-, neuro-, reproductive and genotoxicity) and organisms. Introduction into developmental toxicology and ecotoxicology.

Objective
Understanding of the impact of chemicals on biological systems; evaluation of the effects from different biomedical perspectives.

Content
Explanation of important interactions between xenobiotic chemicals and cellular structures such as membranes, enzymes, and nucleic acids. Relevance of intake, distribution, excretion, and biochemical transformation processes. Relevance of mixtures. Explanation of important modes of toxic action such as immune toxicity, neurotoxicity, reproduction toxicity, genotoxicity based on examples of certain xenobiotics and their effects on important organs.

Lecture notes
Course material will be handed out as the lectures progress

Literature
- Textbooks of pharmacology and toxicology (cf. list in course material)

Prerequisites / notice
Educational basis: basic chemistry, biology and biochemistry

Laboratory Courses and Research Projects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>529-0200-00L</td>
<td>Research Project I</td>
<td>O</td>
<td>16</td>
<td>16A</td>
<td>Professors</td>
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</table>

Abstract
In a research project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic. Research projects are carried out in a core or optional subject area as chosen by the student.

Objective
Students are accustomed to scientific work and they get to know one specific research field.

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<tr>
<th>Number</th>
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<tr>
<td>529-0201-00L</td>
<td>Research Project II</td>
<td>O</td>
<td>17</td>
<td>17A</td>
<td>Professors</td>
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</tbody>
</table>

Abstract
In a research project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic. Research projects are carried out in a core or optional subject area as chosen by the student.
Objective
Students are accustomed to scientific work and they get to know one specific research field.

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0739-00L</td>
<td>Biological Chemistry A: Technologies for Directed Evolution of Enzymes</td>
<td>W</td>
<td>16 credits</td>
<td>16P</td>
<td>P. A. Kast, D. Hilvert</td>
</tr>
<tr>
<td></td>
<td>Limited number of participants.</td>
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<td>Before online enrolment, it is mandatory to sign up directly with P. Kast, no later than 2 weeks prior to start of autumn semester.</td>
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<td>Further information to registration and work hours: <a href="http://www.protein.ethz.ch/kast/praktikum.html">www.protein.ethz.ch/kast/praktikum.html</a></td>
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</table>

Abstract
During this semester course, methodologies will be taught for biological-chemical enzyme evolution experiments using molecular genetic mutation technologies and in vivo selection in recombinant bacterial strains.

Objective
All technologies used for the experiments will be explained to the students in practice with the goal that they will be able to independently apply them for the course project and in future research endeavors. After the course, an individual report about the results obtained has to be prepared.

Content
This class conducts and supports experiments for a specifically designed genuine research project. We will carry out biological-chemical enzyme evolution experiments using molecular genetic mutation technologies and in vivo selection in recombinant bacterial strains. The relevant technologies will be taught to the students, such as the preparation of competent cells, production and isolation of DNA fragments, transformation of gene libraries, and DNA sequencing. The course participants will generate a variety of different variants of a chorismate mutase. Individual enzyme catalysts will be purified and subsequently characterized using several different spectroscopic methods. The detailed chemical-physical analyses include determination of the enzymes' kinetic parameters, their molecular mass, and the integrity of the protein structure. The students will present the results obtained from their individual evolution experiments at the end of the semester. We expect that during this lab course we will not only generate novel enzymes, but also gain new mechanistic insights into the investigated catalyst.

Lecture notes
The necessary documents and protocols will be distributed to the participants during the course.

Literature
General literature to "Directed Evolution" and chorismate mutases, e.g.:


Prerequisites / notice
- This laboratory course will involve experiments that require a tight schedule and (sometimes) long (!) working days.
- The projects of this course are tightly linked to the ones of the Biology BSc course "Biological Chemistry B: New Enzymes from Directed Evolution Experiments", which takes place as a block course during the month of November. There will be joint lectures for the participants of both courses during that time. The teaching language is English.
- The number of participants for the laboratory class is limited. It is mandatory to sign up for the course directly with P. Kast at latest 2 weeks prior to the start of the fall semester. A valid registration is considered a commitment for attendance of the entire semester course, as involved material orders and experimental preparations are necessary and, once the class has started, the flow of the experiments must not be interrupted by individual absences. In case of an emergency, please immediately notify P. Kast.
- For more information, see also http://www.protein.ethz.ch/kast/praktikum.html or contact P. Kast directly (HCI F 333, Tel. 044 632 29 08, kast@org.chem.ethz.ch).

Compulsory Electives in Humanities, Social and Political Sciences
Recommended GESS compulsory elective courses (Type B) for D-CHAB.

Master Thesis
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>Lecturers</th>
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<tr>
<td>529-0500-00L</td>
<td>Master's Thesis</td>
<td>O</td>
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<td>Professors</td>
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<td>Only students who fulfill the following criteria are allowed to begin with their master thesis: a. successful completion of the bachelor programme; b. fulfilling of any additional requirements necessary to gain admission to the master programme.</td>
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<td>Duration of the Master's Thesis 16 weeks.</td>
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</tbody>
</table>

Abstract
In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is usually carried out in a core or optional subject area as chosen by the student.

Objective
In the Master Thesis students prove their ability to independent, structured and scientific working.

Course Units for Additional Admission Requirements
The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0051-AAL</td>
<td>Analytical Chemistry I</td>
<td>E-</td>
<td>3 credits</td>
<td>6R</td>
<td>D. Günther, R. Zenobi</td>
</tr>
<tr>
<td></td>
<td>Enrolment only for MSc students who need this course as additional requirement.</td>
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</tbody>
</table>

Abstract
Introduction into the most important spectroscopical methods and their applications to gain structural information.

Objective
Knowledge about the necessary theoretical background of spectroscopical methods and their practical applications.
Content
Application oriented basics of organic and inorganic instrumental analysis and of the empirical employment of structure elucidation methods:
- Mass spectrometry: Ionization methods, mass separation, isotope signals, rules of fragmentation, rearrangements.
- NMR spectroscopy: Experimental basics, chemical shift, spin-spin coupling.
- IR spectroscopy: Revisiting topics like harmonic oscillator, normal vibrations, coupled oscillating systems (in accordance to the basics of the related lecture in physical chemistry); sample preparation, acquisition techniques, law of Lambert and Beer, interpretation of IR spectra; Raman spectroscopy.
- UV/VIS spectroscopy: Basics, interpretation of electron spectra. Circular dichroism (CD) and optical rotation dispersion (ORD).

Lecture notes
Script will be for the production price

Literature
- M. Hesse, H. Meier, B. Zeeh, Spektroskopische Methoden in der organischen Chemie, 5. überarbeitete Auflage, Thieme, Stuttgart, 1995

Prerequisites / notice
Exercises are integrated in the lectures. In addition, attendance in the lecture 529-0289-00 "Instrumental analysis of organic compounds" (4th semester) is recommended.

529-0122-AAL  Inorganic Chemistry II
Enrollment only for MSc students who need this course as additional requirement.

Abstract
The lecture is based on Inorganic Chemistry I and addresses an enhanced understanding of the symmetry aspects of chemical bonding of molecules and translation polymers, i.e. crystal structures.

Objective
The lecture is based on Inorganic Chemistry I and addresses an enhanced understanding of the symmetry aspects of chemical bonding of molecules and translation polymers.

Content
Symmetry aspects of chemical bonding, point groups and representations for the deduction of molecular orbitals, energy assessment for molecules and solids, Sanderson formalism, derivation and understanding of band structures, densities of states, overlap populations, crystal symmetry, basic crystal structures and corresponding properties, visual representations of crystal structures.

Lecture notes
Additional information is available on the internet at:
http://www.ac.ethz.ch/

Literature

Prerequisites / notice
Requirements: Inorganic Chemistry I

529-0132-AAL  Inorganic Chemistry III: Organometallic Chemistry and E- Homogeneous Catalysis
Enrollment only for MSc students who need this course as additional admission requirement.

Abstract
Fundamental aspects of the organometallic chemistry of the transition elements. Mechanistic homogeneous catalysis including oxidative additions, reductive eliminations and insertion reactions. Catalytic hydrogenation, carboxylation, C-C bond-forming and related reactions.

Objective
Towards an understanding of the fundamental coordination-chemical and mechanistic aspects of transition-metal chemistry relevant to homogeneous catalysis.

Content
Fundamental aspects of the organometallic chemistry of the transition elements. Mechanistic homogeneous catalysis including oxidative additions, reductive eliminations and insertion reactions. Catalytic hydrogenation, carboxylation, C-C bond-forming and related reactions.

Literature
A more comprehensive standard work on organometallic chemistry. Several chapters written by various authors, partly specialized review-article style.

Additional information is available on the internet at:
http://www.ac.ethz.ch/

Key for Hours
- V: lecture
- G: lecture with exercise
- U: exercise
- S: seminar
- K: colloquium
- P: practical/laboratory course
- A: independent project
- D: diploma thesis
- R: revision course / private study

Data: 06.02.2019 Autumn Semester 2015 Page 329 of 1434
### Polymers

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0615-00L</td>
<td>Polymerization Reaction and Colloid Engineering</td>
<td>W+</td>
<td>7 credits</td>
<td>3G</td>
<td>M. Morbidelli</td>
</tr>
</tbody>
</table>

**Abstract**


**Objective**

Introduce the students to the design of polymerization reactors for the production of polymers with molecular characteristics suitably tuned for specific applications. This includes the post-treatment of polymer latexes and the analysis of their colloidal behavior.

**Content**

The aim of the course is to provide the tools needed for the understanding of the fundamental processes and the design of the industrial units involved in the production of polymeric materials and in the post-treatment of polymer colloids. In particular, the following topics are discussed: Physico-chemical characterization of polymers and description of the polymerization processes. Kinetics of free-radical polymerization and use of population balance models. Production of homo- and co-polymers with controlled characteristics in terms of molecular weight distribution and chain composition distribution. Living polymerizations. Design of polymerization reactors and the thermal runaway problem. Kinetics and control of emulsion polymerization. The radical segregation problem. Surfactants and colloidal stability. Aggregation kinetics and aggregate structure in conditions of diffusion and reaction limited aggregation. The role of shear conditions on aggregation and breakage kinetics and on the aggregate structure. Modeling and design of colloid aggregation processes.

**Lecture notes**

Skripts are available on the 'Polymerization Reaction and Colloid Engineering' web page of the Morbidelli-group, vide the given link for details.

**Literature**


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### Bioengineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0637-00L</td>
<td>Biomicrofluidic Engineering</td>
<td>W+</td>
<td>7 credits</td>
<td>3G</td>
<td>A. de Mello</td>
</tr>
</tbody>
</table>

**Abstract**

Microfluidics describes the behaviour, control and manipulation of fluids that are geometrically constrained within sub-microliter environments. The use of microfluidic devices offers an opportunity to control physical and chemical processes with unrivalled precision, and in turn provides a route to performing chemistry and biology in an ultra-fast and high-efficiency manner.

**Objective**

In the course students will investigate the theoretical concepts behind microfluidic device operation, the methods of microfluidic device manufacture and the application of microfluidic architectures to important problems faced in modern day chemical and biological analysis. A design workshop will allow students to develop new microscale flow processes by appreciating the dominant physics at the microscale.

The application of these basic ideas will primarily focus on biological problems and will include a treatment of diagnostic devices for use at the point-of-care, advanced functional material synthesis, DNA analysis, proteomics and cell-based assays. Lectures, assignments and the design workshop will acquaint students with the state-of-the-art in applied microfluidics.

**Content**

Specific topics in the course include, but not limited to:

1. Theoretical Concepts
   - Features of mass and thermal transport on the microscale
   - Key scaling laws
2. Microfluidic Device Manufacture
   - Conventional lithographic processing of rigid materials
   - Soft lithographic processing of plastics and polymers
3. Mass fabrication of polymeric devices
4. Unit operations and functional components
   - Analytical separations (electrophoresis and chromatography)
   - Chemical and biological synthesis
   - Sample pre-treatment (filtration, SPE, pre-concentration)
5. Molecular detection
6. Design Workshop
   - Design of microfluidic architectures for PCR, distillation & mixing
7. Contemporary Applications in Biological Analysis
   - Microarrays
   - Cellular analyses (single cells, enzymatic assays, cell sorting)
8. Proteomics
9. System integration
   - Applications in radiochemistry, diagnostics and high-throughput experimentation

**Lecture notes**

Lecture handouts, background literature, problem sheets and notes will be provided electronically.

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### Polymeric Materials

**Number** 529-0619-00L

**Title** Chemical Product Design

**Abstract**

The 'Chemical Product Design' course teaches students quantitative concepts to analyze, select and transform theoretical concepts from chemistry and engineering into valuable real-world products. Basic chemistry and chemical engineering knowledge is required (Diffusion, Thermodynamics, Kinetics,...).

**Objective**

This course starts with analyzing existing chemical needs and unmet technical challenges. We then develop the skills to critically analyze a specific chemical idea for a product, to rapidly test feasibility or chance for success and to eventually realize its manufacturing. The chemical engineering basics are then used to assess performance of products or devices with non-traditional functions based on dynamic properties (e.g. responsive building materials; personal medical diagnostics on paper strips). The course teaches the interface between laboratory and market with a specific focus on evaluating the chemical value of a given process or compound, and the necessary steps to pursue the resulting project within an entrepreneurial environment. We therefore extend the questions of process design ("how do we make something?") to the question of "what should we make?"
Content

Part A: The 'Chemical Product Design' course starts with discussing questions along, 'What is a chemical product, and why do people pay for it? How does a given compound in a specific setting provide a service?' We then learn how to translate new, often ill-defined wishes or ideas into quantifiable specifications.

Part B: Thermodynamic and kinetic data allow sharp selection criteria for successful products. We learn how to deal with insufficient data and development of robust case models to evaluate their technical and financial constraints. How can parameters of a running process in one industry be scaled into another industry? Can dimensionless engineering numbers be applied beyond traditional chemical processes?

Part C: Manufacturing of commodity products, devices and molecular products: Chemical reactors, separation and detection or isolation units as part of a toolbox. Planning of manufacturing and decisions based on hard data. Providing quantitvative answers on potential value generated.

Students are expected to actively develop chemical products along the course. Contributions will be made individually, or in small groups, where a larger topic is studied.

Literature


Process Design

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0613-00L</td>
<td>Process Simulation and Flowsheeting</td>
<td>W+</td>
<td>7</td>
<td>3G</td>
<td>E. Capón García, K. Hungerbühler</td>
</tr>
</tbody>
</table>

Abstract

This course encompasses the theoretical principles of chemical process simulation, as well as its practical application in process analysis and optimization. The techniques for simulating stationary and dynamic processes are presented, and illustrated with case studies. Commercial software packages are presented as a key engineering tool for solving process flowsheeting and simulation problems.

Objective

This course aims to develop the competency of chemical engineers in process flowsheeting and simulation. Specifically, students will develop the following skills:

- Deep understanding of chemical engineering fundamentals: the acquisition of new concepts and the application of previous knowledge in the area of chemical process systems and their mechanisms are crucial to intelligently simulate and evaluate processes.
- Modeling of general chemical processes and systems: students have to be able to identify the boundaries of the system to be studied and develop the set of relevant mathematical relations, which describe the process behavior.
- Mathematical reasoning and computational skills: the familiarization with mathematical algorithms and computational tools is essential to be capable of achieving rapid and reliable solutions to simulation and optimization problems. Hence, students will learn the mathematical principles necessary for process simulation and optimization, as well as the structure and application of process simulation software. Thus, they will be able develop criteria to correctly use commercial software packages and critically evaluate their results.

Content

Overview of process simulation and flowsheeting

- Definition and fundamentals
- Classification: stationary (steady-state) versus dynamic (transient state) systems
- Fields of application
- Case studies

Process modeling

- Modeling strategies of process systems
- Mass conservation
- Species balance
- Energy conservation
- Momentum balance
- Multiphase-systems: equilibrium & non-equilibrium models
- Process system model

Process simulation

- Process specification
- Introduction to process specification
- Classification of mathematical models: AMS, DOE, DAE, PDE
- Model validation
- Software tools
- Solution methods for process flowsheeting
- Simultaneous methods
- Sequential methods
- Dynamic simulation
- Numerical solution: explicit and implicit methods
- Continuous-discrete simulation: handling of discontinuities

Process optimization and analysis

- Classification of optimization problems
- Linear programming
- Non-linear programming
- Dynamic programming
- Optimization methods in process flowsheeting
- Sequential methods
- Simultaneous methods

Commercial software for simulation: Aspen Plus

- Thermodynamic property methods
- Reaction and reactors
- Separation / columns
- Convergence & debugging

Literature

An exemplary literature list is provided below:


Prerequisites / notice

A basic understanding of material and energy balances, thermodynamic property methods and typical unit operations (e.g., reactors, flash separations, distillation/absorption columns etc.) is required.
The course is focused on the design of Chemical Processes, with emphasis on the preliminary stage of the design approach, where process creation and quick selection among many alternatives are important. The main concepts behind more detailed process design and process simulation are also examined in the last part of the course.

Objective

Content
Detailed Process Design: unit operation models, flowsheet solution algorithms (different iterative methods, inside-out method), sequencing of nonideal distillation columns, networks of chemical reactors.

Lecture notes
no script

Literature

Prerequisites / notice
Prerequisite: Thermal Unit Operations
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Credit Distribution</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0109-00L</td>
<td>Turbulent Flows</td>
<td>4</td>
<td>2V+1U</td>
<td>P. Jenny</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Contents</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>- Laminar and turbulent flows, instability and origin of turbulence - Statistical description: averaging, turbulent energy, dissipation, closure problem - scalings, homogeneous isotropic turbulence, correlations, fourier representation, energy spectrum - free turbulence: wake, jet, mixing layer - wall turbulence: channel and boundary layer - computation and modelling of turbulent flows</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Objective</strong></td>
<td>Basic physical phenomena of turbulent flows, quantitative and statistical description, basic and averaged equations, principles of turbulent flow computation and elements of turbulence modelling</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Lecture notes are available</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>151-0951-00L</td>
<td>Process Design and Safety</td>
<td>4</td>
<td>2V+1U</td>
<td>P. Rudolf von Rohr</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Process design and safety deals with the fundamentals of process apparatus, plant design and safety.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Objective</strong></td>
<td>The goal of the lecture is to expound design characteristics of systems for process engineering applications.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Content</strong></td>
<td>Fundamentals of plant and apparatus design; materials in the process industries, mechanical design and design rules of main components; pumps and fans; piping and armatures, safety in process industry</td>
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<td></td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Script is available, english slides will be distributed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Literature</strong></td>
<td>Coulson and Richardson's: Chemical Engineering, Vol 6: Chemical Engineering Design, (1996)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>151-0927-00L</td>
<td>Rate-Controlled Separations in Fine Chemistry</td>
<td>4</td>
<td>3G</td>
<td>M. Mazzotti</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.</td>
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<tr>
<td><strong>Content</strong></td>
<td>The class covers separation techniques that are central in the purification and downstream processing of chemicals and biopharmaceuticals. Examples from both areas illustrate the utility of the methods: 1) Liquid-liquid extraction; 2) Adsorption and chromatography; 3) Membrane processes; 4) Crystalization and precipitation.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Handouts during the class</td>
<td></td>
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</tr>
<tr>
<td><strong>Literature</strong></td>
<td>Recommendations for text books will be covered in the class</td>
<td></td>
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</tr>
<tr>
<td><strong>Prerequisites</strong></td>
<td>Requirements: Thermal separation Processes I (151-0926-00) and Modelling and mathematical methods in process and chemical engineering (151-0940-00)</td>
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</tr>
<tr>
<td>252-0523-00L</td>
<td>Computational Biology</td>
<td>6</td>
<td>3V+2U</td>
<td>G. H. Gonnet</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Study of computational techniques, algorithms and data structures used to solve problems in computational biology. Topics: basic biology, string alignment, phylogeny (distance, character, parsimony), molecular evolution, multiple sequence alignment, probabilistic and statistical models, Markov models, microarrays, dynamic programming, maximum likelihood and specialized DNA and protein analysis.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Familiarize the students with the basic concepts of molecular biology and the models and algorithms used to understand, classify and predict behaviour of living organism. This course is at the most basic level, where the main issues, mostly of molecular sequences, are studied.</td>
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<tr>
<td><strong>Content</strong></td>
<td>This course lies in the intersection between Computer Science and Molecular Biology. The main purpose is to study computational techniques, algorithms and data structures which are usually applied to solve problems in Molecular Biology and Biochemistry. The following topics are likely to be covered: introduction, mathematical models of evolution, protein and DNA sequence alignment and its meaning, phylogenetic tree construction, multiple sequence alignments, molecular dynamics, threading, role of bioinformatics in drug design, etc. From the computer science point of view we concentrate our attention in practical solutions for the above problems. Biological knowledge is an asset but not a prerequisite.</td>
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</tr>
<tr>
<td>529-0611-00L</td>
<td>Characterization of Catalysts and Surfaces</td>
<td>7</td>
<td>3G</td>
<td>J. A. van Bokhoven, D. Ferri</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Basic elements of surface science important for materials and catalysis research. Physical and chemical methods important for research in surface science, material science and catalysis are considered and their application is demonstrated on practical examples.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Basic aspects of surface science. Understanding of principles of most important experimental methods used in research concerned with surface science, material science and catalysis.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Methods which are covered embrace: Gas adsorption and surface area analysis, IR-Spectroscopy, X-ray diffraction, X-ray photoelectron spectroscopy, X-ray absorption, solid state NMR, Electron Microscopy and others.</td>
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<tr>
<td>529-0615-00L</td>
<td>Polymerization Reaction and Colloid Engineering</td>
<td>7</td>
<td>3G</td>
<td>M. Morbidelli</td>
</tr>
<tr>
<td><strong>Objective</strong></td>
<td>Introduce the students to the design of polymerization reactors for the production of polymers with molecular characteristics suitably tuned for specific applications. This includes the post-treatment of polymer latexes and the analysis of their colloidal behavior.</td>
<td></td>
<td></td>
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<tr>
<td><strong>Content</strong></td>
<td>The aim of the course is to provide the tools needed for the understanding of the fundamental processes and the design of the industrial units involved in the production of polymeric materials and in the post-treatment of polymer colloids. In particular, the following topics are discussed: Physico-chemical characterization of polymers and description of the polymerization processes. Kinetics of free-radical polymerization and use of population balance models. Production of homo- and co-polymers with controlled characteristics in terms of molecular weight distribution and chain composition distribution. Living polymerizations. Design of polymerization reactors and the thermal runaway problem. Kinetics and control of emulsion polymerization. The radical segregation problem. Surfactants and colloidal stability. Aggregation kinetics and aggregate structure in conditions of diffusion and reaction limited aggregation. The role of shear conditions on aggregation and breakage kinetics and on the aggregate structure. Modeling and design of colloid aggregation processes.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Skripts are available on the 'Polymerization Reaction and Colloid Engineering' web page of the Morbidelli-group, vide the given link for details.</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
This course aims to develop the competency of chemical engineers in process flowsheeting and simulation. Specifically, students will develop the following skills:

- Deep understanding of chemical engineering fundamentals: the acquisition of new concepts and the application of previous knowledge in the area of chemical process systems and their mechanisms are crucial to intelligently simulate and evaluate processes.
- Modeling of general chemical processes and systems: students have to be able to identify the boundaries of the system to be studied and develop the set of relevant mathematical relations, which describe the process behavior.
- Mathematical reasoning and computational skills: the familiarization with mathematical algorithms and computational tools is essential to be capable of achieving rapid and reliable solutions to simulation and optimization problems. Hence, students will learn the mathematical principles necessary for process simulation and optimization, as well as the structure and application of process simulation software. Thus, they will be able develop criteria to correctly use commercial software packages and critically evaluate their results.

Overview of process simulation and flowsheeting
- Definition and fundamentals
- Classification: stationary (steady-state) versus dynamic (transient state) systems
- Fields of application
- Case studies

Process modeling
- Modeling strategies of process systems
- Mass conservation
- Species balance
- Energy conservation
- Momentum balance
- Multiphase-systems: equilibrium & non-equilibrium models
- Process system model

Process simulation
- Process specification
- Introduction to process specification
- Classification of mathematical models: AMS, DOE, DAE, PDE
- Model validation
- Software tools
- Solution methods for process flowsheeting
- Simultaneous methods
- Sequential methods
- Dynamic simulation
- Numerical solution: explicit and implicit methods
- Continuous-discrete simulation: handling of discontinuities

Process optimization and analysis
- Classification of optimization problems
- Linear programming
- Non-linear programming
- Dynamic programming
- Optimization methods in process flowsheeting
- Sequential methods
- Simultaneous methods

Commercial software for simulation: Aspen Plus
- Thermodynamic property methods
- Reaction and reactors
- Separation / columns
- Convergence & debugging

An exemplary literature list is provided below:


A basic understanding of material and energy balances, thermodynamic property methods and typical unit operations (e.g., reactors, flash separations, distillation/absorption columns etc.) is required.
The course is focused on the design of Chemical Processes, with emphasis on the preliminary stage of the design approach, where process creation and quick selection among many alternatives are important. The main concepts behind more detailed process design and process simulation are also examined in the last part of the course.

By the use of modern case studies of industrial relevance, aspects of catalyst preparation and characterization, kinetics, mass and heat transport, and deactivation are discussed. Emphasis is put on understanding the interaction among these basic elements in order to select the optimal catalytic process. Since no textbooks covering this area are available at this time and the intention of this course is unique, the lectures will be based on own texts and journal articles. During the course, there will be specific topics addressed by industrial contributors.

It is assumed that students selecting this course are familiar with general concepts of catalysis, reactor design, and transport phenomena. By the use of modern case studies of industrial relevance, aspects of catalyst preparation and characterization, kinetics, mass and heat transport, and deactivation are discussed. Emphasis is put on understanding the interaction among these basic elements in order to select the optimal catalytic process. Since no textbooks covering this area are available at this time and the intention of this course is unique, the lectures will be based on own texts and journal articles. During the course, there will be specific topics addressed by industrial contributors.

It is assumed that students selecting this course are familiar with general concepts of catalysis, reactor design, and transport phenomena.
529-0047-00L  Risk Assessment of Chemicals  W  7 credits  6A  C. Bogdal, C. A. Baumel, K. Hungerbühler

**Abstract**
Projects on chemical assessment with the focus on the analysis and assessment of basic substance data for selected chemical classes; analysis and modelling of technical processes; characterisation of environmental and health risks. Risk assessment on the basis of quality and protection goals. Estimation of model and parameter uncertainty. Precaution and safety measures.

**Objective**
Project thesis (report) on chemicals assessment; time frame totals ca. 80 hours.

**Content**
Projects on chemical assessment with the focus on the following aspects:
- Analysis and assessment of basic substance data for selected chemical classes: physical chemical properties, environmental behaviour (distribution, persistence), human and eco-toxicity (biochemical metabolism, effect mechanisms), safety.
- Analysis and modelling of technical processes determining chemical release into the environment, e.g., chemicals applications.
- Characterisation of environmental and health risks on the basis of exposure and effect models, QSARs from environmental chemistry, toxicology and methods of risk analysis.
- Risk assessment on the basis of quality and safety goals. Estimation of the model and data uncertainty.
- Demonstration of possibilities and limits of precaution and safety measures (technical, organisational, concerning personnel) including effectiveness and efficiency.

**Lecture notes**
See recommended literature.

**Literature**

**Prerequisites / notice**
Co-operation with chemical companies.

529-0745-00L  General and Environmental Toxicology  W  7 credits  3V  M. Arand, H. Nägeli, B. B. Stieger, I. Werner

**Abstract**
Toxico-kinetic and toxico-dynamic aspects of xenobiotic interactions with cellular structures and mechanisms. Toxic responses at the level of organs (immune-, neuro-, reproductive and genotoxicity) and organisms. Introduction into developmental toxicology and ecotoxicology.

**Objective**
Understanding of the impact of chemicals on biological systems; evaluation of the effects from different biomedical perspectives.

**Content**
Explanation of important interactions between xenobiotic chemicals and cellular structures such as membranes, enzymes, and nucleic acids. Relevance of intake, distribution, excretion, and biochemical transformation processes. Relevance of mixtures. Explanation of important modes of toxic action such as immune toxicity, neurotoxicity, reproduction toxicity, genotoxicity based on examples of certain xenobiotics and their effects on important organs.

**Lecture notes**
See recommended literature.

**Literature**
Course material will be handed out as the lectures progress

**Prerequisites / notice**
Textbooks of pharmacology and toxicology (cf. list in course material)

529-0569-00L  Electrochemistry  W  6 credits  3G  P. Novák

**Abstract**

**Objective**
Towards the end of the course the students will understand the basics of electrochemistry and will be able to describe and calculate electrochemistry-related matters in industrial processes and products.

**Content**

529-0193-00L  Renewable Energy Technologies I  W  4 credits  3G  A. Wokaun, A. Steinfield

The lectures Renewable Energy Technologies I (529-0193-00L) and Renewable Energy Technologies II (529-0191-01L) can be taken independently from one another.
Abstract
Scenarios for world energy demand and CO2 emissions, implications for climate. Methods for the assessment of energy chains. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaic electricity, solar chemistry). Wind and ocean energy, heat pumps, geothermal energy, energy from waste, CO2 sequestration.

Objective

Content

Lecture notes
Lecture notes will be distributed during the course.

Literature

Prerequisites / notice
Fundamentals of chemistry and physics are a prerequisite for this course.

Topics are available to carry out a Project Work (Semesterarbeit) on the contents of this course.

### 376-1714-00L Biocompatible Materials

**Abstract**
Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

**Objective**
The class consists of three parts:
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

**Content**
Molecular and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. The interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

**Lecture notes**
Handouts will be distributed during the course.

**Literature**

(available online via ETH library)

Handouts provided during the classes and references therein.

### 636-0007-00L Computational Systems Biology

**Abstract**
Study of fundamental concepts, models and computational methods for the analysis of complex biological networks. Topics: Systems approaches in biology, biology and reaction network fundamentals, modeling and simulation approaches (topological, probabilistic, stoichiometric, qualitative, linear / nonlinear ODEs, stochastic), and systems analysis (complexity reduction, stability, identification).

**Objective**
The aim of this course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.

**Content**
Biology has witnessed an unprecedented increase in experimental data and, correspondingly, an increased need for computational methods to analyze this data. The explosion of sequenced genomes, and subsequently, of bioinformatics methods for the storage, analysis and comparison of genetic and protein data provides a prominent example. Recently, however, the amount of data generated is overwhelming. This course will provide a comprehensive introduction to the basics of mathematical and computational modeling. The focus will be on some of the most important and powerful tools in systems biology.

**Literature**

Handouts provided during the classes and references therein.
Chemical Engineering Laboratory II

Abstract

Introduction to the main specific areas in chemical and biochemical engineering. The students sharpen their laboratory skills and learn to plan and perform problem-oriented experiments and to analyse, interpret and present the results.

Objective

Introduction to the main specific areas in chemical and biochemical engineering. The students sharpen their laboratory skills and learn combined techniques to plan and perform problem-oriented experiments and to analyse, interpret and present the results.

Content

Teams of two students will conduct four or five experiments from the following areas: reactor stability, characterization of multiphase reactors, heterogeneous gas phase catalysis, polymer reaction engineering, process control and automation, safety and ecological analysis.

The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

In a research project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic. Research projects are carried out in a core or optional subject area as chosen by the student.

First contact with experimental techniques of chemical engineering in a research group. Critical evaluation and presentation of the results in a scientific report.

Research Project

Type

ECTS

Hours

Lecturers

O

8 credits

8A

Professors

Research Project

529-0300-00L

Abstract

In a research project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic. Research projects are carried out in a core or optional subject area as chosen by the student.

Objective

First contact with experimental techniques of chemical engineering in a research group. Critical evaluation and presentation of the results in a scientific report.

Content

This laboratory project is organised during the spring vacation before the sixth semester. The participant can choose his topic from the list of projects suggested. Main emphasis during this research work is to get experience in using different engineering tools and evaluation and the interpretation of the results. Those are presented as a scientific report.

Chemical Engineering Laboratory II

529-0637-00L

Abstract

Introduction to the main specific areas in chemical and biochemical engineering. The students sharpen their laboratory skills and learn to plan and perform problem-oriented experiments and to analyse, interpret and present the results.

Objective

Introduction to the main specific areas in chemical and biochemical engineering. The students sharpen their laboratory skills and learn combined techniques to plan and perform problem-oriented experiments and to analyse, interpret and present the results.

Content

Teams of two students will conduct four or five experiments from the following areas: reactor stability, characterization of multiphase reactors, heterogeneous gas phase catalysis, polymer reaction engineering, process control and automation, safety and ecological analysis.

A chemical process is investigated using one or several simulation programs. A cost calculation has to be implemented considering investment and operating cost. Afterwards sensitivity analyses and optimizations are conducted considering technical and in particular economic criteria.

- modeling a chemical process using simulation and flowsheeting software
- application of the knowledge obtained in lectures
- problem-oriented problem solving (application of different methods to the same subject)
- team work
- report writing and presentation techniques

The same chemical process will be investigated as in part I and II of the case study course. This process will be depicted in one (or several) simulation programs. A cost calculation will be implemented considering investment and operating cost. Afterwards sensitivity analyses and optimizations are conducted considering technical and in particular economic criteria.

Recommended GESS compulsory elective courses (Type B) for D-CHAB.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UEZH

Master’s Thesis

529-0600-00L

Abstract

The same chemical process will be investigated as in part I and II of the case study course. This process will be depicted in one (or several) simulation programs. A cost calculation has to be implemented considering investment and operating cost. Afterwards sensitivity analyses and optimizations are conducted considering technical and in particular economic criteria.

Levels of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UEZH

Prerequisites / notice

- Electrodynamic (or equivalent)

Phyics I+II

Nano-Optics

529-0663-00L

Abstract

Nano-Optics is the study of optical phenomena and techniques on the nanometer scale. It is an emerging field of study motivated by the rapid advance of nanoscience and technology. It embraces topics such as plasmonics, optical antennas, optical trapping and manipulation, and high-resolution imaging and spectroscopy.

Objective

Understanding concepts of light localization and light-matter interactions on the nanoscale.

Content

Starting with an angular spectrum representation of optical fields the role of inhomogeneous evanescent fields is discussed. Among the topics are: theory of strongly focused light, point spread functions, resolution criteria, confocal microscopy, and near-field optical microscopy. Further topics are: optical interactions between nanoparticles, atomic decay rates in inhomogeneous environments, single molecule spectroscopy, light forces and optical trapping, photonic bandgap materials, and theoretical methods in nano-optics.
Only students who fulfill the following criteria are allowed to begin with their master thesis:

a. successful completion of the bachelor programme;

b. fulfilling of any additional requirements necessary to gain admission to the master programme.

Duration of the Master's Thesis 16 weeks.

Abstract

In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is carried out in a research group of the Department of Chemistry and Applied Biosciences, usually in the Institute of Chemical and Bioengineering, as chosen by the student.

Objective

In the Master Thesis students prove their ability to independent, structured and scientific working.

► Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

Abstract

The goal of this course is to provide students with a wide general understanding in cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

Objective

The goal of this course is to provide students with a wide general understanding cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

Content

The focus is animal cells and the development of multicellular organisms with a clear emphasis on the molecular basis of cellular structures and phenomena. The topics include biological membranes, the cytoskeleton, protein sorting, energy metabolism, cell cycle and division, viruses, extracellular matrix, cell signaling, embryonic development and cancer research.

Literature


Prerequisites / notice

none

551-0016-AAL Biology II

Enrolment only for MSc students who need this course as additional requirement.

Abstract

The lecture course Biology II is a basic introductory course into biology for students who need to pass this course for admission to their MSc curriculum.

Objective

The objective of the lecture course Biology II is the understanding of form, function, and development of animals and of the basic underlying mechanisms.

Content

The following chapters refer to the text-book "Biology" (Campbell & Reece, 7th edition, 2005) on which the course is based. Chapters 1-4 are a basic prerequisite. The sections "Structure of the Cell" (Chapters 5-10, 12, 17) and "General Genetics" (Chapters 13-16, 18, 46) are covered by the lecture Biology I.

1. Genomes, DNA Technology, Genetic Basis of Development
   - Chapter 19: Eukaryotic Genomes: Organization, Regulation, and Evolution
   - Chapter 20: DNA Technology and Genomics
   - Chapter 21: The Genetic Basis of Development

2. Form, Function, and Development of Animals I
   - Chapter 40: Basic Principles of Animal Form and Function
   - Chapter 41: Animal Nutrition
   - Chapter 44: Osmoregulation and Excretion
   - Chapter 47: Animal Development

3. Form, Function, and Development of Animals II
   - Chapter 42: Circulation and Gas Exchange
   - Chapter 43: The Immune System
   - Chapter 45: Hormones and the Endocrine System
   - Chapter 48: Nervous Systems
   - Chapter 49: Sensory and Motor Mechanisms

Literature

The following text-book is the basis for the courses Biology I and II:


Data: 06.02.2019 13:00 Autumn Semester 2015 Page 339 of 1434
Prerequisite: Lecture course Biology I of winter semester

529-0051-AAL  Analytical Chemistry I  E-  3 credits  6R  D. Günther, R. Zenobi

Abstract  Introduction into the most important spectroscopical methods and their applications to gain structural information.

Objective  Knowledge about the necessary theoretical background of spectroscopical methods and their practical applications

Content  Application oriented basics of organic and inorganic instrumental analysis and of the empirical employment of structure elucidation methods:
- Mass spectrometry: Ionization methods, mass separation, isotope signals, rules of fragmentation, rearrangements.
- IR spectroscopy: Revisiting topics like harmonic oscillator, normal vibrations, coupled oscillating systems (in accordance to the basics of the related lecture in physical chemistry); sample preparation, acquisition techniques, law of Lambert and Beer, interpretation of IR spectra; Raman spectroscopy.

Lecture notes  Script will be for the production price

- M. Hesse, H. Meier, B. Zeeh, Spektroskopische Methoden in der organischen Chemie, 5. überarbeitete Auflage, Thieme, Stuttgart, 1995

Prerequisites / notice  Exercises are integrated in the lectures. In addition, attendance in the lecture 529-0289-00 "Instrumental analysis of organic compounds" (4th semester) is recommended.

551-0013-AAL  Biochemistry  E-  2 credits  4R  R. Glockshuber

Abstract  The lecture is a basic introductory course on the molecular principles of biology for students who need to pass this course for admission to their MSc curriculum.

Objective  The goal of this course is to give the students a basic understanding of the molecules that build a cell and make it function, and the basic principles of metabolism and molecular genetics

Content  The course content is based on the following chapters of the textbook Biochemistry (Berg, Tymoczko, Stryer, 7th edition, 2012, Freeman & Co, New York)

Chapter 1: The molecular design of life
Chapter 2: Protein composition and structure
Chapter 3: Exploring proteins and proteomes
Chapter 4: DNA, RNA and the flow of information
Chapter 5: Exploring Genes and Genomes
Chapter 7: Hemoglobin
Chapter 8: Enzymes and the basic concepts of catalysis
Chapter 11: Carbohydrates
Chapter 12: Lipids and cell membranes
Chapter 15: Metabolism: Basic concepts and design


Data: 06.02.2019 13:00  Autumn Semester 2015  Page 340 of 1434
Copies of the course slides as well as other documents will be provided as pdf files via the ILIAS platform (myStudies).

The lecture Biology I, together with the lecture Biology II in the following summer semester, is a basic, introductory course into Biology for Students of Materials Sciences and other students with biology as subsidiary subject.

Voraussetzungen: Maturastoff. Insbesondere Integral- und Differentialrechnung.

The course provides an introduction to the history of organic chemistry, introduction to nomenclature, learning of classical structures and stereochemistry:

- Introduction to the structures of organic compounds as well as the structural and energetic basis of organic chemistry.
- Chemical equilibrium and equilibrium constants, mono- and polyprotic acids and bases in aqueous solution, calculation of equilibrium concentrations, acidity functions, Lewis acids, acids in non-aqueous solvents, redox reactions and equilibria, Galvanic cells, electrode potentials, Nerst equation, coordination chemistry, stepwise formation of metal complexes, solubility

General Chemistry (Organic Chemistry) I

- Introduction to Organic Chemistry. Classical structure theory, stereochemistry, chemical bonds and bonding, symmetry, nomenclature, organic thermochemistry, conformational analysis, basics of chemical reactions.
- Introduction to the history of organic chemistry, introduction to nomenclature, learning of classical structures and stereochemistry: isomerism, Fischer projections, CIP rules, point groups, molecular symmetry and chirality, topicity, chemical bonding: Lewis bonding model and resonance theory in organic chemistry, description of linear and cyclic conjugated molecules, aromaticity, Huckel rules, organic thermochemistry, learning of organic chemistry reactions, intramolecular interactions.

General Chemistry (Physical Chemistry) I

- Atomic structure and structure of matter; Atomic orbitals and energy levels; Quantum mechanical atom model; Chemical bonding; Equations of state.
- Atomic structure and structure of matter: atomic theory, elementary particles, atomic nuclei, radioactivity, nuclear reactions. Atomic orbitals and energy levels: ionisation energies, atomic spectroscopy, term values and symbols. Quantum mechanical atom model: wave-particle duality, the uncertainty principle, Schrödinger’s equation, the hydrogen atom, construction of the periodic table of the elements. Chemical bonding: ionic bonding, covalent bonding, molecular orbitals. Equations of state: ideal gases

Biology I

- The goal of this course is to give the students a basic understanding of the molecules that build a cell and make it function, and the basic principles of metabolism and molecular genetics.
- The course provides an introduction to metabolic pathways and key enzymes, and the regulation of gene expression.

Chemical Engineering Bachelor

1. Semester

Compulsory Subjects First Year Examinations

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0011-02L</td>
<td>General Chemistry (Inorganic Chemistry) I</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>A. Togni</td>
</tr>
<tr>
<td>529-0011-03L</td>
<td>General Chemistry (Organic Chemistry) I</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>H. Wennemers</td>
</tr>
<tr>
<td>529-0011-01L</td>
<td>General Chemistry (Physical Chemistry) I</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>F. Merkt</td>
</tr>
<tr>
<td>551-0015-00L</td>
<td>Biology I</td>
<td>O</td>
<td>2 credits</td>
<td>2V</td>
<td>R. Glockshuber, E. Hafen</td>
</tr>
</tbody>
</table>

Mathematical Foundations I: Analysis A

- Introduction to calculus in one dimension. Building simple models and analysing them mathematically.
- Functions of one variable: the notion of a function, of the derivative, the idea of a differential equation, complex numbers, Taylor polynomials and Taylor series. The integral of a function of one variable.
- Objective
Functions of one variable: the notion of a function, of the derivative, the idea of a differential equation, complex numbers, Taylor polynomials and Taylor series. The integral of a function of one variable.

D. W. Jordan, P. Smith: Mathematische Methoden für die Praxis, Spektrum Akademischer Verlag
R. Sperb/M. Akveld: Analysis I (vdf)
L. Papula: Mathematik für Ingenieure und Naturwissenschaftler (3 Bände), Vieweg

529-0001-00L Introduction to Computer Science
O 4 credits 2V+2U P. H. Hünenberger

Abstract
Introduction to UNIX, data representation, introduction to C++ programming, errors, algorithms, computer architecture, sorting and searching, databases, numerical algorithms, types of algorithms, simulation, data communication & networks, chemical structures, operating systems, programming languages, software engineering.

For more information: www.csms.ethz.ch/education/linfo1

Objective
Discuss fundamentals of computer architecture, languages, algorithms and programming with an eye to their application in the area of chemistry, biology and material science.

Content
Minimal introduction to UNIX, Data representation and processing, algorithms and programming in C++, Errors, programming guidelines, efficiency, computer architecture, algorithms for sorting and searching, databases, numerical algorithms, types of algorithms, simulation, data communication & networks, chemical structures, operating systems, programming languages, style, software engineering.

Lecture notes
Available (in English), distributed at first lecture

Literature
See: www.csms.ethz.ch/education/linfo1

Prerequisites / notice
Since the exercises on the computer do convey and test essentially different skills as those being conveyed during the lectures and tested at the written exam, the results of the exercises are taken into account when evaluating the results of the exam.

For more information about the lecture: www.csms.ethz.ch/education/linfo1

Laboratory Courses

Number Title Type ECTS Hours Lecturers
529-0011-04L Practical Course General Chemistry ■ O 8 credits 12P H. V. Schönberg, E. C. Meister

Abstract
Latest online enrolment is one week before the beginning of the semester.

Information about the practical course will be given on the first day.

Objective
Qualitative analysis (determination of cations and anions), acid-base-equilibria (pH-values, titrations, buffer), precipitation equilibria (gravimetry, potentiometry, conductivity), redox-reactions (syntheses, redox-titrations, galvanic elements), metal complexes (syntheses, complexometric titration)

Content
Analysis of measured values, states of aggregation (vapour pressure, conductivity, calorimetry)

Objective
Qualitative analysis (simple cation and anion separation process, determination of cations and anions), acid-base-equilibria (strengths of acids and bases, pH- and pKa-values, titrations, buffer systems, Kjeldahl determination), precipitation equilibria (gravimetry, potentiometry, conductivity), oxidation state and redox behaviour (syntheses), redox-titrations, galvanic elements), metal complexes (syntheses of complexes, ligand exchange reactions, complexometric titration)

Content
The general aim for the students of the practical course in general chemistry is an introduction in the scientific work and to get familiar with simple experimental procedures in a chemical laboratory. In general, first experiences with the principal reaction behaviour of a variety of different substances will be made. The chemical characteristics of these will be elucidated by a series of quantitative experiments alongside with the corresponding qualitative analyses. In order to get an overview of classes of substances as well as some general phenomena in chemistry suitable experiments have been chosen. In the second part of the practical course, i.e. physical chemistry, the behaviour of substances in their states of aggregation as well as changes of selected physical values will be recorded and discussed.

Lecture notes
http://www.gruetzmacher.ethz.ch/education/labcourses

Prerequisites / notice
Compulsory: online enrolment latest one week prior start of the semester

3. Semester

Compulsory Subjects Examination Block I

Number Title Type ECTS Hours Lecturers
529-0121-00L Inorganic Chemistry I O 3 credits 2V+1U A. Mezzetti

Abstract
Complexes of the transition metals: structure, bonding, spectroscopic properties, and synthesis.

Objective
Introduction to the binding theory in complexes of the transition metals. Interpretation of structure, bonding, and spectroscopic properties. General synthetic strategies.

Content
The chemical bond (overview). Symmetry and group theory. The chemical bond of coordination compounds (Valence Bond Theory, Crystal Field Theory, Molecular Orbital Theory (sigma- and pi-bonding), pi-Accepting ligands (CO, NO, olefins, dioxygen, dihydrogen, phosphines and phosphites). Electronic spectra of coordination compounds (Tanabe-Sugano diagrams). Coordination numbers and isomers in complexes. Dynamic phenomena (stereochemical nonrigidity). Complexes and kinetics.

Lecture notes
Can be bought at the HCI-shop

Literature

529-0221-00L Organic Chemistry I O 3 credits 2V+1U F. Diederich, C. Schaack

Abstract
Chemical reactivity and classes of compounds. Eliminations, fragmentations, chemistry of aldehydes and ketones (hydrates, acetals, imines, enamines, nucleophilic addition of organometallic compounds, reactions with phosphorus and sulfur ylides; reactions of enolates as nucleophiles) and of carboxylic acid derivatives. Aldol reactions.

Objective
Acquisition of a basic repertoire of synthetic methods including important reactions of aldehydes, ketones, carboxylic acids and carboxylic acid derivatives, as well as eliminations and fragmentations. Particular emphasis is placed on the understanding of reaction mechanisms and the correlation between structure and reactivity. A deeper understanding of the concepts presented during the lecture is reached by solving the problems handed out each time and discussed one week later in the exercise class.

Content
Chemical reactivity and classes of compounds. Eliminations, fragmentations, chemistry of aldehydes and ketones (hydrates, acetals, imines, enamines, nucleophilic addition of organometallic compounds, reactions with phosphorus and sulfur ylides; reactions of enolates as nucleophiles) and of carboxylic acid derivatives. Aldol reactions.

Lecture notes
A pdf file of the printed lecture notes is provided online. Supplementary material may be provided online.

Literature
No set textbooks. Optional literature will be proposed at the beginning of the class and in the lecture notes.

529-0422-00L Physical Chemistry II: Introduction to Chemical Reaction Kinetics O 4 credits 3V+1U H. J. Wörner
Abstract

Objective
Introduction to Chemical Reaction Kinetics

Content

Lecture notes
in Vorbereitung, wird verteilt).

Literature

Prerequisites / notice
Voraussetzungen;
- Mathematik I und II
- Allgemeine Chemie I und II
- Physikalische Chemie I

402-0043-00L Physics I O 4 credits 3V+1U M. R. Meyer

Abstract
Introduction to the concepts and tools in physics with the help of demonstration experiments: mechanics of point-like and ridged bodies, periodic motion and mechanical waves.

Objective
The concepts and tools in physics, as well as the methods of an experimental science are taught. The student should learn to identify, communicate and solve physical problems in his/her own field of science.

Content
Mechanics (motion, Newton's laws, work and energy, conservation of momentum, rotation, gravitation, fluids)
Periodic Motion and Waves (periodic motion, mechanical waves, acoustics).

Lecture notes
The lecture follows the book "Physics" by Paul A. Tipler.

Literature

Prerequisites / notice
Prerequisites: Mathematics I & II

529-0051-00L Analytical Chemistry I O 3 credits 3G D. Günther, M.O. Ebert, R. Zenobi

Abstract
Introduction into the most important spectroscopical methods and their applications to gain structural information.

Objective
Knowledge about the necessary theoretical background of spectroscopical methods and their practical applications

Content
Application oriented basics of organic and inorganic instrumental analysis and of the empirical employment of structure elucidation methods:
Mass spectrometry: Ionization methods, mass separation, isotope signals, rules of fragmentation, rearrangements.
NMR spectroscopy: Experimental basics, chemical shift, spin-spin coupling.
IR spectroscopy: Revisiting topics like harmonic oscillator, normal vibrations, coupled oscillating systems (in accordance to the basics of the related lecture in physical chemistry); sample preparation, acquisition techniques, law of Lambert and Beer, interpretation of IR spectra; Raman spectroscopy.
UV/VIS spectroscopy: Basics, interpretation of electron spectra. Circular dichroism (CD) und optical rotation dispersion (ORD).

Lecture notes
Script will be for the production price

Literature
- M. Hesse, H. Meier, B. Zeeh, Spektroskopische Methoden in der organischen Chemie, 5. überarbeitete Auflage, Thieme, Stuttgart, 1995
- M. Hesse, H. Meier, B. Zeeh, Spektroskopische Methoden in der organischen Chemie, 5. überarbeitete Auflage, Thieme, Stuttgart, 1995

Prerequisites / notice
Exercises are integrated in the lectures. In addition, attendance in the lecture 529-0289-00 "Instrumental analysis of organic compounds" (4th semester) is recommended.

401-0373-00L Mathematics III: Partial Differential Equations O 4 credits 2V+1U F. Da Lio

Abstract

Objective
The main objective is that the students get a basic knowledge of the classical tools to solve explicitly linear partial differential equations.
## Examples of partial differential equations
- Classification of PDEs
- Superposition principle

## One-dimensional wave equation
- D'Alembert's formula
- Duhamel's principle

## Fourier series
- Representation of piecewise continuous functions via Fourier series
- Examples and applications

## Separation of variables
- Resolution of wave and heat equation
- Homogeneous and inhomogeneous boundary conditions, Dirichlet and Neumann boundary conditions

## Laplace equation
- Resolution of the Laplace equation on rectangle, disk and annulus
- Poisson formula
- Mean value theorem and maximum principle

## Fourier transform
- Derivation and Definition
- Inverse Fourier transformation and inversion formula
- Interpretation and properties of the Fourier transform
- Resolution of the heat equation

## Laplace transform
- Definition, motivation and properties
- Inverse Laplace transform of rational functions
- Application to ordinary differential equations

### Lecture notes
There are available some Lecture Notes in English and also in German of the Professor. These can be found following the links provided under the tab 'Lernmaterialien'.

### Literature
2) Y. Pinchover and J. Rubinstein, An Introduction to Partial Differential Equations, Cambridge University Press
3) E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons (only Chapters 1,2,6,11)

### Prerequisites / notice
It is required a minimal background of:
1) multivariable functions (Riemann integrals in two or three variables, change of variables in the integrals through the Jacobian, partial derivatives, differentiability, Jacobian)
2) numerical and functional sequences and series, basic knowledge of ordinary differential equations.

### Laboratory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0129-00L</td>
<td>Inorganic and Organic Chemistry II</td>
<td>O</td>
<td>11 credits</td>
<td>16P</td>
<td>A. Mezzetti, A. Togni</td>
</tr>
</tbody>
</table>

**Abstract**
Introduction to the experimental methods of Inorganic Chemistry

**Objective**
The teaching laboratory offers an insight into different aspects of Inorganic Chemistry, including solid state chemistry, organometallic chemistry, kinetics, etc. The synthesis, characterization and analysis of inorganic compound are a main topic. Emphasis is given to scientific writing (experiment reports).

**Content**
Inorganic chemistry part: Synthesis and analysis of elemento-organic compounds, metal complexes, and organometallic compounds. Introduction to Schlenk techniques, solid state synthesis, and kinetics. Introduction in the chemistry library: literature data banks and collections of spectra.

Organic synthesis with organometallic compounds and catalysts: Experiments in the framework of a selected specialised project. Possible projects: Rh catalysed asymmetric hydrogenation of enamides, Mn-catalysed epoxidation of olefins, Cu catalysed Diels-Alder reactions, synthesis of organo-boron compounds and Pd catalysed coupling with halides, Ru catalysed transfer hydrogenation.

**Lecture notes**
A manual is distributed in the teaching laboratory.

**Prerequisites**
- Practical Course General Chemistry (1. Semester, 529-0011-04)
- Practical Course Inorg. and Org. Chemistry I (2. Sem., 529-0230)
- Attendance of Course Inorg. Chemistry 1 (3. Sem., 529-0121)

**notice**
If necessary, access priority will be settled according to the results of the first-year examinations.

### 5. Semester

#### Compulsory Subjects

#### Examination Block Thermodynamics and Transport Phenomena

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0557-00L</td>
<td>Chemical Engineering Thermodynamics</td>
<td>O</td>
<td>4 credits</td>
<td>3G</td>
<td>A. Butté</td>
</tr>
</tbody>
</table>

**Abstract**
This course teaches the fundamentals of thermodynamics applied to the description of real mixtures in the presence of physicochemical equilibria, including methods to quantitatively estimate them. While giving insights into the meaning and properties of main thermodynamic quantities, the course keeps primary focus on application to real chemical engineering problems.

**Objective**
The objective of the course is twofold. First, to teach the methods to calculate the volumetric and thermodynamic properties of mixtures in the presence of physicochemical equilibria. In particular, students are supposed to acquire the knowledge on which thermodynamic properties have to be estimated to carry out such calculation, on which data which need to be gathered and estimated, on the methods, the relative assumption and approximations. Second, the course is intended to give the students a sufficient theoretical insight on the thermodynamic properties, which will be used for future applications and studies.
At the end of this course students should be familiar with the basics of heat transfer and fluid dynamics, and have acquired the ability to

The first part of the course is focusing on pure fluids (ideal and real). First, some fundamentals of thermodynamics are reviewed, including thermodynamic quantities and balances (of mass, energy and entropy). Then, equations of state and their use to estimate the volumetric properties of pure fluids are introduced. Finally, it is discussed how to use previous results for the estimation of the main thermodynamic properties (internal energy, entropy, free Gibbs energy, fugacity, etc.).

The second part of the course is focusing on mixtures, starting from binary mixture to mixtures of N components. Again, real mixtures are discussed, with emphasis on when such mixtures can be approximated as ideal ones and on the corrections which are needed to switch from ideal to real mixtures. As for pure fluids, first the use of the equations of state is discussed to estimate volumetric properties, then the estimation of thermodynamic properties of mixtures is introduced. In this part, a particular focus is given to phase equilibria in the absence of chemical reactions. The most common equilibria (liquid-vapor, solid-liquid, liquid-liquid, etc) are discussed.

In the last part of the course, the chemical equilibria are discussed, with particular focus on the calculation of mass and energy balances for multicomponent systems (mixtures), also in the presence of physical equilibria. During the lectures, theoretical aspects will be discussed and will be linked to application by the discussion of a comprehensive study case, including the methods for its solution. Detailed exercises will be given (and discussed later) to the students, to let them familiarize with the main methods discussed during the lecture. No script will be available. Support material consists of PowerPoint presentations, which will be available in PDF format online.

Books on this subject can be mostly found under the title: 'Chemical Engineering Thermodynamics', 'Thermodynamics for Chemical Engineers', or 'Chemical Process Principles'. A selection:


Acquisition of material properties and data:

[11] "TRE Thermodynamic Tables", Thermodynamic Research Center, College Station USA

Prerequisites / notice
Knowledge in chemical thermodynamics required

Mass Transfer  O  4 credits  2V+2U  R. Büchel, S. E. Pratsinis

This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

Content
Fick’s laws; application and significance of mass transfer; comparison of Fick’s laws with Newton’s and Fourier’s laws; derivation of Fick’s 2nd law; diffusion in dilute and concentrated solutions; rotating disk; dispersion; diffusion coefficients, viscosity and heat conduction (Pr and Sc numbers); Brownian motion; Stokes-Einstein equation; mass transfer coefficients (Nu and Sh numbers); mass transfer across interfaces; Reynolds- and Chilton-Colburn analogies for mass-, heat-, and momentum transfer in turbulent flows; film-, penetration-, and surface renewal theories; simultaneous mass, heat and momentum transfer (boundary layers); homogeneous and heterogenous reversible and irreversible reactions; diffusion-controlled reactions; mass transfer and first order heterogenous reaction. Applications.

Prerequisites / notice

Heat Transport and Fluid Dynamics n  O  4 credits  4G  A. A. Kubik

This course teaches the basis and the methods for the description and for the quantitative treatment of heat transfer and fluid flow with emphasis on physico-chemical processes.

Objective
At the end of this course students should be familiar with the basics of heat transfer and fluid dynamics, and have acquired the ability to describe these phenomena in practical processes and to perform corresponding calculations

Content
Mechanisms of heat and momentum transfer; analogy between mass, heat and momentum transfer; dimensional analysis; kinematics and continuum mechanics; steady and non-steady heat conduction; convective heat transfer; heat transfer correlations; radiation heat transfer; steady and non-steady; laminar and turbulent flow; inviscid flows; Navier-Stokes equations; Bernoulli equation; boundary layer theory; multiphase flow

Lecture notes
Lecture notes will be handed out

Exam Block Reaction Engineering and Modelling

Homogeneous Reaction Engineering  O  4 credits  3G  M. Morbidelli, T. Casalini
Abstract


Objective

Provide to the students a complete methodology for the analysis and design of homogeneous reactors

Content


Lecture notes

Scripts are available on line on the web page of the Morbidelli group.

Literature

J. Baldyga and J.R. Bourne, Turbulent Mixing and Chemical Reactions, John Wiley, 1999
A. Varma and M. Morbidelli, Mathematical Methods in Chemical Engineering, Oxford University Press, 1997

752-4001-00L Microbiology O 2 credits 2V M. Ackermann, M. Schuppler, J. Vorholt-Zambelli

Abstract

Teaching of basic knowledge in microbiology with main focus on Microbial Cell Structure and Function, Molecular Genetics, Microbial Growth, Metabolic Diversity, Phylogeny and Taxonomy, Prokaryotic Diversity, Human-Microbe Interactions, Biotechnology.

Objective

Teaching of basic knowledge in microbiology.

Content


Lecture notes

Wird von den jeweiligen Dozenten ausgegeben.

Literature

Die Behandlung der Themen erfolgt auf der Basis des Lehrbuchs Brock, Biology of Microorganisms

401-0675-00L Statistical and Numerical Methods for Chemical Engineers O 3 credits 2V+2U R. Käppeli, P. Müller, M. Sokolov

Abstract

This course covers common numerical algorithms and statistical methods used by chemical engineers to solve typical problems arising in industrial and research practice.

Objective

This course covers common numerical algorithms and statistical methods used by chemical engineers to solve typical problems arising in industrial and research practice. The focus is on application of these algorithms to real world problems, while the underlying mathematical principles are also explained. The MATLAB environment is adopted to integrate computation, visualization and programming.

Content

Part I: Numerical Methods:
- Systems of linear equations: direct and iterative methods
- Systems of non-linear equations
- Eigenvalue problems and the singular value decomposition
- Linear and non-linear least squares
- Quadrature: deterministic and Monte-Carlo methods
- Ordinary differential equations (non stiff and stiff): initial value problems and structure preservation

Part II: Statistical Methods:
- Data analysis and regression methods
- Statistical experimental design
- Multivariate analysis of spectra

Lecture notes

Lecture slides will be provided for the part on the numerical methods.

Literature

For the statistics part, see http://stat.ethz.ch/~meier/teaching/cheming/

Recommended reading:
2) A. Constantinides, N. Mostoufizadeh, Numerical Methods for Chemical Engineers with Matlab Applications, Prentice Hall, 1999
4) W. A. Stahel, Statistische Datenanalyse, Vieweg, 4th edition 2002

351-0778-00L Discovering Management Entry level course in management for BSc, MSc and PHD students at all levels not belonging to D-MTEC. This course can be complemented with Discovering Management (Exercises) 351-0778-01. O 3 credits 3G P. Baschera, M. Ambühli, S. Brusoni, E. Fleisch, P. Frauenfelder, G. Grote, F. Hacklin, V. Hoffmann, P. Schönslieben, D. Sornette, J.E. Sturm, G. von Krogh, F. von Wangenheim

Abstract

Discovering Management offers an introduction to the field of business management and entrepreneurship for engineers and natural scientists. The module provides an overview of the principles of management, teaches knowledge about management that is highly complementary to the students' technical knowledge, and provides a basis for advancing the knowledge of the various subjects offered at D-MTEC.

Objective

Discovering Management offers an integrated learning system, which combines in an innovative format a set of lectures, an advanced business game simulation and a set of group exercises involving industry speakers (ranging from leading venture capitalists to executives at established corporations). Unlike more traditional courses, the learning model for Discovering Management involves 'learning by doing'. While the 13 different lectures, in-class discussions and assigned readings provide the theoretical and conceptual foundations, the experiential learning outcomes result from the interrelated group activities: 1) the interactive case studies and exercises, 2) the business game simulation.

By discovering the key aspects of entrepreneurial management, the purpose of the course is to advance students' understanding of factors driving company success, where success is understood as a broad construct including financial return, employee, customer and supplier satisfaction as well as social and ecological responsibility.

Discovering Management is designed to suit the needs and expectations of Bachelor students at all levels as well as Master and PhD students not belonging to D-MTEC. By providing an overview of Entrepreneurial Management, this course is an ideal enrichment of the standard curriculum at ETH Zurich. No prior knowledge of business or economics is required to successfully complete this course.
The lectures for Discovering Management are designed to broaden the participant's understanding of the principles of entrepreneurial management, emphasizing the interdependence of various specialties in the development and management of a firm. For this reason, the lectures are structured on the basis of a coherent business model and will be presented by the respective area specialists at D-MTEC.

The lectures broaden the view and the understanding of technology by interlinking it with society. Corporate sustainability, for example, introduces economic, ecological and social issues that are relevant to all engineering disciplines. Practical examples stimulate the students to assess these issues and be aware of their responsibilities as engineers. Technology and innovation management, to mention a second example, focuses on the interplay of technical and organizational change, and how these often neglected interactions explain why many new technologies are never used. It fosters the students' ability to see the business and social consequences of their 'technical' decisions.

Critical skills will be trained by the case study exercise, a participant-centered learning activity, which provides students with the opportunity to place themselves in the role of the decision maker, as they learn more about the specific case and identify the challenge they are faced with. Students will be presented real case scenarios by industry guests from established corporations and will have to critically analyze specific issues. The case study exercise will provide an insight into the context of a managerial problem-solving and enhance the participant's appreciation for the complex tasks companies deal with.

Discovering Management attempts to overcome the limitations of traditional teaching curricula of management in technical universities, which often merely focus on transferring specific skills to students, e.g. planning or forecasting. In response to the new challenges for entrepreneurial decision-making, students will be offered the opportunity to actively engage in an advanced business game simulation; a business game that establishes a link between business management theory and business management in practice. The simulation presents a realistic model of a company and provides participants with the opportunity to quickly gain the lasting effects of practical experience in a risk-free environment. All this provides a valuable learning platform to integrate the increasingly important development of the skills and competences required to identify entrepreneurial opportunities, analyze the future business environment and successfully respond to it by taking systematic decisions, e.g. critical assessment of technological possibilities.

Discovering Management is designed to suit the needs and expectations of Bachelor students at all levels as well as Master and PhD students not belonging to D-MTEC. By providing an overview of Business Management, this course is an ideal enrichment of the standard curriculum at ETH Zurich.

No prior knowledge of business or economics is required to successfully complete this course.

**Examination Block Catalysis and Heterogeneous Process Engineering**

Subjects will be given in spring semester

**Examination Block Process Engineering**

Subjects will be given in spring semester

**Laboratory Courses and Case Studies**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content</td>
<td>The focus of part I of the case study course lies on the literature-based comparison of chemical process alternatives. Based on this compilation and selected quantitative as well as qualitative measures a process assessment and comparison is conducted and the most promising process alternative is chosen for further evaluation, and a basic flowsheet and mass and energy balances are generated.</td>
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**Examination Block Catalysis and Heterogeneous Process Engineering**

Subjects will be given in spring semester

3A Chemical Engineering Laboratory I

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0639-01L</td>
<td>Chemical Engineering Laboratory I</td>
<td>O</td>
<td>6</td>
<td>8P</td>
<td>M. Morbidelli, N. Kober</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to various tools of chemical engineering techniques with reference to the lectures. In groups of two, students will conduct experiments in the following areas: thermodynamics and phase equilibria including electrochemistry, transport phenomena, kinetics and selectivity of complex reactions, characterisation of ideal and real reactors.</td>
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</table>

**Compulsory Electives in Humanities, Social and Political Sciences**

Recommended GESS compulsory elective courses (Type B) for D-CHAB

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UBZH

**Chemical Engineering Bachelor - Key for Type**

<table>
<thead>
<tr>
<th>Type</th>
<th>Recommended, not eligible for credits</th>
<th>Compulsory</th>
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<tbody>
<tr>
<td>O</td>
<td>Available</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
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</table>

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 347 of 1434
**Key for Hours**

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**

- European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
Comparative and International Studies Master

Core Seminars

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>857-0001-00L</td>
<td>Methods I: Research Design, Qualitative Methods, and Data Collection</td>
<td>O</td>
<td>8</td>
<td>2U+2S</td>
<td>C. Bara, F. Schimmelfennig, S. Baier, T. Ohmura</td>
</tr>
<tr>
<td>857-0002-00L</td>
<td>Democracy</td>
<td>O</td>
<td>8</td>
<td>2S</td>
<td>F. Schimmelfennig, D. Kübler</td>
</tr>
<tr>
<td>857-0003-00L</td>
<td>Political Violence</td>
<td>O</td>
<td>8</td>
<td>2S</td>
<td>L.E. Cederman, A. Wenger</td>
</tr>
<tr>
<td>857-0004-00L</td>
<td>Methods II: Quantitative Methods</td>
<td>O</td>
<td>4</td>
<td>3S</td>
<td>J. Bölstad, L. Beiser-McGrath</td>
</tr>
</tbody>
</table>

Electives

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>857-0005-00L</td>
<td>Contemporary Security Studies</td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>M. Dunn Cavelty, J. Hagmann</td>
</tr>
<tr>
<td>857-0006-00L</td>
<td>International Environmental Politics</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>T. Bernauer</td>
</tr>
</tbody>
</table>

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 349 of 1434
This course deals with how and why international cooperation in environmental politics emerges, and under what circumstances such cooperation is effective and efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental policies are discussed: the management of international water resources, the problem of unsafe nuclear power plants in Eastern Europe, political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

The course is open to all ETH students. Participation does not require previous coursework in the social sciences.

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 4 ECTS credit points. The workload is around 120 hours (meetings, reading assignments, preparation of test).

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory (http://www.rektorat.etlz.ch/students/admission/auditors/specialstudents_uzh/index_EN; see menu on left side of that webpage for students from other universities).

Lecture notes
Slides and reading material will be made available at www.ib.etlz.ch (teaching, materials, then menu on the left side of the screen). They are password protected. Use your Netzh username and password to access the material.

Literature
See www.ib.etlz.ch (teaching, materials)

Prerequisites / notice
Students from ETH will receive 4 ECTS credit points if they attend classes regularly and obtain a grade of 4.0 or higher for the written exam in the final week of the semester. Students who obtain a grade of less than 4.0 for the end-of-semester test will have a second chance in the first week of the following semester. The rules of the game are defined in detail on the course syllabus. Students who do not participate in the end of semester test will not have access to the repeat exam unless they submit compelling and documented reasons for why they were unable to participate in the first test. Except for language dictionaries, no additional materials and no laptops and mobile phones are allowed during the exam.

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory (http://www.rektorat.etlz.ch/students/admission/auditors/specialstudents_uzh/index_EN; see menu on left side of that webpage for students from other universities).

The workload for this course is approx. 120 hours (all inclusive).

857-0027-00L International Organizations (Field Trip) W 2 credits 1S F. Schimmelfennig

Abstract
A three-day visit to international organizations in Geneva - e.g., the World Trade Organization, the World Health Organization and the International Committee of the Red Cross. Teams of 2-3 students prepare a 2-3 page background reading for the group on a specific international organization and lead the discussion with representatives of that organization during the visit.

Objective
Become familiar with the work and challenges of international organizations based in Geneva.

Content
A three-day visit to international organizations in Geneva - e.g., the World Trade Organization, the World Health Organization and the International Committee of the Red Cross. Teams of 2-3 students prepare a 2-3 page background reading for the group on a specific international organization and lead the discussion with representatives of that organization during the visit.

Literature

Briefing papers prepared by the students.

857-0057-00L Democratic Representation in Theory and Practice W 4 credits 2S

Abstract
This course discusses normative and empirical models of democracy, and compares the actual behavior of the main actors in a democratic system to that which is required by the different models. The course also looks at why democracies often produce sub-optimal outcomes when dealing with certain issues, such as budget deficits and environmental externalities.

Objective
After taking this course, students should be able to:
- Discuss the differences between various normative models of democratic representation
- Discuss how the normative models relate to empirical studies on the topic
- Discuss when, why, and in what sense, democratic representation fails or works well
- Discuss the strengths and weaknesses of current empirical research
- Identify needs for further research

857-0075-00L Development and Current Issues of European Integration W 4 credits 2S A. Zhelyazkova, J. Bölstad, C. Kaya, J. Moreno Rocabert, R. Schrama

Abstract
How have the EU’s powers developed until now and what are the problems facing the Union today? In this course, we will discuss the development of European integration. Furthermore, the course will address key issues such as the EU’s democratic deficit, the consequences from enlargement to Central and Eastern Europe, the prospects for future entrants and the Euro-crisis.

Objective
Since its start in the fifties, the European Union has evolved into an ever more important multilevel system of integration in terms of decision-making competences and scope of policy. How have the EU’s powers developed until now and what are the problems facing the Union today? To address these questions, the course is divided into two parts. The first part discusses the development of European integration in terms of the functioning of the EU institutions and the policy-making process (i.e. agenda-setting, decision-making and implementation). In the second part of the course, we analyze the problems confronting Europe during the process of European integration, as well as current issues associated with the EU’s expansion of power and membership. For example, key questions include: Is there a “democratic deficit” in the EU in terms of responsiveness to public opinion? To what extent does the existing EU institutional structure allow for representation? How can we explain patterns of “differentiated integration” across policy areas and countries? What are the consequences of the EU’s enlargement on the “new” Central and Eastern European member states and the prospects for future entrants? We will conclude with a discussion about the Euro-crisis.

857-0088-00L Political Islam: Islamist Movements in Arab MENA States (University of Zurich) W 6 credits 2S

Abstract
The winds of change that swept over the Middle East and North Africa have transformed the political landscape in an unexpected manner. This seminar will look closely at the concept of political Islam and at the ideologies and programs of some of these parties and groups. It will also investigate the consequences of their participation on citizenship rights and the democratization process.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Semester</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>857-0092-00L</td>
<td>Decentralisation, Local Democracy and Social Justice W - European and Global Perspectives (UZH)</td>
<td>6</td>
<td>2S</td>
<td>3G</td>
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<tr>
<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: 615722</td>
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<td>Mind the enrolment deadlines at UZH:</td>
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<td></td>
<td><a href="http://www.uzh.ch/studies/application/mobilitaet.html">http://www.uzh.ch/studies/application/mobilitaet.html</a></td>
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<tr>
<td>Objective</td>
<td>1. Examine the concept of political Islam and at the ideologies and programs of some of these parties and groups.</td>
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<td>2. Examine some of these movements within the contexts of different countries</td>
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<td></td>
<td>3. Investigate the consequences of their participation on citizenship rights and the democratization process.</td>
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<td>Part I: Decentralisation and local democracy</td>
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<td></td>
<td>- Understanding central concepts: decentralisation, federalism, local autonomy, metropolitan governance, government/party systems, local democracy</td>
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<td>- Gaining expert knowledge on selected cases</td>
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<td>- Reflection and examination of possible relationships between decentralisation, local democracy, and social justice</td>
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<td>Part II: Causes</td>
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<td>- Account for the broader context: traditions, capacities, ethnic tensions</td>
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<td>Part III: Consequences</td>
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<td>- Fine tuning the model of decentralised democracy: values, trade-offs, conditions, aims</td>
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<td>Presentation essay: Conceptual elaboration, theoretical argument case description, recommendations</td>
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<tr>
<td>857-0093-00L</td>
<td>Visualizing and Analyzing Spatial Data in Political Science</td>
<td>4</td>
<td>2S</td>
<td>P. Hunziker</td>
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<tr>
<td></td>
<td>Number of participants limited to 16.</td>
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<tr>
<td>Objective</td>
<td>This course introduces students to the analysis of geospatial data for applications in political science. It provides them with the tools and methods necessary for incorporating geospatial data in their own research projects, and guides participants through the entire workflow of creating, viewing, managing, visualizing, and analyzing geospatial data for understanding political phenomena.</td>
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<tr>
<td></td>
<td>The analysis of geospatial data is increasingly important in political science. Many traditional types of data that are used to understand political phenomena (e.g., survey data, voting data, governance indicators, etc.) refer to geospatial units (e.g., countries, cantons, villages, etc.). In addition, recent advances in computing allow for collecting and analyzing novel forms of geocoded information that are of tremendous value for modern social science applications, such as conflict event data, satellite imagery, or geo-tagged social media data. Managing, analyzing and visualizing these types of data require tools that go beyond the traditional skill set taught in basic social science methods classes. This course introduces students to the tools and methods necessary for incorporating geospatial data in their own research projects, and guides participants through the entire workflow of creating, viewing, managing, visualizing, and analyzing geospatial data.</td>
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<td></td>
<td>Overall, students will learn to</td>
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<tr>
<td></td>
<td>- view and manage geospatial data in various formats;</td>
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<td>- develop a basic understanding of the problem of cartographic projection;</td>
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<td>- collect, create, manipulate, and combine geospatial data for their own research projects;</td>
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<td>- visualize geospatial data in maps and interactive applications;</td>
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<td>- understand the challenges associated with analyzing geospatial data with statistical tools;</td>
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<td></td>
<td>- prepare, run, and interpret basic spatial econometric models (linear SEM and SAR models).</td>
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<td>Requirements:</td>
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<td></td>
<td>- Basic understanding of linear regression and simple statistical concepts.</td>
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<td></td>
<td>- Interest in quantitative analysis.</td>
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<td></td>
<td>- Laptop (Win/Mac/Linux) for exercises.</td>
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<tr>
<td>857-0094-00L</td>
<td>Globalization: An Empirical Political Economy Perspective (University of Zurich)</td>
<td>6</td>
<td>2S</td>
<td>T. Bernauer, S. Bechtold, F. Schimmelfennig</td>
</tr>
<tr>
<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: 615613</td>
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<td></td>
<td>Mind the enrolment deadlines at UZH:</td>
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<td></td>
<td><a href="http://www.uzh.ch/studies/application/mobilitaet.html">http://www.uzh.ch/studies/application/mobilitaet.html</a></td>
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<tr>
<td>Objective</td>
<td>This course gives a broad overview of the various dimensions of globalization. It starts with discussing the measurement of globalization and then turns to its causes and consequences.</td>
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<tr>
<td></td>
<td>- Students are provided with a broad overview of the various dimensions of globalization</td>
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<tr>
<td></td>
<td>- They are aware of the options to measuring globalization and know about its causes and consequences.</td>
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<td></td>
<td>- Students expand their view of globalization in an interdisciplinary framework</td>
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<td></td>
<td>- Students learn and become able to express their views on the current research via intensive discussions</td>
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<td></td>
<td>- Awareness of the current literature and its shortcomings (potential for further research)</td>
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<tr>
<td>860-0001-00L</td>
<td>Public Institutions and Policy-Making Processes ■</td>
<td>6</td>
<td>3G</td>
<td></td>
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<tr>
<td></td>
<td>Number of participants limited to 25.</td>
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<tr>
<td></td>
<td>Priority for ISTP MSc students.</td>
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<tr>
<td>Objective</td>
<td>Students acquire the contextual knowledge for analyzing public policies. They learn why and how public policies and laws are developed, designed, and implemented at national and international levels.</td>
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</tbody>
</table>

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 351 of 1434
Objective

Public policies result from decision-making processes that take place within formal institutions of the state (parliament, government, public administration, courts). That is, policies are shaped by the characteristics of decision-making processes and the characteristics of public institutions and related actors (e.g. interest groups). In this course, students acquire the contextual knowledge for analyzing public policies. They learn why and how public policies and laws are developed, designed, and implemented at national and international levels. The course is organized in three modules. The first module (Stefan Bechtold) examines basic concepts and the role of law, law-making, and law enforcement in modern societies. The second module (Thomas Bernauer) deals with the functioning of legislatures, governments, and interest groups. The third module (Frank Schimmelfennig) focuses on the European Union and international organisations.

Content

Schedule:
W1: (no class because of ISTP cornerstone course)
W2: Bechtold, Bernauer: Introduction
W3: Bechtold: Why do we need laws and why do people and other actors (e.g. firms) usually obey the law?
W4: Bechtold: How is the law enforced, and when do laws fail to influence the behavior of individuals and other actors (e.g. firms)?
W5: Bechtold: Courts as policy-makers
W6: Bernauer: How are parliaments (legislatures) elected, how do they work, and how do their characteristics and processes affect policy-making?
W7: Bernauer: Why do forms of government differ and how does this affect policy-making? Why and in what respect are public administrations efficient/effective, and why sometimes not?
W8: Bernauer: How do interest groups and social movements affect policy-making?
W9: Schimmelfennig: Governance beyond the state: why and how states create international institutions.
W10: Schimmelfennig: International organizations and regimes: case studies of global governance.
W11: Schimmelfennig: Governance in the European Union: policy-making and policy enforcement.
W12: Schimmelfennig: The international diffusion of policies: how states learn from each other.
W13: study week, Q&A meeting
W14: End of semester test
End of January: deadline for review essay

Lecture notes
Reading materials will be distributed to the students before the semester starts.

Prerequisites / notice
This is a Master level course. The course is capped at 25 students, with ISTP Master students having priority.

Master Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>857-0019-00L</td>
<td>Master’s Thesis Colloquium</td>
<td>O</td>
<td>4</td>
<td>3K</td>
<td>D. Hangartner</td>
</tr>
</tbody>
</table>

Permission to begin master thesis is required to take part in Colloquium.

Abstract
In this colloquium, students enrolled in the MACIS program first present and discuss research design and methods issues concerning their prospective MA theses. Towards the end of the semester they present preliminary findings from their MA thesis work.

Objective
It is the goal of the colloquium to help students with the initial steps of writing their master theses. During the colloquium, they will develop a relevant research question and hypotheses and select appropriate methods and data.

857-0021-00L | Master’s Thesis | O    | 26    | 56D   | Professors |

Only students who fulfill the following criteria are allowed to begin with their master thesis:
- a. successful completion of the bachelor programme;
- b. fulfilling of any additional requirements necessary to gain admission to the master programme.

Abstract
The Master Thesis is an independent piece of research on an issue in comparative and international politics. It combines theory, methods, and empirical work.

Objective
The Thesis should demonstrate the students’ ability to conduct independent research on the basis of the theoretical and methodological knowledge acquired during the MA program.

Comparative and International Studies Master - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
<tr>
<td>ECTS</td>
<td>European Credit Transfer and Accumulation System</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

Key for Hours

V lecture
G lecture with exercise
U exercise
S seminar
K colloquium

Special students and auditors need special permission from the lecturers.
### Computational Biology and Bioinformatics Master

#### Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0523-00L</td>
<td>Computational Biology</td>
<td>W</td>
<td>6</td>
<td>3V+2U</td>
<td>G. H. Gonnet</td>
</tr>
</tbody>
</table>

**Abstract**
Study of computational techniques, algorithms and data structures used to solve problems in computational biology. Topics: basic biology, string alignment, phylogeny (distance, character, parsimony), molecular evolution, multiple sequence alignment, probabilistic and statistical models, Markov models, microarrays, dynamic programming, maximum likelihood and specialized DNA and protein analysis.

**Objective**
Familiarize the students with the basic concepts of molecular biology and the models and algorithms used to understand, classify and predict behaviour of living organism. This course is at the most basic level, where the main issues, mostly of molecular sequences, are studied.

**Content**
This course lies in the intersection between Computer Science and Molecular Biology. The main purpose is to study computational techniques, algorithms and data structures which are usually applied to solve problems in Molecular Biology and Biochemistry. The following topics are likely to be covered: Introduction, mathematical models of evolution, protein and DNA sequence alignment and its meaning, phylogenetic tree construction, multiple sequence alignments, secondary structure prediction, molecular dynamics, threading, role of bioinformatics in drug design, etc. From the computer science point of view we concentrate our attention in practical solutions for the above problems. Biological knowledge is an asset but not a prerequisite.

<table>
<thead>
<tr>
<th>Number</th>
<th>Principles of Evolution: Theory (University of Zurich)</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>262-5120-00L</td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: BIO351</td>
<td>W</td>
<td>6</td>
<td>3V</td>
<td>University lecturers</td>
</tr>
</tbody>
</table>

**Abstract**
"Nothing in Biology Makes Sense Except in the Light of Evolution". Evolutionary theory and methods are essential in all branches of modern biology.

**Objective**
Subject specific skills:
By the end of the course, students will be able to:
- describe basic evolutionary theory and its applications
- discuss ongoing debates in evolutionary biology
- critically assess the presentation of evolutionary research in the popular media

Key skills:
By the end of the course, students will be able to:
- approach biological questions from an evolutionary perspective

**Content**
This course will provide a broad overview of current evolutionary thought, including the mechanisms of evolutionary change, adaptation and the history of life and will involve practical field and lab work as well as lecture material.

<table>
<thead>
<tr>
<th>Number</th>
<th>Scientific Databases</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>263-5150-00L</td>
<td>Scientific Databases</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>G. H. Gonnet</td>
</tr>
</tbody>
</table>

**Abstract**
Scientific databases share many aspects with classical DBs, but have additional specific aspects. We will review Relational DBs, Object Oriented DBs, Knowledge DBs, textual DBs and the Semantic Web. All these topics will be studied from the point of view of the scientific applications (Bioinformatics, Physics, Chemistry, Health, Engineering) A toy SDB will be used for exercises.

**Objective**
The goals of this course are to:
- Familiarize the students with how existing DBs can be used for scientific applications.
- Recognize the areas where SciDBs differ and require additional features compared to classical DBs.
- Be able to understand more easily SciDBs, improve existing ones or design/create new ones.
- Familiarize the students with at least two examples of SciDBs.
1) - Introduction, Statement of the problem, course structure, exercises, why Scientific DBs (SDBs) do not fit exactly the classical DB area. Efficiency issues and how they differ from classical DB.

2) - Relational DB used for scientific data, pros/cons Introduction to RDB, limitations of the model, basics of SQL, handling of metadata, examples of scientific use of RDBs.

3) - Object Oriented DB. Rich/structured objects are very appealing in SDB. OODB primitives and environments. OODB searching, Space and access time efficiency of OODBs.

4) - Knowledge bases, key-value stores, ontologies, workflow-based architectures. WASA.

5) - MapReduce / Hadoop

6) - Storing and sharing mathematical objects, Open Math, its relation with OODB and Knowledge bases. Also the problem of chemical formula representation.

7) - SGML and XML, human-readable databases, genomic databases. Advantages of human-readable databases (the huge initial success of genomic databases).

8) - Semantic web, Resource Description Framework (RDF) triples, SparQL. An example of very flexible database for knowledge storage. Goals of the Semantic Web, discussion about its future.

9) - An ideal scenario (and the design of a toy system for most of the desired features for exploration and exercises).


11) - Functional testing, Verifiers, Consistency, Short-circuit testing, Recovery and Automatic recovery, Backup (incremental) methods.

12) - Performance and space issues, various uses of compression, concurrency control. Hardware issues, clusters, Cloud computing,

13) - Guest speaker: Ioannis Xenarios (UniProtKB/Swiss-Prot).

Literature

Several papers and online articles will be made available.

There is no single textbook for this course.

A significant amount of material will be delivered in the lectures making lecture attendance highly recommended.

401-6282-00L Statistical Analysis of High-Throughput Genomic and Transcriptomic Data (University of Zurich)

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract

A range of topics will be covered, including basic molecular biology, genomics technologies and in particular, a wide range of statistical and computational methods that have been used in the analysis of DNA microarray and high throughput sequencing experiments.

Objective

-Understand the fundamental "scientific process" in the field of Statistical Bioinformatics
-Be equipped with the skills/tools to preprocess genomic data (Unix, Bioconductor, mapping, etc.) and ensure reproducible research (Sweave)

Lecture notes

Lecture notes, published manuscripts

Prerequisites / notice

Prerequisites: Basic knowledge of the programming language R, sufficient knowledge in statistics

Former course title: Statistical Methods for the Analysis of Microarray and Short-Read Sequencing Data

551-0307-00L Biomolecular Structure and Mechanism I: Protein Structure and Function

D-BIOL BSc students are obliged to take part I and part II (next semester) as a two-semester course

Abstract

Biophysics of protein folding, membrane proteins and biochemistry of membranes, enzymatic catalysis, catalytic RNA and RNAi, current topics in protein biochemistry and structural biology.

Objective

Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalytics.

Lecture notes

Scripts on the individual topics can be found under http://www.mol.biol.ethz.ch/teaching.
The course consists of three parts. We first introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Second, we employ these evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. Throughout the class, the models and methods are illustrated on different datasets. The aim of this course is to understand and to appreciate mathematical models and computational methods that provide insight into the evolutionary process.

Evolutionary Dynamics is concerned with the mathematical principles according to which life has evolved. This course offers an introduction to mathematical modeling of evolution, including deterministic and stochastic models. The goal of this course is to understand and to appreciate mathematical models and computational methods that provide insight into the evolutionary process. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets. These include (i) graph theoretical approaches for revealing large-scale network organization, (ii) probabilistic (Bayesian) network representations, (iii) structural network analysis based on reaction stoichiometries, (iv) qualitative methods for dynamic modeling and simulation (Boolean and piece-wise linear approaches), (v) mechanistic modeling using ordinary differential equations (ODEs) and finally (vi) stochastic simulation methods.

Molecular Evolution, Phylogenetics and Phylodynamics. The aim of this course is to provide an up-to-date knowledge on how we can obtain an understanding of the evolution and population dynamics of organisms based on their genetic sequencing data, employing key concepts from molecular evolution, phylogenetics and phylodynamics. Throughout the course, we tie the models and methods closely with applications, mainly in the field of epidemiology and evolution of cancer, stochastic tunneling, cell differentiation, hematopoietic tumor stem cells, genetic progression of cancer and the speed of adaptation, diffusion theory, fitness landscapes, neutral networks, branching processes, evolutionary escape, and epistasis.

The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:

- Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST.

Prerequisites / notice

Basic knowledge in linear algebra, analysis, and statistics.

Advanced Courses and Methods of Computer Science

Advanced Courses
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>252-0023-00L</td>
<td>Discrete Mathematics</td>
<td>W</td>
<td>8</td>
<td>5+2U</td>
<td>U. Maurer</td>
</tr>
<tr>
<td>Abstract</td>
<td>Content: Mathematical reasoning and proofs, abstraction. Sets, relations, functions, combinatorics, (un-)countability, graph theory, number theory, algebra (groups, rings, fields, polynomials, subalgebras, morphisms), logic (propositional and predicate logic, proof calculi).</td>
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<tr>
<td>Objective</td>
<td>The primary goals of this course are (1) to introduce the most important concepts of discrete mathematics, (2) to understand and appreciate the role of abstraction and mathematical proofs, and (3) to discuss a number of applications, e.g., in cryptography, coding theory, and algorithm theory.</td>
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<tr>
<td>Content</td>
<td>See course description.</td>
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<tr>
<td>Lecture notes</td>
<td>available (in english)</td>
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<tr>
<td>227-1033-00L</td>
<td>Neuronomorphic Engineering I</td>
<td>W</td>
<td>6</td>
<td>2V+3U</td>
<td>K. A. Martin, G. Indiveri, S.C. Liu</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course covers analog circuits with emphasis on neuromorphic engineering: MOS transistors in CMOS technology, static circuits, dynamic circuits, systems (silicon neuron, silicon retina, silicon cochlea) with an introduction to multi-chip systems. The lectures are accompanied by weekly laboratory sessions.</td>
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<tr>
<td>Objective</td>
<td>Understanding the characteristics of neuromorphic circuit elements.</td>
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<tr>
<td>Content</td>
<td>Neuromorphic circuits are inspired by the organizing principles of biological neural circuits. Their computational primitives are based on physics of semiconductor devices. Neuromorphic architectures often rely on collective computation in parallel networks. Adaptation, learning and memory are implemented locally within the individual computational elements. Transistors are often operated in weak inversion (below threshold), where they exhibit exponential I-V characteristics and low currents. These properties lead to the feasibility of high-density, low-power implementations of functions that are computationally intensive in other paradigms. Application domains of neuromorphic circuits include silicon retinas and cochleas for machine vision and audition, real-time emulations of networks of biological neurons, and the development of autonomous robotic systems. This course covers devices in CMOS technology (MOS transistor below and above threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, transconductance amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina and cochlea) and an introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory sessions.</td>
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<tr>
<td>Literature</td>
<td>S.-C. Liu et al.: Analog VLSI Circuits and Principles; various publications.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Partially: The course is highly recommended for those who intend to take the spring semester course 'Neuronomorphic Engineering II', that teaches the conception, simulation, and physical layout of such circuits with chip design tools.</td>
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<tr>
<td>Prerequisites</td>
<td>Background in basics of semiconductor physics helpful, but not required.</td>
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<tr>
<td>227-1037-00L</td>
<td>Introduction to Neuroinformatics</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>K. A. Martin, M. Cook, V. Mante, M. Pfeiffer</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.</td>
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<tr>
<td>Objective</td>
<td>Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute to their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monocolours of physics, maths, computer science, engineering, biology, psychology, and even philosophy and history, to discover the engravings and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions.</td>
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<tr>
<td>Content</td>
<td>This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. The biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.</td>
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<tr>
<td>Literature</td>
<td>M. Pfeiffer</td>
<td></td>
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<tr>
<td>Prerequisites / notice</td>
<td>Since the exercises on the computer do convey test etc.</td>
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<tr>
<td>Prerequisites</td>
<td>Background in basics of semiconductor physics helpful, but not required.</td>
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<tr>
<td>529-0004-00L</td>
<td>Computer Simulation in Chemistry, Biology and Physics</td>
<td>W</td>
<td>7</td>
<td>4G</td>
<td>P. H. Hünninger</td>
</tr>
<tr>
<td>Abstract</td>
<td>Molecular models, Force fields, Boundary conditions, Electrostatic interactions, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.</td>
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<tr>
<td>Objective</td>
<td>Introduction to computer simulation of (bio)molecular systems, development of skills to carry out and interpret computer simulations of biomolecular systems.</td>
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<tr>
<td>Content</td>
<td>Molecular models, Force fields, Spatial boundary conditions, Calculation of Coulomb forces, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.</td>
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<tr>
<td>Lecture notes</td>
<td>Available (copies of powerpoint slides distributed before each lecture)</td>
<td></td>
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<td></td>
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<tr>
<td>Literature</td>
<td>See: <a href="http://www.csms.ethz.ch/education/CSCBP">www.csms.ethz.ch/education/CSCBP</a></td>
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<tr>
<td>Prerequisites / notice</td>
<td>Since the exercises on the computer do convey test etc.</td>
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<tr>
<td>Prerequisites</td>
<td>More for the lecture: <a href="http://www.csms.ethz.ch/education/CSCBP">www.csms.ethz.ch/education/CSCBP</a></td>
<td></td>
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<tr>
<td>529-0733-00L</td>
<td>Enzymes</td>
<td>W</td>
<td>7</td>
<td>3G</td>
<td>D. Hilvert</td>
</tr>
<tr>
<td>Abstract</td>
<td>Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>Overview of enzymes, enzyme-catalyzed reactions and metabolic processes.</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Content</td>
<td>Principles of enzymatic catalysis, enzyme kinetics, mechanisms of enzyme-catalyzed reactions (group transfer reactions, carbon-carbon bond formation, eliminations, isomerisations and rearrangements), cofactor chemistry, enzymes in organic synthesis and the biosynthesis of natural products, catalytic antibodies.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>A script will not be handed out.</td>
<td></td>
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</tr>
</tbody>
</table>
### 535-0810-00L Gene Technology

**Abstract**
The aim of the lecture course is to provide a solid overview of the science and issues in gene technology and genome science. Topics: Antibody phage technology, protein modification technology, genome projects, genome sequencing, transcriptomics, proteomics, and SNP technology. The course is suited for advanced undergraduate and early graduate students in pharmaceutical sciences or related fields.

**Objective**
The course will provide a solid overview of the science and issues in gene technology and genome science.

**Content**
1. Antibody phage technology
   - The antibody molecule
   - V genes, CDRs, basics of antibody engineering
   - Principles of phage display
   - Phagemid and phage vectors
   - Antibody libraries
   - Phage display selection methodologies
   - Other phage libraries (peptides, globular proteins, enzymes)
   - Alternative screening/selection methodologies
   - DNA-encoded chemical libraries

2. Proteins: chemical modification and detection of biomolecular interactions
   - Homo- and hetero-dimerization of proteins
   - Chemical modifications of proteins
   - Radioactive labeling of proteins
   - Kinetic association and dissociation constants
   - Affinity constant: definition and its experimental measurement

3. Genomics: Applications to Human Biology
   - Protein cloning and expression
   - Functional Genomics
   - Sequencing genomes and novel sequencing methods
   - Genetic disorders: discovery and pharmaceutical implications
   - Transcriptomics
   - Proteomics
   - Principles of Cancer
   - Principles of Vaccine Development
   - Principles of Gene Therapy

4. Pharmaceuticals: Focus on Discovery
   - Chemical Libraries
   - Protein Therapeutics
   - Consideration on pharmacokinetics and half-life extension

**Lecture notes**
Skript "Gene Technology" by Prof. Dario Neri

### 551-0307-00L Biomolecular Structure and Mechanism I: Protein Structure and Function

**Abstract**
Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNAi, current topics in protein biophysics and structural biology.

**Objective**
Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalytics.

**Lecture notes**
Scripts on the individual topics can be found under http://www.mol.biol.ethz.ch/teaching.

**Literature**
- Creighton, T.E., Proteins, Freeman, (1993)

Current topics: References will be given during the lectures.

### 551-0309-00L Concepts in Modern Genetics

**Abstract**
Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

**Objective**
This course focuses on the concepts of classical and modern genetics and genomics.

**Content**
The topics include principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

**Lecture notes**
 Scripts and additional material will be provided during the semester.

**Prerequisites / notice**
This course is a co-production of the University of Zurich and ETH Zurich, and will be taught in English. The course takes place on Monday afternoon at ETH Hoenggerberg, and on Tuesday morning at UniZH Irchel.

### 551-0313-00L Microbiology (Part I)

**Abstract**
Advanced lecture class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

**Objective**
This concept class will be based on common concepts (Grundlagen der Biologie IIb, Teil Mikrobiologie) and introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

**Content**
Advanced class covering the state of the research in bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

**Lecture notes**
Updated handouts will be provided during the class.

**Literature**
Current literature references will be provided during the lectures.
Methods of Computer Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0057-00L</td>
<td>Theoretical Computer Science</td>
<td>W</td>
<td>8</td>
<td>4V+2U</td>
<td>J. Hromkovic, E. Welzl</td>
</tr>
</tbody>
</table>

Abstract
Concepts to cope with: a) what can be accomplished in a fully automated fashion (algorithmically solvable) b) How to measure the inherent difficulty of tasks (problems) c) What is randomness and how can it be useful? d) What is nondeterminism and what role does it play in CS? e) How to represent infinite objects by finite automata and grammars?

Objective
Learning the basic concepts of computer science along their historical development

Content
The main topics of the lecture are:
- alphabets, words, languages, measuring the information content of words, representation of algorithmic tasks
- finite automata, regular and context-free grammars
- Turing machines and computability
- complexity theory and NP-completeness
- design of algorithms for hard problems

The lecture is covered in detail by the textbook "Theoretical Computer Science".

Literature
Basic literature:

Further reading:

More exercises and examples in:
6. A. Asteroth, Ch. Baier: Theoretische Informatik

Prerequisites / notice
During the semester, two non-obligatory test exams will be offered.

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>252-0535-00L</td>
<td>Machine Learning</td>
<td>W</td>
<td>6</td>
<td>3V+2U</td>
<td>J. M. Buhmann</td>
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</table>

Abstract
Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

Objective
Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensible to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.
The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:
- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non-parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

Lecture notes
No lecture notes, but slides will be made available on the course webpage.

Literature

Prerequisites / notice
Solid basic knowledge in analysis, statistics and numerical methods for CSE. Experience in programming for solving the project tasks.

<table>
<thead>
<tr>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-0104-00L</td>
<td>Uncertainty Quantification for Engineering &amp; Life Sciences</td>
<td>1. Direct Methods for linear systems of equations</td>
<td>W  4 credits</td>
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<tr>
<td>262-0500-00L</td>
<td>Lab Rotation in Experimental Biology</td>
<td>O  3 credits</td>
<td>6A</td>
<td>Lecturers</td>
<td></td>
</tr>
</tbody>
</table>

Autumn Semester 2015

Data: 06.02.2019 13:00
The course provides a practical overview of an experimental biology research area, applying concepts taught in the General and Core courses, and preparing for further specialization through the Master thesis.

**Objective**

The course provides a practical overview of a computer science research area, applying concepts taught in the General and Core courses, and preparing for further specialization through the Master thesis.

**Abstract**

Flexible, short research project within the field of computational biology/bioinformatics.

**Content**

Flexible, short research project within the field of computational biology/bioinformatics (can be chosen within any department participating in the CBB-Master). The course provides a practical overview of a bioinformatics research area, applying concepts taught in the General and Core courses, and preparing for further specialization through the Master thesis.

The course is about fundamental algorithm design paradigms (such as induction, divide-and-conquer, backtracking, dynamic programming), classic algorithmic problems (such as sorting and searching), and data structures (such as lists, hashing, search trees). The connection between algorithms and data structures is explained for geometric and graph problems.

- In general, the concepts provided in the course are motivated and illustrated with algorithms and applications.
- Secondary goals are an algorithmic computational thinking, understanding the possibilities and limits of programming and to impart the way of thinking of a computer scientist.
- The course covers fundamental data types, expressions and statements, (Limits of) computer arithmetic, control statements, functions, arrays, structural types and pointers. The part on object orientation deals with classes, inheritance and polymorphy, simple dynamic data types are introduced as examples.
- The course covers the fundamental concepts of computer programming with a focus on systematic algorithmic problem solving. Teached language is C++. No programming experience is required.
- The course is about fundamental algorithm design paradigms (such as induction, divide-and-conquer, backtracking, dynamic programming), classic algorithmic problems (such as sorting and searching), and data structures (such as lists, hashing, search trees). The connection between algorithms and data structures is explained for geometric and graph problems.
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- The course covers the fundamental concepts of computer programming with a focus on systematic algorithmic problem solving. Teached language is C++. No programming experience is required.

**Laboratory Rotation in Bioinformatics**

- **Objective**: Students learn to transfer and apply their knowledge by working independently in the laboratory or on projects. By applying knowledge acquired from the core and advanced courses, and the Methods of Computer Science course, students gain insight into different research areas.

**Compulsory Electives in Humanities, Social and Political Sciences**

- **Recommended GESS compulsory elective courses (Type B) for D-INFK**

- **see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability**

- **see GESS Compulsory Electives: Language Courses ETHZ/ZZH**

**Master Thesis**

- **Objective**: The Master thesis concludes the Master programme. By writing up the Master thesis, students show their ability to independently produce a coherent and scientific piece of work. The program concludes with a Master thesis of 6 months duration that includes a written report and an oral presentation. The topic of the thesis can be chosen according to the student's interests in the field of computational biology & bioinformatics.

**Course Units for Additional Admission Requirements**

The courses below are only available for MSc students with additional requirements.

**Data Structures and Algorithms**

- **Objective**: Only students who fulfill the following criteria are allowed to begin with their master thesis:
  a. successful completion of the bachelor programme;
  b. fulfilling of any additional requirements necessary to gain admission to the master programme.

- **Abstract**: The Master Thesis is the result of an independent scientific research and/or constructive development project in the chosen area of specialization.

- **Content**: The program concludes with a Master thesis of 6 months duration that includes a written report and an oral presentation. The topic of the thesis can be chosen according to the student's interests in the field of computational biology & bioinformatics.

**Enrolment only for MSc students who need this course as additional admission requirement.**

---

**Computer Science I**

- **Objective**: An understanding of the design and analysis of fundamental algorithms and data structures.

**Laboratory Rotation in Computer Science**

- **Objective**: Flexible, short research project with emphasis on computer science/theory

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- **Objective**: An understanding of the design and analysis of fundamental algorithms and data structures.

**Laboratory Rotation in Computer Science**

- **Objective**: Flexible, short research project with emphasis on computer science/theory

Textbooks in English:
- J. Stewart: Multivariable Calculus, Thomson Brooks/Cole
- V. I. Smirnov: A course of higher mathematics. Vol. II. Advanced calculus
- M. Akveld, R. Sperb, Analysis II, vdf
- L. Papula: Mathematik für Ingenieure 2, Vieweg Verlag

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Instructor</th>
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<tbody>
<tr>
<td>406-0603-AAL</td>
<td>Stochastics (Probability and Statistics)</td>
<td>4</td>
<td>E-</td>
<td>M. Kalisch</td>
</tr>
</tbody>
</table>

Enrolment only for MSc students who need this course as additional admission requirement.

Abstract
Introduction to basic methods and fundamental concepts of statistics and probability theory for non-mathematicians. The concepts are presented on the basis of some descriptive examples. Learning the statistical program R for applying the acquired concepts will be a central theme.

Objective
The objective of this course is to build a solid fundament in probability and statistics. The student should understand some fundamental concepts and be able to apply these concepts to applications in the real world. Furthermore, the student should have a basic knowledge of the statistical programming language "R".

Content
- From "Statistics for research" (online)
  - Ch 1: The Role of Statistics
  - Ch 2: Populations, Samples, and Probability Distributions
  - Ch 3: Binomial Distributions
  - Ch 6: Sampling Distribution of Averages
  - Ch 7: Normal Distributions
  - Ch 8: Student’s t Distribution
  - Ch 9: Distributions of Two Variables
- From "Introductory Statistics with R (online)"
  - Ch 1: Basics
  - Ch 2: The R Environment
  - Ch 3: Probability and distributions
  - Ch 4: Descriptive statistics and tables
  - Ch 5: One- and two-sample tests
  - Ch 6: Regression and correlation

Literature
- "Statistics for research" by S. Dowdy et. al. (3rd edition); Print ISBN: 9780471267355; Online ISBN: 9780471477433; DOI: 10.1002/0471477435
  From within the ETH, this book is freely available online under:
  From within the ETH, this book is freely available online under:
  http://www.springerlink.com/content/m17578/

Computational Biology and Bioinformatics Master - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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</table>

Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Diploma Project

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1101-00L</td>
<td>How to Write Scientific Texts in Engineering Sciences</td>
<td>E-</td>
<td>0</td>
<td></td>
<td>J. Leuthold</td>
</tr>
<tr>
<td></td>
<td>Strongly recommended prerequisite for Semester Projects and Master Theses at D-ITET (MSc BME, MSc EEIT, MSc EST).</td>
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</table>

**Abstract**
The 4 hour lecture covers the basics of writing & presenting a scientific text. The focus will be on the structure and elements of a scientific text and not on the language. Citation rules, good practice of scientific writing and an overview on software tools will be part of the training. The lecture will be thought on two afternoons. Some exercises will be built into the lecture.

**Objective**
Knowledge on structure and content of a scientific text. The course further is arranged to stimulate a discussion on how to properly write a legible scientific text versus writing an interesting novel. We will further discuss the practice of properly citing and critically reflect on recent plagiarism allegations.

**Content**
- *Topic 1: Structure of a Scientific Text (The Title, the author list, the abstract, State-of-the Art, the “in this paper” paragraph, the scientific part, the summary, Equations, Figures).*
- *Topic 2: Power Point Presentations.*
- *Topic 3: Citation Rules and Citation Software.*
- *Topic 4: Guidelines for Research Integrity.*

**Literature**
- ETH "Citation Etiquette", see www.plagiate.ethz.ch.

**Prerequisites / notice**
Students should already have a Bachelor degree and plan to do either a semester project or a master thesis in the immediate future.

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
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<td>227-3001-00L</td>
<td>Diploma Thesis</td>
<td>O</td>
<td>12</td>
<td>36D</td>
<td>Professors</td>
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<td></td>
<td>Only for DAS in Information Technology and Electrical Engineering.</td>
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<tr>
<td></td>
<td>Registration for the diploma thesis requires the successful completion of 18 credits ECTS from subjects of specialization.</td>
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</table>

**Abstract**
The Diploma of Advanced Studies finishes with a 3-months diploma thesis which is directed by a professor of the department ITET. Students prove their ability to conduct independent scientific research on a specific research problem, using skills and knowledge acquired during the program. The thesis includes a written report and an oral presentation.

**Objective**
see above

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**DAS in Information Technology and Electrical Engineering - Key for Type**

<table>
<thead>
<tr>
<th>W</th>
<th>Eligible for credits</th>
<th>Dr</th>
<th>Suitable for doctorate</th>
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<tbody>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
<td>O</td>
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</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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</table>

**Key for Hours**

<table>
<thead>
<tr>
<th>V</th>
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</table>

**ECTS**
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DAS Military Sciences

This program is taking place every Second Year. The next realization of this 2 semester program: Autumn Semester 2016.

### DAS Military Sciences - Key for Type

<table>
<thead>
<tr>
<th>Dr</th>
<th>Suitable for doctorate</th>
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<tbody>
<tr>
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<td>W+</td>
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ECTS  European Credit Transfer and Accumulation System
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### Pharmacology and Toxicology I

**Number:** 535-0521-00L  
**Title:** Pharmacology and Toxicology I  
**Type:** W  
**ECTS:** 2 credits  
**Hours:** 2V  
**Lecturers:** U. Quitterer

**Abstract:** The two-semester lecture course will provide a detailed understanding of the fundamentals of drug action and the mechanisms of action and therapeutic use of the important classes of drugs. The lectures are intended for students of pharmaceutical sciences.

**Objective:** The lectures will provide a comprehensive survey of pharmacology and toxicology. Special emphasis is placed on the interrelationship between pharmacological, pathophysiological and clinical aspects.

**Content:** Topics include disease-relevant macroscopic, microscopic, pathobiochemical and functional disturbances of specific organs and organ systems. The lectures integrate disease pathology with mechanisms of drug action, usage, metabolism, pharmacokinetics, side effects, toxicity, contraindications and dosage of relevant drug classes. Basic principles of clinical pharmacology and pharmacotherapy will be covered.

**Lecture notes:** Für jede Vorlesung wird ein Skript abgegeben, das eine Zusammenfassung mit den wichtigsten Stichpunkten beinhaltet.

**Literature:**  
Recommended reading:  
Klaus Aktories, Ulrich Förstermann, Franz Hofmann, Klaus Starke.  
Allgemeine und spezielle Pharmakologie und Toxikologie.  
11. überarb. Auflage - 1216 Seiten  
2013; Urban & Fischer bei Elsevier, München  
or  
Heinz Lüllmann, Klaus Mohr, Lutz Hein  
Pharmakologie und Toxikologie.  
Arzneimittelwirkungen verstehen - Medikamente gezielt einsetzen  
17. Auflage - 666 Seiten  

Comprehensive overview:  
Heinz Lüllmann, Klaus Mohr, Lutz Hein.  
Taschenatlas der Pharmakologie.  
6th edition - 394 Seiten  

English version  
Heinz Lüllmann, Klaus Mohr, Lutz Hein.  
4th edition - 408 pages  

The classic textbook in Pharmacology:  
Goodman and Gilman`s The Pharmacological Basis of Therapeutics  
Laurence Brunton, Bruce Chabner, Bjorn Knollman.  
12th edition - 1808 Seiten  

**Prerequisites / notice:**  
Voraussetzungen: Abschluss Grundstudium

---

### Clinical Microbiology

**Number:** 535-0165-00L  
**Title:** Clinical Microbiology  
**Type:** W  
**ECTS:** 1 credit  
**Hours:** 1V  
**Lecturers:** K. Lucke

**Abstract:** Thorough knowlegde of major pathogens involved in infectious diseases; principles of laboratory diagnosis of pathogenic bacteria and fungi.

**Objective:** Thorough knowlegde of all major pathogens involved in infectious diseases; principles of laboratory diagnosis of pathogenic bacteria and fungi.

**Content:** Basics and principles of clinical microbiology:  
- host-pathogen interaction  
- symptoms and diagnosis of major bacterial pathogens  
- therapeutic regimens commonly used against bacterial disease  
- major aspects of medical mycology, virology and parasitology  
- epidemiology

**Literature:**  
- Brock, Mikrobiologie, Pearson, 13. aktualisierte Auflage  
- Kayser F. et al., Medizinische Mikrobiologie, Thieme, Stuttgart, New York  

**Prerequisites / notice:** Basic knowledge of biochemistry, general microbiology, immunology

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### Gene Technology

**Number:** 535-0810-00L  
**Title:** Gene Technology  
**Type:** W  
**ECTS:** 2 credits  
**Hours:** 2G  
**Lecturers:** D. Neri

**Abstract:** The aim of the lecture course is to provide a solid overview of the science and issues in gene technology and genome science.  
Topics: Antibody phage technology, protein modification technology, genome projects, genome sequencing, transcriptomics, proteomics and SNP technology. The course is suited for advanced undergraduate and early graduate students in pharmaceutical sciences or related fields.

**Objective:** The course will provide a solid overview of the science and issues in gene technology and genome science.
1. Antibody phage technology
   - The antibody molecule
   - V genes, CDRs, basics of antibody engineering
   - Principles of phage display
   - Phagemid and phage vectors
   - Antibody libraries
   - Phage display selection methodologies
   - Other phage libraries (peptides, globular proteins, enzymes)
   - Alternative screening/selection methodologies
   - DNA-encoded chemical libraries

2. Proteins: chemical modification and detection of biomolecular interactions
   - Homo- and hetero-dimerization of proteins
   - Chemical modifications of proteins
   - Radioactive labeling of proteins
   - Kinetic association and dissociation constants
   - Affinity constant: definition and its experimental measurement

3. Genomics: Applications to Human Biology
   - Protein cloning and expression
   - Functional Genomics
   - Sequencing genomes and novel sequencing methods
   - Genetic disorders: discovery and pharmaceutical implications
   - Transcriptomics
   - Proteomics
   - Principles of Cancer
   - Principles of Vaccine Development
   - Principles of Gene Therapy

4. Pharmaceuticals: Focus on Discovery
   - Chemical Libraries
   - Protein Therapeutics
   - Consideration on pharmacokinetics and half-life extension

Abstract
Get Students familiar with basic Immunological concepts of pharmaceutical relevance.

Objective
Get Students familiar with basic Immunological concepts of pharmaceutical relevance.

Content
Chapters 1 - 11 of the Janeway's ImmunoBiology, by Kenneth Murphy (8th Edition; Garland).

Literature
Janeway's ImmunoBiology, by Kenneth Murphy (8th Edition).

Paperback [www.garlandscience.com]
Therapeutic Proteins

Handouts to the lectures will be available for downloading under http://www.pharma.ethz.ch/scripts/index.

C. Halin Winter

- Chapters 13-16 of the Immunobiology VIII book
- EMEA Dossier for Humira

Objective

- To familiarize participants with the principles of pharmacoepidemiology and epidemiology in addressing drug related questions with concern to the use, effects and risks of medicinal products in a large population.
- To introduce participants to fundamental statistical, economic and epidemiological concepts and methods.
- To provide the appropriate tools to critique pharmacoepidemiologic studies in the literature and to critically read and understand papers in the medical literature which relate to drug benefits, risks, and costs.
- To address controversial topics in drug use and benefit-risk assessment, and to critically appraise the outcome of drug therapy.
- To equip participants with skills to facilitate further studies in these areas.

Content

- The contribution of epidemiology to the study of drug uses, effects and risks:
  - Pharmacoepidemiology study methodologies, concepts and strategies,
  - Detection and identification of unintended drug effects (pharmacovigilance),
  - Quantifying unintended effects and drug interactions,
  - Bias and confounding by indication,
  - Drug utilization

Pharmacoepidemiology and outcome assessment of drug therapy.

Meta-analysis in pharmacoepidemiology.

Lecture notes

This course will be a combination of formal lectures, group discussions and self-directed project work. Course material will be taught through seminars, case studies and group projects. Reading material and scripts will be given for each week.

Literature

A reading list pertinent to the course will be provided during the course.

Methodological referen

Strom B; Pharmacoepidemiology, 3rd ed. Wiley, Chichester, 2000
Rothman K, Greenland S; Modern Epidemiology, 2nd ed. Lippincott, Philadelphia, 1998
Mann R, Andrews E; Pharmacovigilance, Wiley, Chichester, 2003

535-0030-00L Therapeutic Proteins

Abstract

In this course, various topics related to the development, GMP production and application of therapeutic proteins will be discussed. Furthermore, students will expand their training in pharmaceutical immunology and will be introduced to the basic concepts of pharmaceutical product quality management.

Objective

Students know and understand:
- basic mechanisms and regulation of the immune response
- the pathogenic mechanisms of the most important immune-mediated disorders
- the most frequently used expression systems for the production of therapeutic proteins
- the use of protein engineering tools for modifying different features of therapeutic proteins
- the mechanism of action of selected therapeutic proteins and their application
- basic concepts in the GMP production of therapeutic proteins

Content

The course consists of two parts:

In a first part, students will complete their training of pharmaceutical immunology (Chapter 13 - 16 Immunobiology VIII textbook). This part particularly focuses on the pathogenic mechanisms of immune-mediated diseases. Deepened knowledge of immunology will be relevant for understanding the mechanism of action of many therapeutic proteins, as well as for understanding one major concern related to the use of protein-based drugs, namely, immunogenicity.

The second part focuses on topics related to the development and application of therapeutic proteins, such as protein expression, protein engineering, reducing immunogenicity, and GMP production of therapeutic proteins. Furthermore, selected examples of approved therapeutic proteins will be discussed.

Lecture notes

Handouts to the lectures will be available for downloading under http://www.pharma.ethz.ch/scripts/index

- Lecture Handouts
- Paper References provided in the Scripts
- Lecture Handouts
- EMEA Dossier for Humira

Second Series of Courses

Compulsory Block Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-5501-00L</td>
<td>Applied Pharmacology</td>
<td>O</td>
<td>6</td>
<td>7G</td>
<td>P. Wiedemeier, S. Erni, B. Falch, K. Fuchs</td>
</tr>
</tbody>
</table>

Abstract

Overview of the most important clinical pictures: symptoms, recognition, differentiation, pharmacotherapy for the most important general and special medical indications. Groups of pharmaceutical compounds, active pharmaceutical ingredients, proprietary medicinal products: mechanisms of action, contraindication, therapeutic patterns, side effects, interactions.

Objective

Students have a thorough knowledge of all clinical pictures and their symptoms regarding outpatient treatment. They know the main groups of indications including active pharmaceutical self-medication and ingredients, mechanisms of action, pharmacokinetics, pharmacodynamics and dosage. They are also able to identify the relevant side effects and interactions.

Content

Pathophysiology of selected clinical pictures and their main symptoms and clinical parameters. Recognition of alarm symptoms and distinction between pharmaceutical self-medication and the need for medical treatment. Detailed coverage of the pharmacotherapy of all fields of indication encountered in outpatient treatment. Outlining of therapeutic strategies and patterns with regard to suitable pharmaceutical compounds, active pharmaceutical ingredients and representative range of proprietary medicinal products. Discussion of the most important mechanisms of action, contraindications, side effects and interactions.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-5502-00L</td>
<td>Pharmaceutical Manufacturing in Small Quantities</td>
<td>O</td>
<td>3</td>
<td>3G</td>
<td>J. Fröhlich, H. Hartenberg, C. Meier</td>
</tr>
</tbody>
</table>

Abstract

Hands-on course in pharmaceutical manufacturing in the pharmacy according to "GMP regulations for small quantities" defined in the pharmacopeia: Design and practical approach in compounding of formulas using the most important dosage forms including their risks and quality assurance.
Objective

Students are able to manufacture, to package, to quality-control and document pharmaceutical compounding on their own, "lege arts" and according to GMP regulations, using the appropriate techniques. They know the most important properties of active ingredients and excipients frequently used. They achieve the necessary knowledge including the relevant literature and other sources of information, as well as the legal requirements regarding pharmaceutical manufacturing in small quantities.

Content

To impart knowledge about the principal techniques and processes in the manufacturing of pharmaceuticals in small quantities (formulas), focusing on the design, manufacturing, quality assurance and risk based self-appraisal including the patient specific dispensing. During the practical training periods: by means of pharmaceutical relevant examples the design, the planning, the manufacturing including the correct use of the equipment, the in-process control, the packaging and the quality assurance are practiced for various dosage forms and recipes. Quality assurance and control are mainly risk adapted considering as well hygiene regulations according to current pharmaceutical practice. The participants will thus improve their general GMP knowledge and skills.

535-5503-00L Institutional Pharmacy

<table>
<thead>
<tr>
<th>Objective</th>
<th>Institutional Pharmacy (emergency hospitals), with special focus on the medication process and institutional pharmaceutical care (continuum of care).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content</td>
<td>Organisation of institutional environments (emergency hospitals), with special focus on the medication process and institutional pharmaceutical care (continuum of care).</td>
</tr>
</tbody>
</table>

Abstract

Organisation of institutional environments (emergency hospitals), with special focus on the medication process and institutional pharmaceutical care (continuum of care).

Institutional Pharmacy

<table>
<thead>
<tr>
<th>535-5504-00L Basics of Practical Pharmacy</th>
<th>O 6 credits</th>
<th>7G</th>
<th>P. Wiedemeier, S. Erni, B. Falch, K. Fünfschilling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>Basics of Practical Pharmacy (Pharmaceutical Care and Public Health): problems with regard to therapy and approaches to solutions, service, first aid and medicinal products. Methods of illness prevention and health promotion. Important additional assortments including complementary medicine. Law and economy in everyday pharmacy, structures of the national health care system.</td>
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<tr>
<td>Content</td>
<td>Introduction to managed care systems (Pharmaceutical Care und Public Health): problems with regard to therapy and approaches to solutions, service, first aid and medicinal products. Methods of illness prevention and health promotion. Important additional assortments including complementary medicine. Law and economy in everyday pharmacy, structures of the national health care system.</td>
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</tr>
</tbody>
</table>

Abstract

Introduction to managed care systems (Pharmaceutical Care and Public Health): problems with regard to therapy and approaches to solutions, service, first aid and medicinal products. Methods of illness prevention and health promotion. Important additional assortments including complementary medicine. Law and economy in everyday pharmacy, structures of the national health care system.

Basics of Practical Pharmacy

<table>
<thead>
<tr>
<th>DAS Preparation for the Swiss Federal Examination in Pharmacy - Key for Type</th>
<th>Dr</th>
<th>Suitable for doctorate</th>
<th>W</th>
<th>Eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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<tr>
<td>O</td>
<td>Compulsory</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
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</tbody>
</table>

Key for Hours

| V | lecture | P | practical/laboratory course |
| G | lecture with exercise | A | independent project |
| U | exercise | D | diploma thesis |
| S | seminar | R | revision course / private study |
| K | colloquium | | |

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 367 of 1434
### Doctoral and Post-Doctoral Courses

#### Course Catalogue of ETH Zurich

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>064-0003-15L</td>
<td>Postgraduate Colloquium on the History and Architecture (N.H.)</td>
<td>W</td>
<td>3</td>
<td>2K</td>
<td>I. Heinze-Greenberg</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>The Postgraduate Colloquium mainly addresses doctoral students of the Chair. It is aimed at presenting and further discussing the current research, thus focusing on the argumentation and verification of contextual and methodical questions. The Colloquium provides a basis for exchange and further education and to establish and promote networking.</td>
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<td></td>
<td><strong>Objective</strong></td>
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<td></td>
<td>The Colloquium focuses on the presentation and further discussion of the current research of doctoral students. It concentrates on the discussion and verification of contextual and methodical questions and provides a basis for exchange and networking among the participants.</td>
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<td><strong>Content</strong></td>
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</tr>
<tr>
<td></td>
<td>Die Themenschwerpunkte der jeweiligen Veranstaltung richten sich nach den präsentierten Forschungsarbeiten. Inhaltlich korrespondieren sie mit den Forschungsschwerpunkten der Professur.</td>
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<td></td>
<td><strong>Prerequisites / notice</strong></td>
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<td></td>
<td>Mehrtägiges Kolloquium. Veranstaltungszeit und -ort nach Vereinbarung.</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>V. Magnago Lampugnani, A. Moravanszky, L. Stalder</td>
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<tr>
<td></td>
<td>Lecturers and doctoral students of the chair report about their experiences and insights in the application of methods concerning their researches and the scientific publications thereof.</td>
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<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>The seminar seeks to provide students with a differentiated knowledge of methods in the field of the History of Art and Architecture.</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td></td>
<td>The seminar addresses the fellows of the Doctoral Program in History and Theory of Architecture. All other doctoral students of the Faculty of Architecture are welcome.</td>
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<tr>
<td>064-0009-15L</td>
<td>Research Colloquium in Architecture and Urbanism (M. Angélil)</td>
<td>W</td>
<td>3</td>
<td>1K</td>
<td>M. Angélil</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>This colloquium is open to doctoral candidates in fields related to Architecture and Urbanism. Its focus will be on contemporary topics in urbanism and will involve two or three one-day sessions over the course of the semester, each of which will be attended by an invited scholar.</td>
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<td><strong>Objective</strong></td>
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<td>The seminar seeks to provide students with a differentiated knowledge of methods in the field of the History of Art and Architecture.</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td>Space is limited and participation is subject to approval from the organizers.</td>
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<tr>
<td>064-0011-15L</td>
<td>PhD Talks - Perspectives and Methods of Architectural Research (L.Stalder)</td>
<td>W</td>
<td>3</td>
<td>2K</td>
<td>L. Stalder</td>
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<tr>
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<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>This colloquium addresses PhD's and researchers of D-ARCH as well as to all interested persons coming from adjacent fields of humanities and cultural studies.</td>
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<td><strong>Objective</strong></td>
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<td></td>
<td>The Colloquium focuses on the presentation and further discussion of the current research of doctoral students. It concentrates on the discussion and verification of contextual and methodical questions and provides a basis for exchange and networking among the participants.</td>
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<td></td>
<td><strong>Content</strong></td>
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<tr>
<td></td>
<td>Die Themenschwerpunkte der jeweiligen Veranstaltung richten sich nach den präsentierten Forschungsarbeiten. Inhaltlich korrespondieren sie mit den Forschungsschwerpunkten der Professur.</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td></td>
<td>Mehrtägiges Kolloquium. Veranstaltungszeit und -ort nach Vereinbarung.</td>
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<tr>
<td>064-0013-15L</td>
<td>Methods in the History and Theory of Architecture</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>I. Heinze-Greenberg</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>Introduction to methodological approaches in the history and theory of architecture; presentation and discussion of individual doctoral projects.</td>
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<td><strong>Objective</strong></td>
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<td></td>
<td>The doctoral students analyze critically relevant approaches in the history and theory of architecture and discuss fundamental questions with regard to their individual research projects, to produce and hand in their proposals.</td>
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<td><strong>Content</strong></td>
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<td>The two-semester course in the first year of the doctoral program in the history and theory of architecture has a twofold objective: First, reading sessions on central approaches in the history and theory of architecture provide a methodological basis for the a doctorate at the Institute gta. Secondly, by both, reading sessions and presentation and discussion sessions on the individual research projects, the doctoral students get support in the production of the proposal which they work on and which they have to present after the first year. Languages: German and English</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td>Mehrtägiges Kolloquium. Veranstaltungszeit und -ort nach Vereinbarung.</td>
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<tr>
<td>064-0015-15L</td>
<td>PhD Colloquium Theory of Information Technology for Architects</td>
<td>W</td>
<td>2</td>
<td>2K</td>
<td>L. Hovestad</td>
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<td><strong>Abstract</strong></td>
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<td>Information technology plays an increasingly important role in research. To meet this challenging development, it is not only important to acquire respective skills, but also to consider and understand information technology in what sets it apart from other gaits of technics (like mechanics, dynamics, or thermodynamics).</td>
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<td><strong>Objective</strong></td>
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<td>The aim of this colloquium is to counter an observable tendency, that proportional to the degree in which students master practical skills in computing, they increasingly submit uncritically, in their understanding and framing of problems, to the dictation of schemata and templates implemented by technical systems.</td>
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<td><strong>Content</strong></td>
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<td>The starting point for this colloquium is to comprehend computing not in terms of skills, but as a literacy we which can experience emerging today. Like in the case of writing as well, computing cannot exhaustively be reduced to either logics, grammar, arithmetics, or analytics. Rather, computation, if comprised as a literacy, relates to any of the established categories of learning and raises questions of an architectonic kind. This colloquium draws from the principal richness of cultural forms of knowing and learning and thematizes approaches to formulate a theoretical stance on information technology for architects which is driven by and resting on the actual reality of computability today. In this, it is complementary to those theory courses on technology offered by the historical disciplines at ETH.</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td>To benefit from this course, you should have a practical affinity to technics, as well as an abstract interest in information technology in its comprehensive cultural context.</td>
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<tr>
<td>862-0002-14L</td>
<td>Research Colloquium History of Knowledge (HS 2015)</td>
<td>W</td>
<td>2</td>
<td>1K+1A</td>
<td>M. Hampe, A. Kilcher</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>Only for MAGPW students, D-GESS PHD and D-ARCH</td>
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</table>
The E4D winter school aims to develop an integrated vision to a global challenge of today's construction industry: the non-usability of desert sand. M. Angélil

Objective

The colloquium deals with the general problems, questions and methods of the interdisciplinary research field "The History of Knowledge". Knowledge has become one of the existential conditions of modern societies and it increasingly determines their dynamics. Therefore, it is getting more and more relevant to develop a differentiated analysis of the epistemic, social and cultural constraints of the production, circulation and the decay of knowledge. In addition, the colloquium asks after the cultural and ethical resonances of knowledge not only within science but also in relation to art, literature, technology, everyday life, and so on.

Prerequisites / notice

Short notice about program changes are possible and will be communicated through the ZGW newsletter. Please register with www.zgw.ethz.ch/de/newsletter.html

Credit points can be gained by regular attending and by writing an essay. In addition to the five colloquia there will be a deepening seminar on offer (lecturer K. Espahangizi).

Free childcare available.

Sand: an (in)finite Resource? - Engineering for Development (E4D) Winter School 2016 will invite 30 master and doctoral students from different disciplines related to international travel to El Gouna.

Costs: CHF 500, including board and accommodation. All participants are responsible for organising and financing their own domestic or international travel to El Gouna.

The Engineering for Development (E4D) Winter School 2016 will invite 30 master and doctoral students from different disciplines related to the topic of the winterschool. Applicants will be selected based on their academic record and previous work experiences.

Applications must send a one-page CV and one-page letter of motivation in PDF format stating their interest, to Mrs. Patricia Heuberger, patricia.heuberger@si.ethz.ch

Deadline: 30 September 2015

Notification: 20 October 2015


Data: 06.02.2019 13:00

PHD students: M. Hagner, P. Sarasin, J. Tanner, P. Ursprung, L. Wingert

This colloquium is highly recommended for first and second semester MAGPW students.

Abstract

The colloquium of the ZGW focuses on present developments, debates and perspectives in the field of history of knowledge. On the second and fourth date there will be public events in the Cabaret Voltaire. Check the program on www.zgw.ethz.ch

Objective

The colloquium deals with the general problems, questions and methods of the interdisciplinary research field "The History of Knowledge". Knowledge has become one of the existential conditions of modern societies and it increasingly determines their dynamics. Therefore, it is getting more and more relevant to develop a differentiated analysis of the epistemic, social and cultural constraints of the production, circulation and the decay of knowledge. In addition, the colloquium asks after the cultural and ethical resonances of knowledge not only within science but also in relation to art, literature, technology, everyday life, and so on.

Prerequisites / notice

Short notice about program changes are possible and will be communicated through the ZGW newsletter. Please register with www.zgw.ethz.ch/de/newsletter.html

Credit points can be gained by regular attending and by writing an essay. In addition to the five colloquia there will be a deepening seminar on offer (lecturer K. Espahangizi).

Free childcare available.

064-0017-15L

NSL Doctoral Colloquium: Methods in Urban and Landscape Studies

Course data: Time and place will follow in due time.

Abstract

Advanced PhD candidates of urban studies, urban and landscape design and urban sociology report about their experiences and insights in the concrete application of methods utilized for their research and scientific publications. Discussion of ongoing individual work, methodological questions, critical perspectives on urban and landscape design and city’s relation to society.

Objective

The seminar seeks to provide participants with a differentiated knowledge of methods in the field of the urbanism. Furthermore, it provides a platform to exchange contemporary urban research experiences across disciplinary boundaries, drawing from different geographies of knowledge production. Possible meta-themes include modes of data assessment in urban studies, ways of progressing from hypothesis to synthesis, and research by design as method.

Content

The format of HS15 will provide an overarching methodological meta-theme, to be defined prior to the event. One external guest critic will be invited. In this case, each presentation will conclude with a discussion round, providing sufficiently detailed feedback for every doctoral candidate.

Prerequisites / notice

The seminar is joint-organized by the chairs of Prof. Kees Christiaanse, Prof. Dr. Christian Schmid, Prof. Dr. Marc Angélil and Prof. Hubert Klumpner as one full-day event in the academic semester.

The will comprise different formats, alternating with the responsible chair.

Participants in both cases will be expected to submit single-page abstracts of their papers in advance and to make a presentation of app. 20 minutes at the colloquium. The discussion rounds will be moderated by the organizing professor and the invited guests.

Enrolment on agreement with the lecturer only.

051-0827-15L

Sand: an (in)finite Resource? - Engineering for Development (E4D) Winter School

Does not take place this semester.

Number of participants limited.

Abstract

The programme revolves around the so-far untapped resource desert sand and the question of how to activate its potential as an alternative building material. The E4D winter school will be composed of 30 master and doctoral students of different disciplines related to the topic from ETH Zurich and from other academic institutions. They will be joined by faculty members and external experts.

Objective

The E4D winter school aims to develop an integrated vision to a global challenge of today's construction industry: the non-usability of desert sand. The programme of the E4D Winter School aims at developing alternative methods to activate the so-far unusable resource of desert sand for the construction industry. Lead by different experts from around the world, students will not only learn the theoretic background of this resource but experiment with current and future technologies to transform desert sand. In workshop experiments the acquired knowledge will be tested and applied. The students will attend workshops along three lines of investigation that could mobilise desert sand for construction and other applications: (i) bio-cementation, (ii) sintering and (iii) 3D printing.

Content

Sand is the most used raw material for the production of goods on our planet. It is found in concrete, glass, computers, detergents and even toothpaste. But sand is a finite resource: what took millions of years to come into being through erosion and sedimentation, man is mining at rivers and ocean coasts in a so-far unknown speed. Sand is the megastar of the industrial and digital era - our culture is literally built upon this resource. But sand is not equal to sand: The construction industry requires grain sizes and rough shapes that are only found in river beds, lakes and the oceans. Over the turn of millions of years, mountains gradually eroded into gravel, sand and dust. Eventually, rainfall carry these particles through existing watercourses to the sea. Sand is mostly composed of quartz, a mineral form of silicon dioxide. It is one of the most abundant materials on the earth surface and also one of the strongest. These properties make it valuable to various industries. Desert sand on the other hand is presently unsuitable to the construction industry: Gradual wind erosion polishes the sand particles into round and even forms and therefore reduces their friction capacity; desert sand is simply too fine and spherical in shape to act as a high-friction aggregate in a concrete matrix.

Prerequisites / notice

Open for students of all Departments of ETH!

Taking place from 9 to 28 January 2016 at the TU Berlin Campus in El-Gouna, Egypt).

Costs: CHF 500, including board and accommodation. All participants are responsible for organising and financing their own domestic or international travel to El Gouna.

The Engineering for Development (E4D) Winter School 2016 will invite 30 master and doctoral students from different disciplines related to the topic of the winterschool. Applicants will be selected based on their academic record and previous work experiences.

Applications must send a one-page CV and one-page letter of motivation in PDF format stating their interest, to Mrs. Patricia Heuberger, patricia.heuberger@si.ethz.ch

Deadline: 30 September 2015

Notification: 20 October 2015


Data: 06.02.2019 13:00
Autumn Semester 2015
Page 369 of 1434
### Doctoral Department of Architecture - Key for Type

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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<td>W</td>
<td>Eligible for credits</td>
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### Key for Hours

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<td>lecture</td>
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<td>seminar</td>
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<td>colloquium</td>
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<td>independent project</td>
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<td>diploma thesis</td>
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<td>R</td>
<td>revision course / private study</td>
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**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Additional Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>102-1227-15L</td>
<td>Advanced Life Cycle Assessment (HS15)</td>
<td>W</td>
<td>1 credit</td>
<td>1S</td>
<td>C. L. Mutel</td>
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</table>

**Abstract**
A seminar on current topic in life cycle assessment. In the fall of 2015, the focus is on assessment of complex systems. We will look a number of topics, including input/output tables, optimization, and linking LCA with physical or economic models.

**Objective**
To improve ones understanding of life cycle assessment, and the broader issues in modeling, improving, and understanding sustainability assessments.

**Content**
The first hour of class is an interactive student presentation with discussion and class participation; each student is expected to present once, either alone or with one other student. The second half of class is devoted to a practical exercise of the concepts introduced and examined in the first half.

**Literature**
Everyone is expected to read one or two scientific articles or manuscripts each week, to be provided by the instructor.

**Prerequisites / notice**
Students should be familiar with either life cycle assessment, environmental science, or economic modeling. This seminar is intended to be primarily for Ph.D. students.

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### Doctoral Department of Civil, Environmental and Geomatic Engineering - Key for Type

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<tr>
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<th>Compulsory</th>
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<th>Courses outside the curriculum</th>
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<td>Dr</td>
<td>Suitable for doctorate</td>
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<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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### Key for Hours

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<tr>
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<th>lecture</th>
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<td>colloquium</td>
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**ECTS**
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Doctoral and Post-Doctoral Courses

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<th>Lecturers</th>
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<td>551-1159-00L</td>
<td>Molecular Systems Biology</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>U. Sauer, R. Aebersold</td>
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<td>Abstract</td>
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<td></td>
<td>Seminar series on current research topics in systems biology</td>
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<tr>
<td></td>
<td>An overview of systems biology research</td>
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<tr>
<td>760-2211-00L</td>
<td>Colloquium Agricultural Science</td>
<td>E-</td>
<td>0</td>
<td>2K</td>
<td>E. Frossard, N. Buchmann, W. Gruissem, M. Kreuzer, O. Voinnet, A. Walter, S. C. Zeeman</td>
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<td></td>
<td>Abstract</td>
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<td>A course dedicated to the reading and discussion of the relevant literature. The actual list of theme papers will be proposed anew for every year. Students then choose a topic and prepare themselves for a general discussion with their colleagues and peers. In the process, current and controversial topics will be discussed and studied.</td>
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<td>To become proficient in reading scientific literature, to understand how to look at publications, to understand them and to be able to put them in context. The course also trains the skills needed for the presentation of scientific contributions and the ability to put things into a broader context. Training in how to participate in a scientific discussion, how to make an argument and how to listen to arguments of others.</td>
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<td>All topics focus on themes from ecology and evolution, notably so on studies on adaptation of organisms, their evolutionary history, or on questions of current methodology.</td>
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<td>701-0265-00L</td>
<td>Ecology and Evolution</td>
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<td>E. Postma, J. Jokela</td>
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<td>Abstract</td>
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<td>A course dedicated to the reading and discussion of the relevant literature. The actual list of theme papers will be proposed anew for every year. Students then choose a topic and prepare themselves for a general discussion with their colleagues and peers. In the process, current and controversial topics will be discussed and studied.</td>
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<td>376-1791-00L</td>
<td>Introductory Course in Neuroscience I</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>J.M. Fritschi, W. Knecht</td>
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<td>Abstract</td>
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<td>The course gives an introduction to the development and anatomical structure of nervous systems. Furthermore, it discusses the basics of cellular neurophysiology and neuropharmacology. Finally, the nervous system is described on a system level with a particular emphasis on the visual system.</td>
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<td>1) Neuroanatomy I</td>
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<td>2) Neuroanatomy II</td>
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<td>3) Neurogenesis</td>
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<td>4) Axon guidance</td>
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<td>5) Action and language development</td>
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<td>6) Circadian rhythms</td>
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<td>7) Synamtic plasticity</td>
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<td>8) Synamtic transmission</td>
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<td>9) Neural circuits in vivo</td>
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<td>10) Visual pathways and visual processing</td>
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<td>11) Somatosensory system</td>
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<td>12) Vestibular system</td>
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<td>13) Sleep</td>
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<td>14) Learning and Memory, mice and human</td>
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<tr>
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<td>For doctoral students of the Neuroscience Center Zurich (ZNZ).</td>
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<td>Abstract</td>
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<td>The goal of this Advanced Course in Neurobiology is to provide students with a broader knowledge in several important areas of neurobiology. The course consists of four parts: Part I deals with various topics in developmental neurobiology; Part II is devoted to aspects of signal transduction. Part III focuses on synaptic transmission. Part IV gives deeper insights into systems neuroscience.</td>
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<td>This credit point course is designed for doctoral students who have successfully completed the Introductory Course in Neuroscience at the Neuroscience Center Zürich. The goal is to provide students with a broader and deeper knowledge in several important areas of neurobiology.</td>
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<td>Prerequisites / notice</td>
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<tr>
<td>151-0255-00L</td>
<td>Energy Conversion and Transport in Biosystems</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>D. Poulikakos, A. Ferrari</td>
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<td></td>
<td>Abstract</td>
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<td></td>
<td>Theory and application of thermodynamics and energy conversion in biological systems and biomedicine at the macro scale and the cellular level.</td>
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<td>Theory and application of energy conversion at the macro scale and the cellular level. Understanding of the basic features governing fluid transport in the principal systems of the human cell. Connection of characteristics and patterns from other fields of engineering to biofluidics. Heat and mass transport processes within the human body and relation to biomedical technologies.</td>
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<td>Mass transfer models for the transport of chemical species in the human cell. Organization and function of the cell membrane and of the cell cytoskeleton. The role of molecular motors in cellular force generation and their function in cell migration. Description of the functionality of these systems and of analytical experimental and computational techniques for understanding of their operation. Introduction to bioengineering approaches for the treatment of common pathogenic conditions of these systems. Introduction to cell metabolism, cellular energy transport and cellular thermodynamics.</td>
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<td>Lecture notes</td>
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<td>Script as well as additional material in the form of hand-outs will be distributed.</td>
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<td>Literature</td>
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<td>Lecture notes and references therein.</td>
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<tr>
<td>151-0927-00L</td>
<td>Rate-Controlled Separations in Fine Chemistry</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>M. Mazzotti</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>Theory and application of thermodynamics and energy conversion in biological systems and biomedicine at the macro scale and the cellular level.</td>
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<tr>
<td></td>
<td>Objective</td>
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<tr>
<td></td>
<td>Theory and application of energy conversion at the macro scale and the cellular level. Understanding of the basic features governing fluid transport in the principal systems of the human cell. Connection of characteristics and patterns from other fields of engineering to biofluidics. Heat and mass transport processes within the human body and relation to biomedical technologies.</td>
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<tr>
<td></td>
<td>Content</td>
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<td></td>
<td>Mass transfer models for the transport of chemical species in the human cell. Organization and function of the cell membrane and of the cell cytoskeleton. The role of molecular motors in cellular force generation and their function in cell migration. Description of the functionality of these systems and of analytical experimental and computational techniques for understanding of their operation. Introduction to bioengineering approaches for the treatment of common pathogenic conditions of these systems. Introduction to cell metabolism, cellular energy transport and cellular thermodynamics.</td>
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<tr>
<td></td>
<td>Lecture notes</td>
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<tr>
<td></td>
<td>Script as well as additional material in the form of hand-outs will be distributed.</td>
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</tr>
<tr>
<td></td>
<td>Literature</td>
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</tr>
</tbody>
</table>
The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

Objective
The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

Content
The class covers separation techniques that are central in the purification and downstream processing of chemicals and biopharmaceuticals. Examples from both areas illustrate the utility of the methods: 1) Liquid-liquid extraction; 2) Adsorption and chromatography; 3) Membrane processes; 4) Crystallization and precipitation.

Lecture notes
Handouts during the class

Literature
Recommendations for text books will be covered in the class

Prerequisites / notice
Requirements: Thermal separation Processes I (151-0926-00) and Modelling and mathematical methods in process and chemical engineering (151-0940-00)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Semester</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0649-00L</td>
<td>Applied Statistical Regression</td>
<td>W 5</td>
<td>2V+1U</td>
<td>M. Dettling</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning &quot;good practice&quot; that can be applied in every student's own projects and daily work life.</td>
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<tr>
<td>Objective</td>
<td>The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.</td>
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<tr>
<td>Content</td>
<td>The course starts with the basics of linear regression modeling, and then proceeds to parameter estimation, tests and confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, categorical input variables, shrinkage and general modeling strategies.</td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>Faraway (2005): Linear Models with R</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Faraway (2006): Extending the Linear Model with R</td>
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<tr>
<td></td>
<td>Draper &amp; Smith (1998): Applied Regression Analysis</td>
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<tr>
<td></td>
<td>Fox (2008): Applied Regression Analysis and GLMs</td>
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<tr>
<td></td>
<td>Montgomery et al. (2006): Introduction to Linear Regression Analysis</td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.</td>
<td></td>
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</tr>
<tr>
<td>In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L &quot;Applied Statistical Regression&quot; and 401-3622-00L &quot;Regression&quot; are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.</td>
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<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Semester</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1035-00L</td>
<td>Dynamical Systems in Biology</td>
<td>W 6</td>
<td>2V+1U</td>
<td>R. Stoop</td>
</tr>
<tr>
<td>Abstract</td>
<td>This lecture uses the concepts from dynamical systems (Course: &quot;Computable Chaos in Dynamical Systems&quot;) for the description of salient phenomena in complex examples from population dynamics, neuroinformatics and system biology. A particular focus is on the concept of limit cycle solutions and their coupling.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Applying concepts from nonlinear dynamics to biological systems. Combining theoretical modeling with supporting computer simulations.</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Semester</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-1615-00L</td>
<td>NMR Methods for Studies of Biological Macromolecules</td>
<td>W 1</td>
<td>1S</td>
<td>G. Wider</td>
</tr>
<tr>
<td>Prerequisites</td>
<td>Basic knowledge in biological NMR spectroscopy.</td>
<td></td>
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</tr>
<tr>
<td>Abstract</td>
<td>Seminar series on technical aspects of high resolution nuclear magnetic resonance (NMR) spectroscopy with biological macromolecules.</td>
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<tr>
<td>Objective</td>
<td>Introduction and discussion of advanced methods for recording and analysis of NMR data with biological macromolecules.</td>
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</tr>
<tr>
<td>Content</td>
<td>Seminar series on technical aspects of high-resolution nuclear magnetic resonance (NMR) spectroscopy with biological macromolecules.</td>
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</table>

<table>
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<tr>
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<th>Credits</th>
<th>Semester</th>
<th>Instructor</th>
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<tbody>
<tr>
<td>551-1619-00L</td>
<td>Structural Biology</td>
<td>W 1</td>
<td>1K</td>
<td>R. Glockshuber, F. Allain, N. Ban, K. Locher, E. Weber-Ban, G. Wider, K. Wuthrich</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course consists of a series of research seminars on Structural Biology, Biochemistry and Biophysics, given by both scientists of the National Center of Competence in Research (NCCR) in Structural Biology and external speakers. Information on the individual seminars is provided on the following websites: <a href="http://www.structuralbiology.uzh.ch/educ002.asp">http://www.structuralbiology.uzh.ch/educ002.asp</a> <a href="http://www.bioc.ethz.ch/dbiol-cal/index">http://www.bioc.ethz.ch/dbiol-cal/index</a></td>
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<tr>
<td>Objective</td>
<td>The goal of this course is to provide doctoral and postdoctoral students with a broad overview on the most recent developments in biochemistry, structural biology and biophysics.</td>
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<tr>
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<th>Semester</th>
<th>Instructor</th>
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</thead>
<tbody>
<tr>
<td>851-0180-00L</td>
<td>Research Ethics</td>
<td>W 2</td>
<td>2G</td>
<td>G. Achermann</td>
</tr>
<tr>
<td>Particularly suitable for students of D-BIOL, D-CHAB, D-HEST</td>
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<tr>
<td>Abstract</td>
<td>This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.</td>
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<tr>
<td>Objective</td>
<td>The main goal of this course is to enhance the student's ability to:</td>
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<td>- recognize and identify ethical issues and conflicts,</td>
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<td>- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.</td>
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<td>Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.</td>
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<td>To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.</td>
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Data: 06.02.2019 13:00 Autumn Semester 2015 Page 373 of 1434
I. Ethics & the Process of Ethical Inquiry

Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)

Integrity in Research & Research Misconduct
- What is “integrity” in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 Rs (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Literature
Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.


Abstract
About 5 talks on applied statistics.

Objective
See how statistical methods are applied in practice.
The Statistical Consulting service is open for all members of ETH, including students, and partly also to other persons.

**551-1109-00L**  
**Seminars in Microbiology**  
**Abstract** Seminars by invited speakers covering selected microbiology themes.  
**Objective** Discussion of selected microbiology themes presented by invited speakers.

**551-0030-01L**  
**Doctoral Thesis**  
**Abstract** Doctoral Thesis

**401-0620-00L**  
**Statistical Consulting**  
**Abstract** The Statistical Consulting service is open for all members of ETH, including students, and partly also to other persons.  
**Objective** Advice for analyzing data by statistical methods.  
**Content** Students and researchers can get advice for analyzing scientific data, often for a thesis. We highly recommend to contact the consulting service when planning a project, not only towards the end of analyzing the resulting data!  
**Prerequisites / notice** This is not a course, but a consulting service. There are no exams nor credits.

**551-0512-00L**  
**Current Topics in Molecular and Cellular Neurobiology**  
**Number of participants limited to 8.**  
**Abstract** The course is a literature seminar or “journal club”. Each Friday a student, or a member of the Suter Lab in the Institute of Molecular Health Sciences, will present a paper from the recent literature.  
**Objective** The course introduces you to recent developments in the fields of cellular and molecular neurobiology. It also supports you to develop your skills in critically reading the scientific literature. You should be able to grasp what the authors wanted to learn i.e. their goals, why the authors chose the experimental approach they used, the strengths and weaknesses of the experiments and the data presented, and how the work fits into the wider literature in the field. You will present one paper yourself, which provides you with practice in public speaking.

**551-0737-00L**  
**Experimental Ecology: Evolution and Ecology**  
**Abstract** Interaction seminar. Student-mediated presentations, guests and discussions on current themes in ecology, evolutionary and population biology.  
**Objective** Getting familiar with scientific arguments and discussions. Overview of current research topics. Making contacts with fellow students in other groups.  
**Content** Scientific talks and discussions on changing subjects.

**551-1509-00L**  
**Research Ethics and Biopatents**  
**Abstract** Introduction to research ethics and patenting for Ph.D. students in the life science area  
**Objective** The goals of the transferable skill course «Research Ethics & Biopatents» are:  
A. to raise student’s attention to and interest in ethical issues related to the work of a life-scientist and to discuss how to deal with such issues;  
B. to provide a general overview on intellectual property, specifically on the patent system. Special regard is paid to details and specialities of patents in biology.

**551-0509-00L**  
**Current Immunological Research in Zürich**  
**Abstract** Students and researchers can get advice for analyzing scientific data, often for a thesis. We highly recommend to contact the consulting service when planning a project, not only towards the end of analyzing the resulting data!  
**Objective** Advice for analyzing data by statistical methods.  
**Content** Students and researchers can get advice for analyzing scientific data, often for a thesis. We highly recommend to contact the consulting service when planning a project, not only towards the end of analyzing the resulting data!  
**Prerequisites / notice** This is not a course, but a consulting service. There are no exams nor credits.

Requirements: Knowledge of the basic concepts of statistics is desirable.

**551-0030-01L**  
**Doctoral Thesis**  
**Abstract** Doctoral Thesis

**401-0620-00L**  
**Statistical Consulting**  
**Abstract** The Statistical Consulting service is open for all members of ETH, including students, and partly also to other persons.  
**Objective** Advice for analyzing data by statistical methods.  
**Content** Students and researchers can get advice for analyzing scientific data, often for a thesis. We highly recommend to contact the consulting service when planning a project, not only towards the end of analyzing the resulting data!  
**Prerequisites / notice** This is not a course, but a consulting service. There are no exams nor credits.

Contact: beratung@stat.math.ethz.ch . Tel. 044 632 2223. See also http://stat.ethz.ch/consulting

Requirements: Knowledge of the basic concepts of statistics is desirable.

**551-0512-00L**  
**Current Topics in Molecular and Cellular Neurobiology**  
**Number of participants limited to 8.**  
**Abstract** The course is a literature seminar or “journal club”. Each Friday a student, or a member of the Suter Lab in the Institute of Molecular Health Sciences, will present a paper from the recent literature.  
**Objective** The course introduces you to recent developments in the fields of cellular and molecular neurobiology. It also supports you to develop your skills in critically reading the scientific literature. You should be able to grasp what the authors wanted to learn i.e. their goals, why the authors chose the experimental approach they used, the strengths and weaknesses of the experiments and the data presented, and how the work fits into the wider literature in the field. You will present one paper yourself, which provides you with practice in public speaking.

**551-0737-00L**  
**Experimental Ecology: Evolution and Ecology**  
**Abstract** Interaction seminar. Student-mediated presentations, guests and discussions on current themes in ecology, evolutionary and population biology.  
**Objective** Getting familiar with scientific arguments and discussions. Overview of current research topics. Making contacts with fellow students in other groups.  
**Content** Scientific talks and discussions on changing subjects.

**551-1509-00L**  
**Research Ethics and Biopatents**  
**Abstract** Introduction to research ethics and patenting for Ph.D. students in the life science area  
**Objective** The goals of the transferable skill course «Research Ethics & Biopatents» are:  
A. to raise student’s attention to and interest in ethical issues related to the work of a life-scientist and to discuss how to deal with such issues;  
B. to provide a general overview on intellectual property, specifically on the patent system. Special regard is paid to details and specialities of patents in biology.

**551-0509-00L**  
**Current Immunological Research in Zürich**  
**Abstract** Students and researchers can get advice for analyzing scientific data, often for a thesis. We highly recommend to contact the consulting service when planning a project, not only towards the end of analyzing the resulting data!  
**Objective** Advice for analyzing data by statistical methods.  
**Content** Students and researchers can get advice for analyzing scientific data, often for a thesis. We highly recommend to contact the consulting service when planning a project, not only towards the end of analyzing the resulting data!  
**Prerequisites / notice** This is not a course, but a consulting service. There are no exams nor credits.

Contact: beratung@stat.math.ethz.ch . Tel. 044 632 2223. See also http://stat.ethz.ch/consulting

Requirements: Knowledge of the basic concepts of statistics is desirable.
Abstract
This monthly meeting is a platform for Zurich-based immunology research groups to present and discuss their ongoing research projects. At each meeting three PhD students or Postdocs from the participating research groups present an ongoing research project in a 30 min seminar followed by a plenary discussion.

Objective
The aim of this monthly meeting is to provide further education for master and doctoral students as well as Postdocs in diverse topics of immunology and to give an insight in the related research. Furthermore, this platform fosters the establishment of science- and technology-based interactions between the participating research groups.

Content
Presentation and discussion of current research projects carried out by various immunology-oriented research groups in Zurich.

Lecture notes
none

551-1409-00L RNA Biology Lecture Series II: Non-coding RNAs: Biology and Therapeutics

| Objective | The students should get familiar with the wide array of roles, which non-coding RNAs play in cellular functions. |
| Content | Micro RNAs; computational approaches to miRNAs; micro RNA function in metabolism; viruses and viral RNAs; nucleic acid-based drugs; ncRNA-mediated genome regulation; epigenetic programming of genome remodelling in ciliates; telomerase and telomeres; tRNA biology. |
| Prerequisites / notice | Basic knowledge of cell and molecular biology. |

Doctoral Department Biology - Key for Type

| W | Eligible for credits | O | Compulsory |
| E- | Recommended, not eligible for credits | W+ | Eligible for credits and recommended |
| Dr | Suitable for doctorate | Z | Courses outside the curriculum |

Key for Hours

| V | lecture | P | practical/laboratory course |
| G | lecture with exercise | A | independent project |
| U | exercise | D | diploma thesis |
| S | seminar | R | revision course / private study |
| K | colloquium | | |

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Doctoral Department of Biosystems Science and Engineering


#### Doctoral and Post-Doctoral Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

**Abstract**

This seminar will feature invited lectures about recent advances and developments in systems biology, including topics from biology, bioengineering, and computational biology.

**Objective**

To provide an overview of current systems biology research.

**Content**

The final list of topics will be available at [http://www.bsse.ethz.ch/education/](http://www.bsse.ethz.ch/education/).

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### Advances in Molecular Biotechnology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>636-0309-00L</td>
<td>Advances in Molecular Biotechnology</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>M. Fussenegger</td>
</tr>
</tbody>
</table>

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#### Doctoral Department of Biosystems Science and Engineering - Key for Type

| O   | Compulsory                                               | E-   | Recommended, not eligible for credits |
| W+  | Eligible for credits and recommended                     | Z    | Courses outside the curriculum        |
| W   | Eligible for credits                                     | Dr   | Suitable for doctorate                |

#### Key for Hours

| V   | lecture                                                  | P    | practical/laboratory course           |
| G   | lecture with exercise                                   | A    | independent project                   |
| U   | exercise                                                 | D    | diploma thesis                        |
| S   | seminar                                                  | R    | revision course / private study       |
| K   | colloquium                                               |      |                                          |

ECTS European Credit Transfer and Accumulation System  

Special students and auditors need special permission from the lecturers.
Doctoral Department of Chemistry and Applied Biosciences

► Doctoral and Post-Doctoral Courses

►► Doctoral Studies in Inorganic Chemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0169-00L</td>
<td>Instrumental Analysis</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>D. Günther</td>
</tr>
<tr>
<td>Abstract</td>
<td>Group seminar on elemental analysis and isotope ratio determinations using various plasma sources</td>
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<tr>
<td>Content</td>
<td>Developments in plasma mass spectrometry and alternative plasma sources</td>
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</tr>
<tr>
<td>529-0198-00L</td>
<td>Main Group Element and Coordination Chemistry</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>H. Grützmacher</td>
</tr>
<tr>
<td>529-0199-00L</td>
<td>Inorganic and Organometallic Chemistry</td>
<td>E-</td>
<td>0</td>
<td>2K</td>
<td>C. Copéret, H. Grützmacher, D. Günther, M. Kovalenko, A. Mezzetti, A. Togni</td>
</tr>
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</table>

►► Doctoral Studies in Organic Chemistry

<table>
<thead>
<tr>
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<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0169-00L</td>
<td>Instrumental Analysis</td>
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</tr>
<tr>
<td>Abstract</td>
<td>Group seminar on elemental analysis and isotope ratio determinations using various plasma sources</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content</td>
<td>Developments in plasma mass spectrometry and alternative plasma sources</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>529-0198-00L</td>
<td>Main Group Element and Coordination Chemistry</td>
<td></td>
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</tr>
<tr>
<td>529-0199-00L</td>
<td>Inorganic and Organometallic Chemistry</td>
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►► Doctoral Studies in Physical Chemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tbody>
<tr>
<td>529-0169-00L</td>
<td>Instrumental Analysis</td>
<td></td>
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</tr>
<tr>
<td>Abstract</td>
<td>Group seminar on elemental analysis and isotope ratio determinations using various plasma sources</td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>Developments in plasma mass spectrometry and alternative plasma sources</td>
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<tr>
<td>529-0198-00L</td>
<td>Main Group Element and Coordination Chemistry</td>
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</tr>
<tr>
<td>529-0199-00L</td>
<td>Inorganic and Organometallic Chemistry</td>
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</tbody>
</table>

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 378 of 1434
The students will learn how to record rotationally and rovibrationally resolved spectra in the THz and IR frequency range. For that purpose, basic concepts of the construction of instrumentation in physical chemistry. Practical exercises in mechanical construction and electronic circuits.

The students will understand how to use the tools needed to analyze simple highly resolved spectra. They will become familiar with experimental techniques in high resolution molecular spectroscopy and will understand how molecular spectroscopy can be applied to solve problems with respect to atmospheric pollutants and the detection of molecules in interstellar space.

The course teaches advanced topics in molecular spectroscopy: techniques for analysing rotationally and rovibrationally resolved spectra will be discussed, the basics of FTIR spectroscopy will be reviewed, and the sources which may be used in high resolution infrared spectroscopy will be described. The fields in which high resolution infrared /THz spectroscopy is applied will also be reviewed. Applications of high resolution molecular spectroscopy in the field of atmospheric and interstellar chemistry will be discussed. The identification and the quantitative determination of atmospheric pollutants will be discussed in detail. In addition, the identification of interstellar molecules in the context of the origin of life will be reviewed. The question of the identification of the interstellar unidentified infrared bands and of the interstellar diffuse bands will also be addressed. Finally, high resolution molecular spectroscopy of chiral molecules in the context of molecular parity violation will be discussed.

Does not take place this semester.

Will be given in the lecture.

Doctoral Studies in Chemical and Bioengineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0699-00L</td>
<td>Safety and Environmental Technology of Chemical Processes and Products</td>
<td>E-</td>
<td>0</td>
<td>2</td>
<td>K. Hungerbühler, C. A. Baumel, C. Bogstal, E. Capdon Garcia, M. Scheringer, N. von Götz</td>
</tr>
<tr>
<td>529-0072-00L</td>
<td>Chemical Process Technology</td>
<td>W</td>
<td>1</td>
<td>2</td>
<td>M. Morbidelli</td>
</tr>
<tr>
<td>529-0690-00L</td>
<td>ICB Seminars on Chemical and Biochemical Engineering</td>
<td>W</td>
<td>1</td>
<td>1</td>
<td>R. Gunawan</td>
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</table>
Seminars on Drug Discovery and Development
Weekly group seminar, in which members of the research team present and discuss the results of their projects and selected reports from

<table>
<thead>
<tr>
<th>Title</th>
<th>Number</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>Seminar in Fundamentals of Process Engineering</td>
<td>535-0585-00L</td>
<td>W</td>
<td>1 credit</td>
<td>1S</td>
<td>P. Rudolf von Rohr</td>
</tr>
<tr>
<td>Only for master and doctoral students of Process and Chemical Engineering.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>This seminar covers actual subjects from the specific research areas of the laboratory of transport processes and reactions.</td>
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<td></td>
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</tr>
<tr>
<td>Content</td>
<td>The contents are announced through the group's webpage.</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>No textbook</td>
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</table>

#### Doctoral Studies in Polymer Science

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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>529-0585-00L</td>
<td>Reactivity in Micelles and Vesicles</td>
<td>W</td>
<td>1 credit</td>
<td>1V</td>
<td>P. J. Walde</td>
</tr>
<tr>
<td>Abstract</td>
<td>Discussion of different aspects of the chemical reactivity in micelles and in vesicles (liposomes) as polymolecular compartments.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>Deeper understanding of micelles and vesicles as self-organizing reaction compartments.</td>
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</tr>
<tr>
<td>Content</td>
<td>With a few selected recent examples, properties of micelles and vesicles will be discussed with respect to applications as reaction compartments.</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>No script</td>
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#### Doctoral Studies in Pharmaceutical Sciences

<table>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
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<tr>
<td>535-2000-00L</td>
<td>Seminar für Mitarbeiter</td>
<td>W</td>
<td>0 credits</td>
<td>2S</td>
<td>G. Schneider</td>
</tr>
<tr>
<td>Abstract</td>
<td>Weekly group seminar, in which members of the research team present and discuss the results of their projects and selected reports from the current scientific literature.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>Participants learn to present scientific studies and discuss own results in greater context.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Abstract</td>
<td>State-of-the-art information on drug discovery and development by experts from academia and industry.</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>State-of-the-art information on drug discovery and development.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content</td>
<td>Seminar series of the Institute of Pharmaceutical Sciences. Experts from academia and industry report on relevant topics.</td>
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#### Additional Courses

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<tr>
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<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>535-0903-00L</td>
<td>RNA Club Zurich</td>
<td>E-</td>
<td>0 credits</td>
<td>1S</td>
<td>J. Hall</td>
</tr>
<tr>
<td>Abstract</td>
<td>The RNA Club Zurich was originally founded to promote the interaction and collaboration of local research groups and individuals with an interest in RNA biology and chemistry. We organise a series of seminars on cutting edge topics in RNA research with internal and external speakers. Our seminars are held on a monthly basis from April-December.</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Content</td>
<td>The RNA Club Zurich was originally founded to promote the interaction and collaboration of local research groups and individuals with an interest in RNA biology and chemistry. We organise a series of seminars on cutting edge topics in RNA research with internal and external speakers. Our seminars are held on a monthly basis from April-December. The format of the meetings is one main presentation (45min) followed by a short seminar (20min). We are constantly looking for new speakers. The club is open to all researchers and students.</td>
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Lectures and Optional subjects in MSc Pharmaceutical Sciences

#### Additional Courses

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>529-0195-00L</td>
<td>Scientific Information Retrieval &amp; Management in Life Sciences and Chemistry</td>
<td>W</td>
<td>1 credit</td>
<td>1V</td>
<td>O. Renn</td>
</tr>
<tr>
<td>Abstract</td>
<td>Students will learn how to effectively retrieve, critically judge, analyze and manage published scientific information - important skill sets in chemistry and life sciences where scientists need to deal with vast amounts of information. The course, being based on practical examples, also covers scientific writing &amp; communication and state-of-the-art technologies for analysis such as text mining.</td>
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</tr>
<tr>
<td>Objective</td>
<td>Ability to select appropriate, subject-specific databases or tools for a given specific scientific question based on a sound understanding on how a tool or database has been developed and maintained, thus building the personal capacity of doing research effectively and efficiently by integrating scientific information into the research process when needed. Ability to communicate own scientific results using additional distribution channels. Ability to easily write-up the Ph.D. thesis or first paper.</td>
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</tbody>
</table>
The course has been primarily designed for Ph.D. students, also for the Life Science Zurich Graduate School, but is also open to Master students. In a series of 13 lectures, which always include practical examples (for some lectures an own notebook is required), the use of scientific information is taught not in a database-centric view but corresponding to the steps through which scientific research is conducted - including the dissemination of scientific results. This is particularly interesting for students who are about to write-up their first paper or thesis.

Students will learn about the different types of information resources and tools, get an insight into the numerous databases and tools that exists and how those are built and maintained, enabling them to critically judge the value and trustworthy of any information resource. Additionally, they will learn how to communicate their own scientific results properly, using also additional measures that are reflected by alternative metrics.

The following topics are covered:
1. The World of Scientific Publishing
2. Searching and Retrieving Scientific Information Using Search Engines and Using Literature Databases
3. Searching and Retrieving Scientific Information Using Subject-Specific Databases in Chemistry
4. Searching and Retrieving Scientific Information Using Subject-Specific Databases in Life Sciences
5. Tools for Managing the Retrieved Scientific Information
7. Patents
8. Text (Literature) and Data Mining
9. Communicating & Analyzing the Impact of (Your) Science
10. Scientific Writing & Good Scientific Practice

Lecture notes
The slide deck and supplementary materials will be made available in the teaching document repository (ILIAS) after each lecture.

Literature
Additional literature and reference are provided in the course material.

Course Catalogue of ETH Zurich

<table>
<thead>
<tr>
<th>Lecturer</th>
<th>Doctoral Department of Chemistry and Applied Biosciences - Key for Type</th>
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</thead>
<tbody>
<tr>
<td>W+</td>
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</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<td>Dr</td>
<td>Suitable for doctorate</td>
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<td>O</td>
<td>Compulsory</td>
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<table>
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<td>lecture</td>
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<td>G</td>
<td>lecture with exercise</td>
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<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</table>

ECTS European Credit Transfer and Accumulation System
Special students and auditors need special permission from the lecturers.
### Doctoral and Post-Doctoral Courses

**Course Catalogue of ETH Zurich**

<table>
<thead>
<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>651-0254-00L</td>
<td>Seminar Geochemistry and Petrology</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>O. Bachmann, M. Schönbächler, C. A. Heinrich, M. W. Schmidt, D. Vance</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Seminar series with external and occasional internal speakers addressing current research topics. Changing programs announced via D-ERDW homepage (Veranstaltungskalender)</td>
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<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>Presentations on isotope geochemistry, cosmochemistry, fluid processes, economic geology, petrology, mineralogy and experimental studies. Mostly international speakers provide students, department members and interested guests with insight into current research topics in these fields.</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
<td></td>
<td>Wöchentliches Seminar mit Fachvorträgen eingeladener oder interner Wissenschaftler, vornehmlich zu Themen der Geochemie, Isotopengeologie, Hydrothermalgeochemie, Lagerstättenbildung, Petrologie, Mineralogie und experimentelle Studien.</td>
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<tr>
<td>651-1617-00L</td>
<td>Geophysical Fluid Dynamics and Numerical Modelling</td>
<td>E-</td>
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<td>1S</td>
<td>P. Tackley, M. D. Ballmer, T. Gerya, D. A. May</td>
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<tr>
<td></td>
<td>Seminar</td>
<td></td>
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<td></td>
<td>Seminar series addressing current research topics in Petrology (Magmatic Petrology and Crystalline Geology and Experimental Petrology)</td>
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<tr>
<td>651-0251-00L</td>
<td>Seminar Petrology</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>M. W. Schmidt, O. Bachmann</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Seminar series with external and occasional internal speakers addressing current research topics in Petrology.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>Einblick in Forschungstätigkeit und Methodik, Erarbeitung von Datensets und Entwicklung von unmittelbaren Schlussfolgerungen sowie Einordnung der Ergebnisse in den großereren Kontext.</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
<td></td>
<td>Seminar series addressing current research topics in Petrology.</td>
</tr>
<tr>
<td>651-4931-00L</td>
<td>Heat and Mass Transfers in Magmatology</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>O. Bachmann</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Heat and mass transfers in the crust control many aspects of the differentiation of our planet, including (1) type of volcanic eruptions we should expect at the surface of our planet, (2) the volcanic/plutonic ratio in the crust, and (3) how volcanic degassing occurs, with important consequences on the climate response following volcanic eruptions.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>The goal of this class is to learn about the modern methods and ideas on heat and mass transfers in magmatology through recently published papers and computer softwares. The class will allow students to explore some of the most challenging concepts in this field, and become familiar with state-of-the-art techniques to model these processes.</td>
</tr>
<tr>
<td></td>
<td>Content</td>
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<td></td>
<td>The class will focus mostly on reading recent literature on topics of interests, and will contain some computer exercises to allow students to work by themselves on some well-defined problems.</td>
</tr>
<tr>
<td>651-4123-00L</td>
<td>Earthquake Physics and Numerical Modelling Paper</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>Y. van Dinther</td>
</tr>
<tr>
<td></td>
<td>Discussions</td>
<td></td>
<td></td>
<td></td>
<td>Biweekly paper discussion series on current challenges and state-of-the-art practices in earthquake physics and seismic cycle and geodynamic modeling.</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>To understand and evaluate current challenges and state-of-the-art practices in earthquake physics and seismic cycle and geodynamic modeling. Besides obtaining an overview of this field, participants can expect to improve their skills to:</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>- disseminate knowledge within their own and neighboring research fields</td>
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<td>- formulate their opinion, new ideas and broader implications</td>
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<td>- present their findings to an audience</td>
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<td>- ask questions and actively participate in discussions on new scientific ideas</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>understand what it takes to get their own research work published</td>
</tr>
<tr>
<td></td>
<td>Prerequisites / notice</td>
<td></td>
<td></td>
<td></td>
<td>PhD or advanced MSc students are expected to present one paper relating to their research interests and read papers discussed by the other students. The grading is based on participation in discussions and the given oral presentations.</td>
</tr>
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</table>

### Doctoral Department of Earth Sciences - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
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<th>Suitable for doctorate</th>
<th>Compulsory</th>
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<tr>
<td>W</td>
<td>E</td>
<td>Dr</td>
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</tr>
<tr>
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### Key for Hours

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<td>G</td>
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<td>A</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
<td></td>
</tr>
</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Students are introduced into how technological innovations take place within complex economical, political and cultural contexts. They get introduced into basic theories and practices of the field.

Key problems of research projects will be discussed. Participants will learn to know arguments and ideas dealing with systematic problems of philosophy.

The aim of this colloquium is that the presenters receive feedback on their research at an important stage (a stage at which significant changes of direction, methodology, etc., may still be undertaken) in the PhD process.

Rational-Choice-Theory has become one of sociology's general theoretical approaches. The seminar concerns itself with major ideas, concepts and questions involved with the development of a theory. The seminar will also include examples of empirical applications from various fields of sociology.

Only for doctoral students sociology.

This colloquium is open for staff members based at the Center for Comparative and International Studies, CIS.

In this seminar staff members of the Center for Comparative and International Studies (CIS) and external guests present and discuss their current research.

This colloquium is devoted to the introduction into the theory and practice of scientific work. The schedule can be found on the institute's website - http://www.wiss.ethz.ch/en/teaching/

This colloquium is devoted to the introduction into the theory and practice of scientific work.

In this internal colloquium doctoral students present their work after about 12 months of research.

In collaboration with Prof. Dr. Norman Braun, Dr. Thomas Hinz, University of Munich, and Dr. Axel Franzen, University of Cologne.

Due to a very limited number of possible participants please register early with the assistant at the Chair of Sociology irene.urbanek@soz.gess.ethz.ch.

Doctoral students and post-doctoral students will be given priority. The seminar will be held in German. Participants are expected to write a paper or give a presentation.
PhD students learn how to present and discuss their own research questions, methods, results and problems. PhD students get familiar with empirical research methods as well as management and legal aspects of conducting research. The colloquium provides a forum for PhD students and postdoctoral researchers to present and discuss their current work. PhD students will have an opportunity to improve their presentation skills and obtain an important chance to receive feedback both from peers and more advanced scholars.

**862-0078-00L**  
**Research Colloquium. Extra-European History and Global History**  
*Does not take place this semester.*

**Abstract**  
The fortnightly colloquium provides a forum for PhD students and postdoctoral researchers to present and discuss their current work. Half of the slots are reserved for presentations by invited external scholars.

**Objective**  
PhD students will have an opportunity to improve their presentation skills and obtain an important chance to receive feedback both from peers and more advanced scholars.

**851-0626-02L**  
**PhD Colloquium in Development Economics**  

**Abstract**  
PhD students interested in empirical development economics will present their ongoing work, with a particular focus on the methods (to be) used and challenges faced. Participants are expected to read the drafts/papers/presentations beforehand and give constructive feedback to the PhD student presenting.

**Objective**  
PhD students learn how to present and discuss their own research questions, methods, results and problems. PhD students get familiar with the challenges of empirical research in developing countries.

**851-0735-10L**  
**Business Law**

**Abstract**  
The students shall obtain a basic knowledge about business law. They shall be able to recognize and evaluate issues in the area of business law and suggest possible solutions.

**Objective**  
The students shall obtain the following competence:
- They shall obtain a working knowledge on the legal aspects involved in setting up and managing an enterprise.
- They shall be acquainted with corporate functions as contracting, negotiation, claims management and dispute resolution.
- They shall be familiar with the issues of corporate compliance, i.e. the system to ascertain that all legal and ethical rules are observed.
- They shall be able to contribute to the legal management of the company and to discuss legal issues.
- They shall have an understanding of the law as a part of the corporate strategy and as a valuable resource of the company.

**851-0735-09L**  
**Workshop & Lecture Series on the Law & Economics of Innovation**

**Abstract**  
This series is a joint project by ETH Zurich and the University of Zurich. It provides an overview of interdisciplinary research on intellectual property, innovation, antitrust and technology policy. Scholars from law, economics, management and related fields give a lecture and/or present their current research. All speakers are internationally well-known experts from Europe, the U.S. and beyond.

**Objective**  
After the workshop and lecture series, participants should be acquainted with interdisciplinary approaches towards intellectual property, innovation, antitrust and technology policy research. They should also have an overview of current topics of international research in these areas.

**Content**  
The workshop and lecture series will present a mix of speakers who represent the wide range of current social science research methods applied to intellectual property, innovation, antitrust policy and technology policy issues. In particular, theoretical models, empirical and experimental research as well as legal research methods will be represented.

**Lecture notes**  
Papers discussed in the workshop and lecture series are posted in advance on the course web page.
Participants will make acquaintance with founding texts of the natural rights property concept (John Locke). They will see the connection between inalienable self-ownership, prohibition of slavery, derivative commercial rights and modern personal rights. They will learn about the problems of self-ownership today concerning property in one's body and intellectual property. Critical alternatives to the property paradigm will be discussed.

Participants will have the opportunity to gain access to unfamiliar texts from the philosophical tradition and to see their relevance today. They experience the consequences of a certain use of concepts and orient themselves in current bioethical, juridical and political discussions.

**Content**

Texts by Locke, Nozick, Christianman, Otsuka, Rasmussen, Schneider, Stinier, Fichte and Forschner. Founding of property right in self-ownership (Locke), revival of this concept in Nozick and his egalitarian critics. Critique of the concept of self-ownership related to property in one's body. Looking back to the personal self-relatedness that comes up again in Intellectual Property and in modern personal rights.

**Literature**

Text, Seminarplan und Literaturliste in ILIAS Lehrendokumentenablage.

**851-0585-15L Complexity and Global Systems Science**

| Objective | Participants will have the opportunity to gain access to unfamiliar texts from the philosophical tradition and to see their relevance today. They experience the consequences of a certain use of concepts and orient themselves in current bioethical, juridical and political discussions. |
| Content | This course discusses complex techno-socio-economic systems, their counter-intuitive behaviors, and how their theoretical understanding empowers us to solve some long-standing problems that are currently bothering the world. |
| Literature | Text, Seminarplan und Literaturliste in ILIAS Lehrendokumentenablage. |

**851-0550-01L Colloquium Postgraduate Programme "History of Knowledge"**

| Objective | Participants should learn to get an overview of the state of the art in the field, to present it in a well understandable way to an interdisciplinary scientific audience, to develop models for open problems, to analyze them, and to defend their results in response to critical questions. In essence, participants should improve their scientific skills and learn to think scientifically about complex dynamical systems. |
| Content | This course starts with a discussion of the typical and often counter-intuitive features of complex dynamical systems such as self-organization, emergence, (sudden) phase transitions at "tipping points", multi-stability, systemic instability, deterministic chaos, and turbulence. It then discusses phenomena in networked systems such as feedback, side and cascade effects, and the problem of radical uncertainty. The course progresses by demonstrating the relevance of these properties for understanding societal and, at times, global-scale problems such as traffic jams, crowd disasters, breakdowns of cooperation, crime, conflict, social unrests, political revolutions, bubbles and crashes in financial markets, epidemic spreading, and/or "tragedies of the commons" such as environmental exploitation, overfishing, or climate change. Based on this understanding, the course points to possible ways of mitigating techno-socio-economic-environmental problems, and what data science may contribute to their solution. |
| Literature | Text, Seminarplan und Literaturliste in ILIAS Lehrendokumentenablage. |

**851-0520-16L Current Research on MINT Learning**

| Objective | Participants are exemplarily introduced to different research methods used in research on learning and instruction and learn to weigh advantages and disadvantages of these approaches. |

**851-0738-00L Intellectual Property: Introduction**

| Objective | The course provides an introduction to Swiss and European intellectual property law (trademarks, copyright, patent and design rights). Aspects of competition law are treated insofar as they are relevant for the protection of intellectual creations and source designations. The legal principles are developed based on current cases. |
| Literature | Text, Seminarplan und Literaturliste in ILIAS Lehrendokumentenablage. |

**851-0738-01L The Role of Intellectual Property in Daily Routine: A Practical Introduction**

| Objective | The lecture gives engineering students an overview of the basic aspects of intellectual property. The lecture aims to make participants aware of the various methods of protection and to put them in a position to be able to use this knowledge in the workplace. |
| Literature | Text, Seminarplan und Literaturliste in ILIAS Lehrendokumentenablage. |
In recent years, knowledge about intellectual property has become increasingly important for engineers. In both production and distribution as well as in research and development, engineers are increasingly being confronted with questions concerning the patenting of inventions and the utilisation of patent information. With up to 80% of publicly-available technical information being stored in patents only, it is of great importance for engineers to know the basics of the patent system and to be in a position to be able to extract relevant information from the flood of patent information available. This relates to daily work in industry as well as in research, where protecting inventions has gained in importance.

Patents are also an important source of information - from competitors and potential cooperation partners to the development of markets and the risk of coming into conflict with third party IP rights. Respectively, a knowledge of patents has also become a key qualification at a company’s strategic level.

The seminar is customised to the needs of engineers. Participants will become familiar with practice-relevant aspects of intellectual property with the emphasis being placed on patents. Participants will be able to use the acquired knowledge in the protection and commercialisation of their own inventions.

The topics covered will include:
- The importance of innovation in industrialised countries and high-tech sectors
- The protection of inventions and the safeguarding of commercial implementation - the role and importance of intellectual property
- Patents as a source of technical and business information
- Practical aspects of intellectual property for day-to-day research work, for the formation of start-ups and at the workplace.

The seminar contains practical exercises on the use and research of patent information. Basic knowledge on how to read and evaluate patent documents, as well as how to use publicly available patent databases in order to obtain the required patent information will also be provided.

The lecture is coordinated in particular to the needs of the following degree programs: Agricultural science, architecture, civil engineering, computational science and engineering, computer science, electrical engineering and information technology, environmental engineering, geomatic engineering and planning, interdisciplinary sciences, materials science, mathematics, mechanical engineering, physics.

For students of chemistry-degree related programs, the lecture ‘Protecting inventions in chemistry’ will be offered, which is coordinated to the needs of students in these degree programs.

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**851-0252-01L**  
**Human-Computer Interaction: Cognition and Usability**  
*W* 3 credits 2S  
C. Hölscher, I. Barisic, S. Ognjanovic  

**Abstract**  
This seminar introduces theory and methods in human-computer interaction and usability. Cognitive Science provides a theoretical framework for designing user interfaces as well as a range of methods for assessing usability (user testing, cognitive walkthrough, GOMS). The seminar will provide opportunity to experience some of the methods in applied group projects.

**Objective**  
This seminar will introduce key topics, theories and methodology in human-computer interaction (HCI) and usability. Presentations will cover basics of human-computer interaction and selected topics like mobile interaction, adaptive systems, human error and attention. A focus of the seminar will be on getting to know evaluation techniques in HCI. Students form work groups that first familiarize themselves with a select usability evaluation method (e.g. user testing, GOMS, task analysis, heuristic evaluation, questionnaires or Cognitive Walkthrough). They will then apply the methods to a human-computer interaction setting (e.g. an existing software or hardware interface) and present the method as well as their procedure and results to the project active participation is vital for the success of the seminar, and students are expected to contribute to presentations of foundational themes, methods and results of their chosen group project. In order to obtain course credit a written essay / report will be required (details to be specified in the introductory session of the course).

**851-0252-02L**  
**Introduction to Cognitive Science**  
*W* 3 credits 2V  
C. Hölscher, L. Konieczny, T. Thrash  

**Abstract**  
The lectures provide an overview of the foundations of cognitive science and investigate processes of human cognition, especially perception, learning, memory and reasoning. This includes a comparison of cognitive processes in humans and technical systems, especially with respect to knowledge acquisition, knowledge representation and usage in information processing tasks.

**Objective**  
Cognitive Science views human cognition as information processing and provides an inter-disciplinary integration of approaches from cognitive psychology, informatics (e.g., artificial intelligence), neuroscience and anthropology among others. The lectures provide an overview of basic mechanisms of human information processing and various application domains. A focus will be on matters of knowledge acquisition, representation and usage in humans and machines. Models of human perception, reasoning, memory and learning are presented and students will learn about experimental methods of investigating and understanding human cognitive processes and representation structures.

**851-0252-03L**  
**Cognition in Architecture - Designing Orientation and Navigation for Building Users**  
*W* 3 credits 2S  
V. Schinazi, B. Emo Nax, C. Hölscher  

**Abstract**  
How can behavioral and cognitive science inform architecture? This project-oriented seminar investigates contributions of cognitive science to architectural design with an emphasis on orientation and navigation in complex buildings and urban settings. It includes theories on spatial memory and decision-making as well as hands-on observations of behavior in real and virtual reality.

**Objective**  
Taking the perspectives of building users (occupants and visitors) is vital for a human-centered design approach. Students will learn about relevant theory and methods in cognitive science and environmental psychology that can be used to understand human behavior in built environments. The foundations of environmental psychology and human spatial cognition will be introduced. A focus of the seminar will be on how people perceive their surroundings, how they orient in a building, how they memorize the environment and how they find their way from A to B. Students will also learn about a range of methods including real-world observation, virtual reality experiments, eye-tracking and behavior simulation for design. Students will reflect on the roles of actors and stakeholders with respect to human-centered design and an evidence-based design perspective. The seminar is geared towards a mix of students from architecture / planning, engineering, computer science and behavioral science as well as anyone interested in the relation between design and cognition.

Architecture students can obtain course credit in "Vertiefungsfach" or "Wahlfach".

**851-0585-04L**  
**Lecture with Computer Exercises: Modelling and Simulating Social Systems with MATLAB**  
*W* 3 credits 2S  
D. Helbing, S. Baliotti, O. Woolley  

**Content**  
Part of this course will consist of supervised programming exercises in a computer pool. Credit points are finally earned for the implementation of a mathematical model from the sociological literature in MATLAB and the documentation in a seminar thesis.

**Lecture notes**  
The lecture slides will be presented on the course web page after each lecture.

**Prerequisites / notice**  
The number of participants is limited to the size of the available computer teaching room. The MATLAB code related to the seminar thesis should be well enough documented for further use by others and must be handed over to the Chair of Sociology, in particular of Modeling and Simulation, for further free and unrestricted use.

**862-0089-00L**  
**Advanced Colloquium in Literary Studies**  
*E- 1 credit 1K  
A. Kilcher  

**Abstract**  
The colloquium addresses advanced and graduate students. First, it offers participants the opportunity to present their own research projects (work in progress); and, second, it provides a most fruitful space to discuss methodological, theoretical and systematic issues.

**Objective**  
The colloquium addresses advanced and graduate students. First, it offers participants the opportunity to present their own research projects (work in progress); and, second, it provides a most fruitful space to discuss methodological, theoretical and systematic issues.

**851-0252-05L**  
**Research Colloquium Cognitive Science**  
*W* 1 credit 2K  
C. Hölscher, V. Schinazi, T. Thrash  

**Prerequisite:** Participants should be involved in research in the cognitive science group.

**Abstract**  
The colloquium provides a forum for researchers and graduate students in cognitive science to present/discuss their ongoing projects as well as jointly discuss current publications in cognitive science and related fields. A subset of the sessions will include invited external visitors presenting their research. Participants of this colloquium are expected to be involved in active research group.
Protecting Inventions in Chemistry  

**Objective**

Graduate student train and improve their presentation skills based on their own project ideas, all participants stay informed on current trends in the field and have the opportunity for networking with invited scholars.

**Abstract**

The lecture gives students of chemistry-related degree programs an overview of the options to protect inventions and the underlying investments in research and development. The lecture aims to put the participants in a position to be able to use this know-how in the workplace.

**Objective**

Research and development play an important role in chemistry-related technology sectors, such as inorganic chemistry, pharmacy or food chemistry.

Investments in the development of new substances and active component in these sectors are traditionally secured by patents because publicly known inventions, generally chemical substances, may easily be reproduced by others.

In the last years, the know-how about intellectual property has become increasingly important for chemists and engineers. Both in the production process and in the distribution sector, chemists and engineers are increasingly concerned with questions related to patenting inventions and the use of patent information. As more than three-quarters of all publicly available technical information is reportedly available only in patents, it is more and more important for researchers and engineers to be capable of extracting relevant information from the flood of patents.

Patents are not only a measure to protect investments and inventions in chemistry-related sectors but also an important source of information about competitors and potential cooperation partners, about the development of markets and the risks of infringing others' patents. Accordingly, the know-how about patents and patent information has also become a key qualification on the strategic level in companies and in the area of research.

The seminar is customised to the needs of chemists and students of related degree programs. Participants will become familiar with practice-relevant aspects of intellectual property with the emphasis being placed on patents. Participants will be able to use the acquired knowledge in the protection and commercialisation of their own inventions.

The topics covered will include:
- The importance of innovation in industrialised countries and high-tech sectors
- The protection of inventions and the safeguarding of commercial implementation - the role and importance of intellectual property
- Patents as a source of technical and business information
- Practical aspects of intellectual property for day-to-day research work, for the formation of start-ups and at the workplace.
- Special aspects of protecting inventions in chemistry-related sectors, including polymorphs and inventions in the field of nanotechnology.

The seminar contains practical exercises on the use and search of patent information in chemistry-related sectors. Basic know-how on how to read and evaluate patent documents, as well as how to use publicly available patent databases in order to obtain the required patent information will also be provided.

**Prerequisites / notice**

The lecture is coordinated in particular to the needs of the following degree programs: Agricultural science, biotechnology, chemical engineering, chemistry, food science, pharmaceutical sciences.

For engineering and physics students, the lecture 'The Role of Intellectual Property in daily routine: A Practical Introduction' will be offered, which is coordinated to the needs of students in these degree programs.

Theoretical Philosophy Work in Progress Seminar  

**Objective**

This course themes from theoretical philosophy are discussed which are of particular interest for current MAPGW students. Primary texts will be read together and the work in progress of the participants (essays, theses) will be presented and discussed.

This course is aimed at MAPGW students who are particularly interested in theoretical philosophy. The seminar provides an opportunity to discuss and present one's own research. The participants learn to critically evaluate primary texts and improve their skills in presenting and discussing work in progress.

From Computational Social Science to Global Systems Science  

**Objective**

Participants of the seminar should understand how tightly connected systems lead to networked risks, and why this can imply systems we do not understand and cannot control well, thereby causing systemic risks and extreme events.

They should also be able to explain how systemic instabilities can be understood by changing the perspective from a component-oriented to an interaction- and network-oriented view, and what fundamental implications this has for the proper design and management of complex dynamical systems.

Computational Social Science and Global Systems Science serve to better understand the emerging digital society with its close co-evolution of information and communication technology (ICT) and society. They make current theories of crises and disasters applicable to the solution of global-scale problems, taking a data-based approach that builds on a serious collaboration between the natural, engineering, and social sciences, i.e. an interdisciplinary integration of knowledge.

Embodied Cognition  

**Objective**

This seminar offers an introduction to embodiment. Does the representation of thought and emotion depend upon the sensory and motor system? Highlights: the figurative processing of "go" still evokes voltage changes in foot muscles, conceptualizing time activates the eyes to look along a mental time line, abstract causality might still be grounded in motor control, emotion shows in the way we walk.
Looking at the degree of embodiment in cognition and emotion naturally leads to the question how the mind works. What is the nature of human thoughts and emotions? How deeply are they dependent upon features of our physical body as an agent? Do the sensory and motor system play a physically constitutive role in conceptualizing thought and emotion? We will look at these questions by examining the degree of embodiment in basic thinking types of our mind (space, time, and causality thinking) as well as in abstract thought (e.g., logical thinking) and in emotion processing. As will be discussed, the topic of how the mind works is not only of central importance in the humanities (psychology, linguistics, philosophy, anthropology, education), but is also relevant for parts of the natural and technological sciences (physiology, neuroscience, medicine, computer science, artificial intelligence). Active participation is expected. Each participant can choose a topic for which they will give an oral presentation (about 30 min.) and write a related written report (about 3000 words).

851-0306-05L Literature and Technology - Simulations, Prototypes, Machines W 3 credits 2S

Abstract: Literature about technology transposes models, products and procedures of scientific progress into the logic of poetry. This literature converts not only technology into fiction, but it also creates new cultural and social contextualisations, which reveal alternative readings of configurations of knowledge.

Objective: Students are familiar with different relations between literature and technology. They can verbalise and analyse central contents.


851-0300-94L Combinatorics: History of a Method Between Mathematics and Literature W 3 credits 2S A. Kilcher

Abstract: Combinatorics is a procedure shared by various disciplines. In mathematics it concerns the calculation of quanta and probabilities, in philosophy the creation of encyclopedic knowledge, in mysticism the achievement of ecstatic experience, in literature, finally, experimental writing. This course investigates these different forms of combinatorics.

Objective: - comparative understanding of combinatorics as a transcultural and transdisciplinary procedure to generate knowledge
- cultural and epistemic history of combinatorics since the medieval ages
- combinatorics in theology, mysticism and occultism
- combinatorics in philosophy and the natural sciences
- combinatorics in literature and literary theory

Content: Kombinatorik, die Verknüpfung von Elementen, tritt als ein Verfahren in unterschiedlichen Disziplinen und Bereichen des Wissens auf: In der Mathematik weicht eine solche Verknüpfung, die kombinatorischen Operationen als eine Grundlage der Disziplin, womöglich die Grenzen von Anzahlen und Wahrscheinlichkeiten. Zugleich spielt die Kombinatorik auch eine große Rolle in der Philosophie (als ein Verfahren der Erzeugung eines enzyklopädischen Wissens), in der Mystik (zur Erlangung ekstatischer Erfahrungen) und in der Literatur (als ein experimentelles Schreiben). Im Seminar werden diese vielfältigen Formen und Funktionen von Kombinatorischen Verfahren zwischen mathematischer, philosophischer, mystischer und ästhetischer Anwendung verglichen und analysiert.

851-0158-00L Living at the Expense of Others. Parasites in the History of Science W 3 credits 2V E. Johach

Abstract: Parasites have a bad reputation. They settle in with other creatures' bodies, they manipulate and deceive them, they live at the expense of others. Such features are not only of biological but also of social, political, and economic importance. The lecture will track the traces of the parasite through the history of biology and medicine and the fields of political economy and cultural theory.

Objective: The course provides insight into the complex and intricate history of the parasite and the various definitions of parasitism. In particular, it will make students aware of the fact that there is no single expert discourse on parasites (such as biology or medicine) which is then transferred to the realm of the social and the political. Instead, it will be considered how and why all these aspects are intertwined when people talk about parasites.

851-0158-01L Science and Wonder W 3 credits 2S E. Johach

Abstract: Wonders seem to be perfectly incompatible with science: Superstition and ignorance here, exactness and certitude there. In the seminar we will study this conflicitive relation in more detail. Texts will cover a broad historical spectrum ranging from pre-modern cabinets of wonder to the anti-wonder polemics in the 19th century to the current dispute on Intelligent Design.

Objective: - to understand how advances in technology and science are historically rooted in European imperial expansion and are connected to global social inequalities in the postcolonial world.
- to understand the historical plurality of forms of knowledge in different parts of the world as well as entanglements between different forms of knowledge
- to systematically reconstruct and reproduce complex arguments (reading-competences)
- to understand, compare and analyse differing approaches to the history of science.
- to enable students to form an educated opinion and participate in discussions on the historical variability of objectivity and scholarly standards.

851-0101-47L Science in the Twentieth Century: A Global Perspective WEBCLASS W 3 credits 2S V. Bharadwaj, B. Schär

Abstract: This course studies the 20th century history of those forms of knowledge framed specifically as science and technology, from a global perspective. It explores how exchanges and relationships between different parts of the world contributed to what is understood as science and “development”. In doing so, it considers how the concept of science is entangled with structures of power and domination.

Objective: - to critically consider the concepts of science and knowledge
- to understand how advances in technology and science are historically rooted in European imperial expansion and are connected to global social inequalities in the postcolonial world.
- to understand the historical plurality of forms of knowledge in different parts of the world as well as entanglements between different forms of knowledge
- to enable students to form an educated opinion and participate in discussions on the global history of science and knowledge.

851-0145-04L History and Philosophy of Pharmacy ■ W 3 credits 2S S. Baier

Abstract: The course provides an insight into selected topics and questions of the history and philosophy of pharmacy by reading and discussing both modern and historical texts.

Objective: The course provides an insight into selected topics and questions of the history and philosophy of pharmacy by reading and discussing both modern and historical texts.

851-0309-13L "Materialmöränen": Thomas Mann's "Zauberberg" from the Point of View of the History of Knowledge W 3 credits 2S J. Reidy

Abstract: This seminar is dedicated to Thomas Mann's "Zauberberg", the great Bildungsroman and "Zeitroman" (Mann) from the author's middle period. Mann himself feared that the novel might be intellectually overburdened with contexts and concepts. The seminar will attempt to elucidate these contexts from the point of view of the history of ideas and knowledge and will take into account current research.
Based on the contributions published between 1910 and 1932 in “Der Sturm”, the seminar gives an overview on the unique diversity of German-Jewish literature, which includes famous modern authors from Heine to Kafka. This lecture course shows the at once productive and problematic dual, transcultural relationship of its history. The key question is how, in this relationship, cultural knowledge is discussed in theoretical, political and literary terms.

The seminar deals with the designs for a new living in the artistic and social avantgarde movements at the beginning of the 20th century. It focuses on the correlation of the contemporary scientific and technological developments and the conceptions of a ‘New Man’. The discipline of psychotechnics together with scientific and technological designs of living and working environments formulated visions of new and enhanced ways of human living and perception. In the seminar, we will examine the utopian visions of life in the avantgarde movements. Touching upon the fields of the life sciences, economics, management, progressive education, architecture, and art we will reflect the diverse relations between science, technology, and human living.

Writing Between Cultures. German-Jewish Literature and Cultural Knowledge 1822–1933

Objective

- Students familiarize themselves with one of the great novels of the 20th century in the context of a diligent reading accompanied by the lecturer.
- On the basis of the primary text, the seminar establishes several perspectives grounded in cultural history, the history of knowledge and ideas, economic and social history and the history of medicine.

851-0300-95L
Writing Between Cultures. German-Jewish Literature and Cultural Knowledge 1822–1933

W 3 credits 2V 2S A. Kilcher

Objective

German-Jewish literature, which includes famous modern authors from Heine to Kafka, is remarkable because it is a cultural double. This lecture course shows the at once productive and problematic dual, transcultural relationship of its history. The key question is how, in this relationship, cultural knowledge is discussed in theoretical, political and literary terms.

Content


Literature

Andreas B. Kilcher (Hrsg.): Metzler Lexikon der deutsch-jüdischen Literatur. 2., aktualisierte und erweiterte Auflage, Stuttgart 2012.

851-0125-51L
Man and Machine Particularly suitable for students of D-CHAB, D-HEST, D-MAVT, D-MATL

W 3 credits 2G 2S M. Hampe, D. A. Strassberg

Objective

The lecture gives an overview about the different Man-Machine-Relations since the 16th century. Different models of machines will be important here: the clockwork, the steam engine and the computer.

Content

This course is suited for all students with an interest in the history of science and knowledge. Conceived of as an advanced introducory course, it critically examines the discourses of, science. The aim of this introductory course is to critically examine some of these seminal texts.

851-0157-56L
Avantgarde-Life: Utopia of the ‘New Man’ Between Science and Technology Particularly suitable for students of D-ARCH, D-HEST, D-MTEC.

W 3 credits 2S M. Wulz

Objective

On the one hand models of machines had a heuristic value in research on man, e.g. in Harvey’s discovery of blood circulation in the 17th century or in brain research in the 20th century. On the other hand these models were always criticised, sometimes polemically, because they are supposedly not adequate for man. Students should learn about the connections between the history of anthropology and technology and be able at the end of the course to evaluate the critical philosophical arguments that are connected with the metaphor of the machine.

851-0300-92L
Institutionalisation of Modernity: "Der Sturm", a German Art & Literary Magazine, Edited by Herwarth

W 3 credits 2S S. S. Leuenberger

Content

Based on the contributions published between 1910 and 1932 in “Der Sturm”, the seminar gives an overview on the unique diversity of literary and cultural movements in Berlin between the turn of the century and the Weimar Republic. Besides the reading of literary texts, the lecture focuses on the aesthetic, philosophical and political discourses of the epoch.

851-0125-48L
Wisdom, Certainty, Insecurity

W 3 credits 2S N. El Kassar

Objective

Wisdom is widely - maybe even universally, at all times and everywhere - regarded as one of the highest virtues. But what constitutes wisdom? And is wisdom compatible with uncertainty? Does a wise person have to be certain or can she be uncertain? These and related questions will be discussed in the seminar to gain an understanding of what wisdom, certainty and uncertainty are.

851-0157-57L
Classics in the History of Science: Approaches, History, Contexts

W 3 credits 2S N. Guettler, M. Stadler

Objective

This course is suited for all students with an interest in the history of science and knowledge. Conceived of as an advanced historiographical introduction to the subject, the course is to explore a selection of “classics” in the history of science - some of them well known, others less so. In this course, we shall be as much concerned with the positions and the perspectives on science that were advanced in these various texts as we shall be concerned with the historical circumstances, political meanings and wider cultural contexts of these perspectives.
The seminar is dedicated to the texts of scandal author Oskar Panizza. Especially the dogmas and beliefs of the Christian churches caused in this perception the grievances in society. Other the subject regimented categories such as ethnicity and gender are denounced by Panizza and discussed in his writings in many ways.

**Objective**
- Acquiring cultural scientific aspects and perspectives of literature and literary history:alterity, ethnicity, gender constructions, social differences, religion, etc.
- Critical analysis of recent research positions and research questions
- Training problem oriented circumvention of literature and its social functions in historical contexts
- Developing genre typological and narratological foundations
- Independent balancing and writing of ones own research ideas

**Content**

**Literature**

1. Dieter Sturma/Bert Heinrichs (Hg.), Handbuch Bioethik, Stuttgart: Metzler 2015.
The course wants to develop the students' ability to critically read and assess historic texts. A detailed program and course materials will be made available during the semester on www.tg.ethz.ch.

2 credits

A detailed program and course materials will be made available during the semester on www.tg.ethz.ch.

M. Pratschke
Research Colloquium History of Knowledge (HS 2015)

The seminar aims at getting to know the theoretical and practical conditions of exhibitions as temporary forms of knowledge. We will develop criteria to explore the various aspects and processes related to exhibitions, including: installations of exhibits, display cases, transporting devices, exhibition catalogues, exhibition architecture, visitor guidance, spatial arrangements of objects etc.

Cooperation and fairness in encounters with strangers are puzzling behaviors, since they contradict the law of natural selection. Notwithstanding, daily experience as well as field and laboratory studies, all reveal that humans do cooperate and behave fairly. This lecture series is intended to present the main theoretical approaches in economics and psychology to understanding cooperation and fairness and to review some of the relevant experimental studies. The seminar lectures will focus on three strategic games: the prisoner's dilemma (PD), the ultimatum game (UG) and the Public Goods (PG) game. The theories to be discussed include: classical game theory, reciprocity theories, altruistic punishment, equity, reciprocity and competition (ERC), inequality aversion (IA), as well as a new psychological theory of aspiration levels. The theories' predictions of cooperativeness and fairness in the above mentioned games will be presented and compared using experimental data.

For more information, see: http://www.socio.ethz.ch/studium.html

Prerequisites / notice
Groups of 2-3 students will write an essay on a topic to be agreed upon during the course meetings. Students will be requested to submit their paper within one month from the last class meeting. The grades will be delivered within two months after the last class meeting.

Evolutionary Foundations of Social Behavior

Number of participants limited to 30.

This lecture will deal with the manifestations of the "selfish gene" principle in human social behavior. Cooperation and competition, selfishness and altruism, gender relations and parent-child conflicts are issues, the evolutionary backgrounds of which will be discussed. Special attention will be paid to the costly signaling theory.

You will receive an in-depth overview of the application of Darwinian theory on behavioral phenomena. This will enable you to approach the heuristic perspective of the so-called adaptationist program of social phenomena. Finally, you will be able to discern the benefits and the problems of the evolutionary perspective within various scientific disciplines, especially anthropology, psychology, empirical social research and comparative cultural sciences.


Prerequisites / notice

Research Colloquium History of Knowledge (HS 2015)

Only for MAQPW students, D-GESS PHD and D-ARCH PHD students.

This colloquium is highly recommended for first and second semester MAQPW students.

The colloquium of the ZGW focuses on present developments, debates and perspectives in the field of history of knowledge. On the second and fourth date there will be public events in the Cabaret Voltaire. Check the program on www.zgw.ethz.ch

The colloquium deals with the general problems, questions and methods of the interdisciplinary research field "The History of Knowledge". Knowledge has become one of the existential conditions of modern societies and it increasingly determines their dynamics. Therefore, it is getting more and more relevant to develop a differentiated analysis of the epistemic, social and cultural constraints of the production, circulation and the decay of knowledge. In addition, the colloquium asks after the cultural and ethical resonances of knowledge not only within science but also in relation to art, literature, technology, everyday life, and so on.

Credit points can be gained by regular attending and by writing an essay. In addition to the five colloquia there will be a deepening seminar on offer (lecturer K. Espahangizi).

Free childcare available.

A Historical Epistemology of Exhibitions

Particularly suitable for students of D-ARCH, D-BAUG.

The seminar provides an introduction to exhibitions as epistemic practices. By means of various research approaches and examples from historical and current exhibitions we will discuss how knowledge is created by temporary spatial constellations of exhibited objects and the ways exhibitions act as laboratories of ideas.

The seminar aims at getting to know the theoretical and practical conditions of exhibitions as temporary forms of knowledge. We will develop criteria to explore the various aspects and processes related to exhibitions, including: installations of exhibits, display cases, transporting devices, exhibition catalogues, exhibition architecture, visitor guidance, spatial arrangements of objects etc.

Using selected historical and current examples, we will discuss different formats of exhibitions that range from trade fair booths to laboratory exhibitions, exhibitions in art museums as well as in science and natural museums. Being a specific humanistic way of creating knowledge experimentally we will pay particular attention to exhibitions that deal with topics at the intersection of the sciences and the humanities, thus acting as agents in the debate on the Two Cultures.


Anke te Heesen: Theorien des Museums zur Einführung, Hamburg 2012.
Does not take place this semester.

Abstract
The course focuses on writers (such as Henry James, Virginia Woolf, Margaret Atwood, Arthur Miller, Charles Dickens, George Eliot and Oscar Wilde) who by approaching the technique of photography i.e. its optical and chemical procedures have discovered novel modes and methods of representation.

Objective
The course introduces students to what an interdisciplinary approach to literature implies. Students are familiar with the main techniques of photography and relate these to the literary discourse of specifically the 20th century.

851-0300-97L Return of Religions, 'Religious turn', Postsecularity: On the Contemporary Prominence of Religions

Abstract
Facing the recent return of religion in the public sphere, we discuss concepts of the relation of religion and modernity: the classical theories of secularization and the actual discussion of the post-secular, anthropology of religion, political theology, psychoanalytic and postcolonial theories of religion.

Objective
The students get familiar with different theories of religion and of the relation of religion and modernity in particular. They discuss the constructivist and epistemological implicants of these theories and understand the significant role of religion, especially under modern conditions. They reflect on the differences and even conflicts between different approaches and face their respective ideas about modernity. The course thus aims to deepen the self-understanding of our modern standpoint in relation both to one's own religious identity and history and to the religion of 'Others'.

851-0300-98L History and/or "Rigorous" Science?

Abstract
The difference between the natural sciences and the humanities is often characterized in terms of their relation to history: here rigorous method & transhistorical laws, there historically conditioned, and hence relative, understanding. But the discrepancy between transhistorical immanence and historical constitution figures also within both disciplines. We will discuss precisely this discrepancy.

Objective
- reflect on the ideal of scientific rigor, as well as the historical constitution of all knowledge;
- question the paradigm of historicity with regard to both the natural sciences and the humanities;
- critical reading of theoretical and literary texts that deal with the tension between scientificity and historicity.

Content

Literature

Prerequisites / notice
Readings in German and English, discussions in class in German.

857-0093-00L Visualizing and Analyzing Spatial Data in Political Science

Number of participants limited to 16.

Abstract
This course introduces students to the analysis of geospatial data for applications in political science. It provides them with the tools and methods necessary for incorporating geospatial data in their own research projects, and guides participants through the entire workflow of creating, viewing, managing, visualizing, and analyzing geospatial data for understanding political phenomena.

Objective
The analysis of geospatial data is increasingly important in political science. Many traditional types of data that are used to understand political phenomena (e.g., survey data, voting data, governance indicators, etc.) refer to geospatial units (e.g., countries, cantons, villages, etc.). In addition, recent advances in computing allow for collecting and analyzing novel forms of geocoded information that are of tremendous value for modern social science applications, such as conflict event data, satellite imagery, or geo-tagged social media data. Managing, analyzing and visualizing these types of data require tools that go beyond the traditional skill set taught in basic social science methods classes.

This course introduces students to the tools and methods necessary for incorporating geospatial data in their own research projects, and guides participants through the entire workflow of creating, viewing, managing, visualizing, and analyzing geospatial data.

Overall, students will learn to
- view and manage geospatial data in various formats;
- develop a basic understanding of the problem of cartographic projection;
- collect, create, manipulate, and combine geospatial data for their own research projects;
- visualize geospatial data in maps and interactive applications;
- understand the challenges associated with analyzing geospatial data with statistical tools;
- prepare, run, and interpret basic spatial econometric models (linear SEM and SAR models).

Requirements:
- Basic understanding of linear regression and simple statistical concepts.
- Interest in quantitative analysis.
- Laptop (Win/Mac/Linux) for exercises.

851-0253-01L Introduction to Cognitive Neuroscience

Abstract
This will be an introductory course in cognitive neuroscience. We will examine both human neurophysiology and cognitive functioning and explore how the latter is understood by the former. Topics will include brain anatomy and development, cellular mechanisms, CNS methodologies, visual perception, object recognition, memory, hemispheric specialization, and complex cognition.

Objective
The focus will be on the interplay between neural and cognitive systems. The course will have a bias towards "higher" cognitive functions. Learning objectives and outcomes: the course will have three basic components: (1) the first component will include basics of brain anatomy and development, functional imaging, and how cellular mechanisms can be modelled as computational processes; (2) the second component will overview CNS methodologies, with an emphasis on fMRI techniques; (3) in the third component we will turn to content topics. These will include visual perception, object recognition, memory, hemispheric specialization, and complex cognition. By the end of the course the student will be able to identify the major brain structures, they should be able to explain the functioning of neurons, as relating to the action potential, have an understanding of the methodologies used to generate the various types or results reported in the literature, and for each of the content topics, the student should be able to identify the phenomenon, give examples, and discuss one or two of the main theories explaining it.
What distinguishes Global History - conceptually and empirically - from other modes of historical inquiry? This research colloquium lecture by J. Große aims to prepare PhD students for conducting their own experiment.

Participants will acquire a systematic overview of different definitions of and approaches to Global History. They will be able to position their own approach within the field of Global History and gain a clearer understanding on how to examine their research projects.

Learning outcomes: By the end of the seminar the student should be familiar with these literatures, should be able to discuss relative strengths and weaknesses, and identify what each has contributed to our ability to design, and to our understanding of the design process itself.

**851-0252-07L Recent Debates in Social Networks Research**

*W 2 credits 2S C. Stadtfeld, P. Block*

**Abstract**
Social Networks research is a highly interdisciplinary field. For example, scholars in Sociology, Psychology, Political Sciences, Computer Science, Physics, Mathematics and Statistics contribute to the development of theories and methods. This course aims at understanding, comparing and structuring recent debates in the field of Social Networks.

**Objective**
Social Networks research is a highly interdisciplinary field. At the end of this seminar, students will understand and be able to compare different subject-specific approaches to social networks research (e.g., from Sociology, Psychology, Political Sciences, Computer Science, Physics, Mathematics and Statistics). They will be familiar with recent publications in the field of Social Networks and be able to critically participate in a number of recent debates. Amongst others, these debates touch upon the co-evolution of selection and influence mechanisms, appropriateness of statistical models, generic mechanisms and features of social networks, models for the analysis of dynamic networks.

**851-0101-49L Concepts and Sources of Global History: Young Researchers’ Colloquium**

*W 1 credit 2K B. Schär, J. Große*

**Abstract**
What distinguishes Global History - conceptually and empirically - from other modes of historical inquiry? This research colloquium provides a collegial and non-competitive forum for young researchers to discuss these questions. We shall examine programmatic texts on Global History and connect them to source materials from our own research projects.

**Objective**
Participants will acquire a systematic overview of different definitions of and approaches to Global History. They will be able to position their own approach within the field of Global History and gain a clearer understanding on how to examine their source materials.

**364-1062-00L Experimental Methods**

*W 1 credit 1V C. Waibel*

**Abstract**
This course introduces PhD students into the principles of experimental methods and outlines how to prepare, conduct and evaluate an experiment.

**Objective**
This course aims to prepare PhD students for conducting their own experiment.

**Content**
1. Introduction: What are economic experiments and why to use them?
4. Conducting experiments: Instructions, testing, recruiting, sessions.
5. Measuring techniques: Eliciting beliefs, risk attitudes, social preferences.

**Literature**
Books:

Basic Articles:

A reading list with articles for each lecture has been published in ILIAS.
### Doctoral Department of Health Sciences and Technology
#### Doctoral and Post-Doctoral Courses

##### Health Sciences and Technology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>376-1791-00L</td>
<td>Introductory Course in Neuroscience I ■</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>J.M. Fritschy, W. Knecht</td>
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<td>Abstract</td>
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<td>The course gives an introduction to the development and anatomical structure of nervous systems. Furthermore, it discusses the basics of cellular neurophysiology and neuropharmacology. Finally, the nervous system is described on a system level with a particular emphasis on the visual system.</td>
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<td>4) Axon guidance</td>
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<td>5) Action and language development</td>
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<td>6) Circadian rhythms</td>
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<td>8) Synaptic transmission</td>
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<td>9) Neural circuits in vivo</td>
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<td>10) Visual pathways and visual processing</td>
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<td>11) Somatosensory system</td>
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<td>12) Vestibular system</td>
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<td>13) Sleep</td>
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<td>14) Learning and Memory, mice and human</td>
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<td>Prerequisites / notice</td>
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<td>For doctoral students of the Neuroscience Center Zurich (ZNZ).</td>
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<td>Abstract</td>
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<td>The goal of this Advanced Course in Neurobiology is to provide students with a broader knowledge in several important areas of neurobiology. The course consists of four parts: Part I deals with various topics in developmental neurobiology. Part II is devoted to aspects of signal transduction. Part III focuses on synaptic transmission. Part IV gives deeper insights into systems neuroscience.</td>
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<td>This credit point course is designed for doctoral students who have successfully completed the Introductory Course in Neuroscience at the Neuroscience Center Zürich. The goal is to provide students with a broader and deeper knowledge in several important areas of neurobiology.</td>
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<td>Prerequisites / notice</td>
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##### Food Science

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>752-0005-00L</td>
<td>Public Colloquium in Food Science</td>
<td>E-</td>
<td>1 credit</td>
<td>2K</td>
<td>L. Meile</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>This course is based on attendance of public seminars in the field of Food Science provided by invited speakers of the Institute of Food, Nutrition and Health (IFNH). A selected side-topic extracted from these seminars are presented by the students and evaluated by specialists in the particular field.</td>
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<td>The main goal for this course is to provide students with topics on current research in Food Science and related fields from which the students have to elaborate and present a more extended topic through literature studies.</td>
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<td>This course is based on 6-10 seminars/semester announced as &quot;IFNH Seminars&quot; where invited speakers of IFNH professorships are presenting a certain topic related to the work of the professorship inviting the speaker. Students have to attend at least 6 seminars, select a seminar side-topic related to a particular speaker's topic and present this individual topic in the presence of a mall number of selected IFNH specialists at a date which has to be arranged with L. Meile.</td>
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<td>Lecture notes</td>
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<td>Individual literature</td>
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**Doctoral Department of Health Sciences and Technology - Key for Type**

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<tr>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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<td>O</td>
<td>Compulsory</td>
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**Key for Hours**

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<th>Type</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

**ECTS** European Credit Transfer and Accumulation System

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**Special students and auditors need special permission from the lecturers.**
## Doctoral and Post-Doctoral Courses

### Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
252-0912-00L | Experimental Computer Systems | W | 2 credits | 2S | T. Gross

**Abstract**: This graduate seminar provides doctoral students in computer science a chance to discuss their research. Enrolment requires permission of the instructor. Credit units are granted only to active participants.

**Objective**: Learn how to formulate a research project, how to conduct research and how to improve presentation skills in an academic setting.

**Content**: The seminar will explore different topics from a research perspective. The seminar is open to assistants of the Department of Computer Science (Informatik), Computer Systems Institute. Others should contact the instructor.

**Lecture notes**: Supporting material will be distributed during the seminar.

**Prerequisites / notice**: Credit will be given only to those who present a paper/project. No credit for "attendance".

252-0923-00L | OMS Case Study I | W | 2 credits | 2S | M. Norrie

**Abstract**: This doctoral seminar consists of a series of talks and discussions covering the history and foundations of OMS, related work and on-going OMS developments and applications.

**Objective**: The seminar will explore different topics from a research perspective.

252-0932-00L | Seminar on Cryptography | W | 2 credits | 1S | U. Maurer, M. Hirt

**Objective**: Latest Topics in Cryptography will be discussed.

252-0933-00L | Algorithms and Complexity (HS) | W | 1 credit | 1S | J. Hromkovic, P. Widmayer

**Abstract**: The seminar treats selected problems of current interest in the area of algorithms and complexity.

**Objective**: Develop an understanding of selected problems of current interest in the area of algorithms and complexity.

**Content**: This seminar treats selected problems of current interest in the area of algorithms and complexity.

**Lecture notes**: None

**Literature**: Research papers, to be chosen in the seminar.

**Prerequisites / notice**: Prerequisites: Basic understanding of algorithms and complexity.


**Abstract**: Only for Ph.D. students at the Institute of Computer Science. All other students need the approval of the lecturer.

**Objective**: An essential aspect of any research project is dissemination of the findings arising from the study. Here we focus on oral communication, which includes: appropriate selection of material, preparation of the visual aids (slides and/or posters), and presentation skills.

**Content**: The seminar participants should learn how to prepare and deliver scientific talks as well as to deal with technical questions. Participants are also expected to actively contribute to discussions during presentations by others, thus learning and practicing critical thinking skills.

**Prerequisites / notice**: This doctoral seminar of the Machine Learning Laboratory of ETH is intended for PhD students who work on a machine learning project, i.e., for the PhD students of the ML lab.

252-4202-00L | Seminar in Theoretical Computer Science | W | 2 credits | 2S | E. Welzl, B. Gärtner, M. Hoffmann, J. Lengler, A. Steger, B. Sudakov

**Abstract**: Presentation of recent publications in theoretical computer science, including results by diploma, masters and doctoral candidates.

**Objective**: The goal is to introduce students to current research, and to enable them to read, understand, and present scientific papers.

252-1425-00L | Geometry: Combinatorics and Algorithms | W | 6 credits | 2V+2U+1A | B. Gärtner, M. Hoffmann, E. Welzl

**Abstract**: Geometric structures are useful in many areas, and there is a need to understand their structural properties, and to work with them algorithmically. The lecture addresses theoretical foundations concerning geometric structures. Central objects of interest are triangulations. We study combinatorial (Does a certain object exist?) and algorithmic questions (Can we find a certain object efficiently?)

**Objective**: The goal is to make students familiar with fundamental concepts, techniques and results in combinatorial and computational geometry, so as to enable them to model, analyze, and solve theoretical and practical problems in the area and in various application domains.

**Content**: Planar and geometric graphs, embeddings and their representation (Whitney's Theorem, canonical orderings, DCEL), polygon triangulations and the art gallery theorem, convexity in R^d, planar convex hull algorithms (Jarvis Wrap, Graham Scan, Chan's Algorithm), point set triangulations, Delaunay triangulations (Lawson flips, lifting map, randomized incremental construction), Voronoi diagrams, the Crossing Lemma and incidence bounds, line arrangements (duality, Zone Theorem, ham-sandwich cuts), 3-SUM hardness, counting planar triangulations.

**Lecture notes**: yes


**Prerequisites / notice**: Prerequisites: The course assumes basic knowledge of discrete mathematics and algorithms, as supplied in the first semesters of Bachelor Studies at ETH.

**Outlook**: In the following spring semester there is a seminar "Geometry: Combinatorics and Algorithms" that builds on this course. There are ample possibilities for Semester-, Bachelor- and Master Thesis projects in the area.

263-4203-00L | Geometry: Combinatorics and Algorithms | W | 2 credits | 2S | B. Gärtner, E. Welzl

**Abstract**: This seminar is held once a year and complements the courses Computational Geometry and Geometric Graphs: Combinatorics & Algorithms. Students of the seminar will present original research papers, some classic and some of them very recent. The seminar is a good preparation for a master, diploma, or semester thesis in the area.
Wherever possible I illustrate by example and present the material in a way to make it immediately applicable. The goal is to provide the

E. Welzl

Study and presentation of research papers from the literature on "Boolean Satisfiability-Combinatorics and Algorithms".

European Credit Transfer and Accumulation System

Each student is expected to read, understand, and elaborate on a selected research paper. To this end, (s)he should give a 45-min.

This seminar is an opportunity to become familiar with current research in software engineering and more generally with the methods and
critical review and analysis. Active participation is required (a presentation of a paper as well as participation in discussions).

Successful completion of that course is a prerequisite for participation in the seminar.

The seminar builds heavily on the material covered in the course "Boolean Satisfiability-Combinatorics and Algorithms." Successful

Organizational note: the seminar will meet only when there is a scheduled presentation. Please consult the seminar's home page for

The publications to be presented will be announced on the seminar home page at least one week before the first session.

The publications to be presented will be announced on the seminar home page at least one week before the first session.

Learning about current research results in the area of programming languages, static program analysis, program verification, and related
topics in both theory and practice, including papers on program verification, program analysis, testing, programming language design,

The seminar builds heavily on the material covered in the course "Boolean Satisfiability-Combinatorics and Algorithms." Successful

Current research at the IVC will be presented and discussed.

Current research at the IVC will be presented and discussed.

To attend the seminar, some basic knowledge in (discrete and computational) geometry and graphs and algorithms is required. Thus,

Data: 06.02.2019 13:00

Spring Semester 2018

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Special students and auditors need special permission from the lecturers.
The entropy rate of a source, typical sequences, the asymptotic equi-partition property, the source coding theorem, Huffman coding.

J. Lygeros, M. Kamgarpour

Linear System Theory

Time-Frequency Analysis and its discretized version, namely Gabor Analysis have required to develop a family of function spaces (the so-called modulation spaces, introduced by Feichtinger in the 80th) which is different from the usual Lebesgue spaces. There is a smallest space (called $S_{0}$) and a largest space (namely the dual space), which is a suitable reservoir of generalized functions relevant for the rigorous establishment of basic results in signal processing (sampling theorem, Poisson formula, Fourier inversion, etc.). The course will be centered about the basic properties of the Banach Gelfand triple $S_{0}$ (also called rigged Hilbert space), its use for signal processing and systems theory applications. Addition to classical questions we will also discuss the fundamental results of time-frequency analysis.

The author proposes a simple approach to generalized functions, based on a Banach space of test functions. The course provides the foundations to Banach Gelfand triples, but also concrete applications in signal processing (time-variant systems, sampling).

Advanced Topics in Magnetic Resonance Imaging

This course is geared towards master and PhD students with a focus on bioimaging. It covers advanced topics in magnetic resonance imaging in biennial rotation, including the electrostatics of MR signal detection, noise mechanisms, image reconstruction, radiofrequency pulse design, RF pulse trains, as well as advanced contrast mechanisms.

K. P. Prüssmann

Information Theory I

This course covers the basics of information theory and communication theory. Topics covered include the entropy rate of a source, mutual information, typical sequences, the asymptotic equi-partition property, Huffman coding, channel capacity, the channel coding theorem, the source-channel separation theorem, and feedback capacity.

A. Lapidoth

Signal and Information Processing: Modeling, Filtering, Learning

Fundamentals in signal processing, detection/estimation, and machine learning.

H. A. Loeliger

Advanced Mathematical Signal Processing

Time-Frequency Analysis and its discretized version, namely Gabor Analysis have required to develop a family of function spaces (the so-called modulation spaces, introduced by Feichtinger in the 80th) which is different from the usual Lebesgue spaces. There is a smallest space (called $S_{0}$) and a largest space (namely the dual space), which is a suitable reservoir of generalized functions relevant for the rigorous establishment of basic results in signal processing (sampling theorem, Poisson formula, Fourier inversion, etc.). The course will be centered about the basic properties of the Banach Gelfand triple $S_{0}$ (also called rigged Hilbert space), its use for signal processing and systems theory applications. In addition to classical questions we will also discuss the fundamental results of time-frequency analysis (Short-time Fourier transform, Gabor frames, best approximation of operators by Gabor multipliers, identification of slowly varying channels using pilot tones, etc.).

H. G. Feichtinger

Doctoral Dep. of Information Technology and Electrical Engineering


The courses on offer below are but a small selection out of a much larger available number of courses. Please discuss your course selection with your PhD supervisor.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0225-00L</td>
<td>Linear System Theory</td>
<td>W</td>
<td>6</td>
<td>5G</td>
<td>J. Lygeros, M. Kamgarpour</td>
</tr>
<tr>
<td>227-0389-00L</td>
<td>Advanced Topics in Magnetic Resonance Imaging</td>
<td>W</td>
<td>0</td>
<td>1V</td>
<td>K. P. Prüsmann</td>
</tr>
<tr>
<td>227-0417-00L</td>
<td>Information Theory I</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>A. Lapidoth</td>
</tr>
<tr>
<td>227-0427-00L</td>
<td>Signal and Information Processing: Modeling, Filtering, Learning</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>H. A. Loeliger</td>
</tr>
<tr>
<td>227-0445-00L</td>
<td>Advanced Mathematical Signal Processing</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>H. G. Feichtinger</td>
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</table>
Randomized Algorithms are algorithms that "flip coins" to take certain decisions. This concept extends the classical model of deterministic algorithms to include probabilistic elements.

Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

This colloquium for MSc and PhD students at D-ITET discusses current research topics in Translational Neuromodeling, a new discipline concerned with the development of mathematical models for diagnostics of brain diseases. The range of topics is broad, incl. statistics and computational modeling, experimental paradigms (fMRI, EEG, behaviour), and clinical questions.

Topics covered in the lecture include:
- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher’s LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

See above for prerequisites.

Courses outside the curriculum
Z Courses outside the curriculum
Dr Suitable for doctorate
O Compulsory
<table>
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<tr>
<th>Key for Hours</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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**ECTS**

- European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
### Doctoral and Post-Doctoral Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>363-1036-00L</td>
<td>Empirical Innovation Economics</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>M. Wörter</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>The course focuses on important factors that drive the innovation performance of firms, like innovation capabilities, science-industry relationships, environmental policy and it shows how innovation activities relate to firm performance and to the technological dynamic of industries. Hence, the course provides an understanding of the relationship between technical change and industrial dynamics.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>The course provides students with the basic skills to understand and assess empirically the technological activities of firms and the technological dynamics of industries.</td>
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<tr>
<td><strong>Content</strong></td>
<td>The course consists of two parts. Part I provides an introduction into important topics in the field of the economics of innovation. Part II consists of empirical exercises based on the KOF Innovation Data. In part I we will learn about ...a) market conditions that encourage firms to invest in R&amp;D (Research and Development) and develop new products. ...b) the role of universities for the technological activities of a firm (technology transfer). ...c) how technologies diffuse among firms. ...d) how the R&amp;D activities of firms are affected by economic crises and how firms finance their R&amp;D activities. ...e) how we can measure the returns to R&amp;D activities. ...f) how (environmental) policies affect the technological activities of a firm. In part II we will use the KOF Innovation Survey Data in order to assess empirically the technological activities of firms referring to the topics introduced in part I.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Will be provided in the course</td>
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<tr>
<td><strong>Literature</strong></td>
<td>Literature will be presented in the course. For an introduction into the economics of innovation see G.M. Peter Swann, The Economics of Innovation - an Introduction, Edward Elgar, 2009. For an overview of empirical innovation studies see W.M. Cohen (2010): Fifty Years of Empirical Studies of Innovation Activities and Performance, in: B.H Hall, N. Rosenberg (eds.), Handbook of Economics of Innovation, volume 1, Elsevier, pp. 129-213.</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Course is directed to advanced Master-Students and PhD Students with an interest in empirical work.</td>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>Credits</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>364-0531-00L</td>
<td>CER-ETH Research Seminar</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>H. Gersbach, A. Bommier, L. Bretschger, W. Mimra</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Research Seminar of Center of Economic Research CER-ETH</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Understanding cutting-edge results of current research in the fields of the CER-ETH Professors.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Referate zu aktuellen Forschungsergebnissen aus den Bereichen Ressourcen- und Umweltökonomie, theoretische und angewandte Wachstums- und Aussenwirtschaftstheorie sowie Energie- und Innovationsökonomie von in- und ausländischen Gastreferierenden sowie von ETH-externen Referierenden.</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Bitte spezielle Ankündigungen beachten.</td>
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<tr>
<td><strong>Literature</strong></td>
<td>Studierende des GESS-Pflichtwahlfachs sollten sich vor Beginn mit der Seminarleitung in Verbindung setzen.</td>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>Credits</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>364-0553-00L</td>
<td>Innovation in the Digital Space</td>
<td>W</td>
<td>1</td>
<td>1G</td>
<td>G. von Krogh</td>
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<tr>
<td><strong>Abstract</strong></td>
<td>The purpose of this course is to review and discuss issues in current theory and research relevant to innovation in the digital space.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Through in-depth analysis of published work, doctoral candidates will identify and appraise theoretical and empirical studies, formulate research questions, and improve the positioning of their own research within the academic debate.</td>
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<tr>
<td><strong>Content</strong></td>
<td>The Internet has a twofold impact on the way individuals and firms innovate. First, firms increasingly draw on digital technology to access and capture innovation-relevant knowledge in their environment. Second, individuals, firms, and other organizations extensively utilize the Internet to create, diffuse, and commercialize new digital products and services. During the past decade, theory and research on innovation in the digital space has flourished and generated extensive insights of relevance to both academia and management practice. This has brought us better understanding of working models, and some fundamental reasons for innovation success or failure. A host of new models and research designs have been created to explore the innovation in the digital space, but these have also brought out many open research questions. We will review some of the existing streams of work, and in the process explore a new research agenda.</td>
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<tr>
<td><strong>Format</strong></td>
<td>The course is organized in one block of 2 days. The course is a combination of pre-readings, presentations by faculty and students, and discussions. The students prepare presentations of papers in order to facilitate analysis and discussion.</td>
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</table>
Innovation, openness and search:
In this course, we will address three blocs of selected problems: (i) estimation of fixed and random effects panel data models for single equations and systems of equations; (ii) estimation of models with endogenous treatment effects or sample selection; (iii) estimation of models with interdependent data (so-called spatial models).

Students are expected to attend the doctoral course "Macroeconomic Dynamics" before registering for this workshop.

Open source and innovation models:


Motivation to Innovate:

Leadership and Governance:

364-0559-00L Dynamic Macroeconomics (Doctoral Course) W 3 credits 2V H. Gersbach
Abstract
Dynamic models and workhorses in macroeconomics
In this doctoral course, we learn dynamic general equilibrium theory and the basic workhorses in macroeconomics. After the course the participants will be able to speak the Arrow-Debreu and recursive language and apply the frameworks to interesting issues in Growth, Public Finance, Monetary Theory and Banking.

Objective
1. Introduction
2. The Arrow-Debreu Approach and Sequential Markets
3. The Neoclassical Growth Model and the Representative Agent Model
4. Mathematical Background
5. Frictions and Banking
5.1 Overview
5.2 Banks in Macroeconomic Models
5.3 Ramsey cum Banks: General Equilibrium with Banks and Outside Equity
6. Overlapping Generations Models and Models with Heterogenous Agents
7. Debates
7.1 Theory of Piketty
7.2 High Bank Equity Requirements

364-0566-00L Doctoral Workshop: Astute Modelling W 3 credits 1G H. Gersbach
Prerequisite: Students are expected to attend the course 364-0559-00L "Dynamic Macroeconomics (Doctoral Course)" before registering for this workshop.
Abstract
In this workshop, ongoing research is presented and the criteria and guidelines for astute modelling of economic, political, and social situations are discussed.
Objective
We will learn how to craft models, how to present our own research and improve our analytical skills.
Prerequisites / notice
Students are expected to attend the doctoral course "Macroeconomic Dynamics" before registering for this workshop.

364-0585-01L PhD Course: Applied Econometrics W 2 credits 2S P. Egger
Abstract
In this course, we will address three blocs of selected problems: (i) estimation of fixed and random effects panel data models for single equations and systems of equations; (ii) estimation of models with endogenous treatment effects or sample selection; (iii) estimation of models with interdependent data (so-called spatial models).
Objective
The main agenda of this course is to familiarize students with the estimation of econometric problems with three alternative types of problems: (i) estimation of fixed and random effects panel data models for single equations and systems of equations; (ii) estimation of models with endogenous treatment effects or sample selection; (iii) estimation of models with interdependent data (so-called spatial models). Students will be able to program estimation routines for such problems in STATA and apply them to data-sets. They will be given a data-set and will have to work out empirical problems in the context of a term paper.

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 402 of 1434
Lecture notes

For panel data analysis, I will rely on the book:

For sample selection and endogenous treatment effect analysis, I will rely on the book:

For spatial econometrics:
I will mostly use papers.

I will prepare a script (based on slides), covering all topics.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Type</th>
<th>Instructor</th>
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</thead>
<tbody>
<tr>
<td>364-0517-00L</td>
<td>Urban and Spatial Economics</td>
<td>3</td>
<td>W</td>
<td>R. H. van Nieuwkoop</td>
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<tr>
<td>Abstract</td>
<td>This course explores the economic factors which influence location decisions of households and firms, and it explores theories of how these decisions induce the formation of cities. The course will cover the neoclassical models of land use, concepts from the new economic geography, zoning, and transportation and traffic congestion.</td>
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<tr>
<td>Objective</td>
<td>The objective of the course is to provide graduate students with an understanding of the economic factors which give rise to urban spatial structure and the models which have been employed to study these processes. The course aims to help students develop an appreciation for the use of economic models in both positive and normative frameworks. We will assess both the history of thought regarding the role of markets in creating urban development, and we will read about modern theories of externalities and economic factors which induce agglomeration. The final section of the course will focus on transportation problems in urban areas and the use of economic models to assess public policy measures to deal with congestion and associated externalities.</td>
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<tr>
<td>Content</td>
<td>Outline of Lectures</td>
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<td></td>
<td>Topic 1: Why do cities exist?</td>
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<td>Topic 2: The Basic Muth-Mills model</td>
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<td>Topic 3: The New Economic Geography</td>
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<td>Topic 4: Business demand for land and Von Thünen's model</td>
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<td>Topic 5: Urban spatial structure</td>
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<td>Topic 6: Land use control</td>
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<td>Topic 7: City size and city growth</td>
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<td>Topic 8: Traffic externalities and congestion</td>
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<td></td>
<td>Topic 9: Public transport</td>
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|              |          | Cities, agglomeration and spatial equilibrium by E. L. Glaeser, 2008, Oxford University Press. |
|              |          | The new introduction to geographical economics, Steven Brakman, Harry Garretsen and Charles van Marrewijk, Cambridge. |

| 364-0581-00L | Microeconomics Seminar (ETH/UZH) | 0    | E    | H. Gersbach |
| Abstract     | Research Seminar research papers of leading researchers in Microeconomics are presented and discussed |
| Objective    | Research Seminar research papers of leading researchers in Microeconomics are presented and discussed |
| Content      | Invited Speakers present current research in Microeconomics |

| 364-1013-00L | Managerial Cognition | 1    | G    | S. Brusoni, D. Laureiro Martinez |
| Abstract     | The primary objective of this module is to introduce some of the major theoretical threads and controversies in the field of managerial cognition. A secondary objective is to help understand the process of empirical research that has the potential to make an impact on research and management practice. |
| Objective    | The module will seek to provide: 1) Exposure to key theoretical streams in the area. 2) Familiarity with the issues, methods, findings and gaps in the area. 3) Skills in finding insight in the literature. 4) Skills in critiquing the literature, defining research problems and proposing empirical research in this area. |
| Content      | Session 1 - Introduction to the field of managerial cognition |
|              | Session 2 - Methods to study managerial cognition |
|              | Session 3 - Sensemaking, Mindfulness and Attention |
Session 1: Introduction

This module aims to introduce major theoretical perspectives on organizational knowledge and to improve the competence of doctoral students to publish in relevant research areas. How knowledge is conceptualized and what aspects of knowledge are being studied are crucial to understand different theories and their implications in practice.

Prerequisites / notice

Assignments: At the beginning of each session, students must distribute copies of their critique of the assigned reading (please see your names at the end of each reference). The critique should be brief, extending to a maximum of one printed page. The critique is meant to serve as a starting point for the student to lead the class in a discussion of the strengths and weaknesses of the paper. For each session, students should emphasize the following topics in their critique:

Session 1: Introduction


Session 2: Some methods to study managerial cognition


Session 3: Sensemaking, Mindfulness and Attention


Assignments: At the beginning of each session, students must distribute copies of their critique of the assigned reading (please see your names at the end of each reference). The critique should be brief, extending to a maximum of one printed page. The critique is meant to serve as a starting point for the student to lead the class in a discussion of the strengths and weaknesses of the paper. For each session, students should emphasize the following topics in their critique:

Session 1:
- summarize the research problem or question
- summarize the central framework/ theory that is proposed
- list the strengths of the paper (you can use bulletpoints)
- list the weaknesses of the paper (you can use bulletpoints)

Session 2:
- Same as for session 1 with particular emphasis on the pros and cons of the method used
- Prepare at least one alternative methodology and explain why you think the alternative method(s) would have been better suited
- Three bullet points summarizing the paper weaknesses
- Prepare a one-page research idea: what would be a new research question? how would you extend the paper? what could be counterintuitive results?

Please contact Dr Daniella Laureiro Martinez for more information on this course.
Objective

This module aims:
- to provide a basic understanding of key theoretical perspectives on organizational knowledge.
- to provide insights on the research questions, methods, findings and implications of the selected papers.
- to build skills in critically analyzing the literature.
- to identify key areas.

Content

Given its prominence in the history of organization science, an impressive variety of theories have evolved that deals with organizational epistemology, the way of knowing in the organization (e.g., Brown & Duguid, 1991; Grant, 1996; Kogut & Zander, 1992; Lave & Wenger, 1991; Nonaka, 1994; Spender, 1996; Tsoukas, 1996; von Krogh et al., 1994). In this module, students will learn about various seminal contributions in the area of organizational knowledge and make connections between theory and empirical research, and identify the ongoing trends and future research directions.

Session 1: Knowledge based view of the firm.
Session 2: Knowledge sharing and transfer
Session 3: Social practice view on knowledge and knowing

Literature

Remark: The list might change. Students will be informed about the changes before the first session.


Prerequisites / notice
In each session, students will have three assignments:
1) prepare for in-depth discussion of all papers. The students are supposed to read in advance all the papers that will be presented in the sessions.
2) critically review and discuss the assigned papers. Assignments will be done after participants confirm their presence.
3) submit in advance a short critique of the assigned papers - max 2 pages.

364-1013-01L Organizations and Technical Change W 1 credit 1G S. Brusoni

Does not take place this semester.

Abstract
This 1-credit module is designed to introduce students to selected topics focused on the relationship between technical change and organizational dynamics.

Objective
The objectives of this module are:
1) to provide students with a relatively detailed understanding of some of the major theoretical perspectives and recent developments in organization theory
2) to illustrate how these perspectives have evolved
3) to discuss how they can be operationalized
4) and on these bases develop the ability of constructively criticizing them in order to learn how to 'build upon and extend'

Content
Session 1: A Man's got to do... Technology rules. Since the 1960s at least, a number of authors have relied on technological lenses to understand organizational design and organizational change. The emergence of complex technologies and production systems (e.g., chemicals, power generation, etc) led many to focus on the pivotal role played by technology in driving (determining?) economic growth and the evolution of firms and industries.

Session 2. Never Mind the Bollocks: Organizations rule. A second stream of research has instead developed the idea that technology is dominant. This approach has been used to explain various aspects of organizational change, with great impact on both strategy and technology and innovation management, but also Information Systems research and entrepreneurship

Session 3. It takes two to tango: Technological and organizational dynamics. Last, we shall discuss approaches which aim at reconciling the first two approaches, looking at the dynamic interplay of technological and organizational dynamics.
The course will be based on some chapters of the books "Advanced Microeconomic Theory" by Jehle and Reny (2011) and technology rules.

Session 1. A Man's got to do ...: Technology rules.


Session 3. It takes two to tango: technological and organizational dynamics

Prerequisites / notice
On each session, students will have two assignments: 1) prepare a summary and critique of at least one of the readings for the day; 2) come prepared to critically discuss all the readings for the day. For the critique, readings will be preassigned in advance of each sessions.

Please contact Prof Stefano Brusoni for further info about this module.

### Literature

- **364-1013-05L**
  - **Organizational Behavior**
    - **Registration closed.**
    - **W 1 credit 1S D. Unger, G. Grote**
  - **Abstract**
    - Organizational behavior concerns the study of individual and group-level processes in organizations like creativity, motivation, decision-making, and leadership. In this module an overview of major research streams and empirical paradigms in organizational behavior is provided.
  - **Objective**
    - The objectives of this course are:
      - to provide an overview of OB research
      - to discuss major research streams in OB
      - to enable students to relate their own research to concepts and methods used in OB

- **364-1013-06L**
  - **Marketing Theory**
    - **W 1 credit 1G F. von Wangenheim**
  - **Abstract**
    - The course is taught Florian Wangenheim (ETHZ)
    - It focuses on the theoretical foundations of marketing and marketing research.
  - **Objective**
    - The purpose of the course is to confront students with current theoretical thinking in marketing, and currently used theories for understanding and explaining buyer and customer behavior in response to marketing action.
  - **Content**
    - In the first class, current understanding of the marketing literature and marketing thought is discussed.
    - In the following classes, various theories are discussed, particularly in light of their importance for marketing. Economic, psychological, and sociological theory will be related to current marketing thought.

- **364-1025-00L**
  - **Advanced Microeconomics**
    - **E- 3 credits 2G A. Bomnier**
  - **Abstract**
    - The objective of the course is to provide students with advanced knowledge in some areas of micro economic theory. The course will focus on 1) Individual behavior 2) Collective behavior 3) Choice under uncertainty 4) Intertemporal choice.
  - **Objective**
    - The aim is to give to the students the opportunity to review the key results in rational individual behavior, collective models, choice under uncertainty, intertemporal choice, as well as to get some insights on more recent advances in those areas.
    - The course is therefore designed for students who have some interest for research in economics.
  - **Content**
    - The following topics will be addressed:
      - 2) Collective models. Cooperative and non cooperative models of household behavior.
      - 3) Choice under uncertainty. The foundations of expected utility theory. Some insights on other approaches to choice under uncertainty.
      - 4) Intertemporal choice. Dynamic model. Life cycle theory.
  - **Literature**
    - The course will be based on some chapters of the books "Advanced Microeconomic Theory" by Jehle and Reny (2011) and "Microeconomic Theory", by Mas-Colell, Whinston and Green (1995), as well as research articles for the most advanced parts.

- **364-1058-00L**
  - **Risk Center Seminar Series**
    - **Number of participants limited to 50.**
  - **Abstract**
    - This course is a mixture between a seminar primarily for PhD and postdoc students and a colloquium involving invited speakers. It consists of presentations and subsequent discussions in the area of modeling complex socio-economic systems and crises. Students and other guests are welcome.
Participants should learn to get an overview of the state of the art in the field, to present it in a well understandable way to an interdisciplinary scientific audience, to develop novel mathematical models for open problems, to analyze them with computers, and to defend their results in response to critical questions. In essence, participants should improve their scientific skills and learn to work scientifically on an internationally competitive level.

This course is a mixture between a seminar primarily for PhD and postdoc students and a colloquium involving invited speakers. It consists of presentations and subsequent discussions in the area of modeling complex socio-economic systems and crises. For details of the program see the webpage of the colloquium. Students and other guests are welcome.

There is no script, but a short protocol of the sessions will be sent to all participants who have participated in a particular session. Transparencies of the presentations may be put on the course webpage.

Eligible for credits and recommended

Prerequisites / notice

Participants should have relatively good mathematical skills and some experience of how scientific work is performed.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Type</th>
<th>Credits</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>364-1015-00L</td>
<td>KOF-ETH-UBHZ International Economic Policy Seminar</td>
<td>W</td>
<td>1</td>
<td>1S</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>P. Egger, J.E. Sturm</td>
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</tr>
<tr>
<td>Abstract</td>
<td>In this seminar series, which is held jointly with Prof. Dr. Wolter and Prof. Hoffmann from the University of Zurich, distinguished international researchers present their current research related to international economic policy. The participating doctoral students are expected to attend the presentations (bi-weekly). Moreover, a critical review has to be prepared for 1 of the papers presented.</td>
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<tr>
<td>Objective</td>
<td>On the one hand, participating students are exposed to research at the frontier of international economic policy research. On the other hand, skills such as critical thinking and preparing reviews are learned.</td>
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<thead>
<tr>
<th>Code</th>
<th>Title</th>
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<th>Credits</th>
<th>Semester</th>
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<tbody>
<tr>
<td>364-1064-00L</td>
<td>Inaugural Seminar - PhD Retreat</td>
<td>W</td>
<td>1</td>
<td>1S</td>
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<td></td>
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<td></td>
<td>F. von Wangenheim, A. Bommier</td>
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</tr>
<tr>
<td>Abstract</td>
<td>This course is geared towards first and second-year Ph.D. students of MTEC. It is held as in a workshop style. Students attending this seminar will benefit from interdisciplinary discussions and insights into current and future work in business and economics research.</td>
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<tr>
<td>Objective</td>
<td>The purpose of this course is to</td>
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<tr>
<td></td>
<td>- introduce students to the world of economic, management and systems research at MTEC</td>
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<td>- make students aware of silo-thinking in the specific subdisciplines and encourage them to go beyond those silos</td>
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<td>- discuss current issues with regard to substantive, methodological and theoretical domains of research in the respective fields</td>
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<thead>
<tr>
<th>Code</th>
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<th>Type</th>
<th>Credits</th>
<th>Semester</th>
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</thead>
<tbody>
<tr>
<td>364-1062-00L</td>
<td>Experimental Methods</td>
<td>W</td>
<td>1</td>
<td>1V</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>C. Waibel</td>
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<tr>
<td>Abstract</td>
<td>This course introduces PhD students into the principles of experimental methods and outlines how to prepare, conduct and evaluate an experiment.</td>
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<tr>
<td>Objective</td>
<td>This course aims to prepare PhD students for conducting their own experiment.</td>
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<tr>
<td>Content</td>
<td>1. Introduction: What are economic experiments and why to use them?</td>
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<td></td>
<td>4. Conducting experiments: Instructions, testing, recruiting, sessions.</td>
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<td></td>
<td>5. Measuring techniques: Eliciting beliefs, risk attitudes, social preferences.</td>
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<tr>
<td>Literature</td>
<td>Books:</td>
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<tr>
<td></td>
<td>Basic Articles:</td>
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<tr>
<td>Literature</td>
<td>A reading list with articles for each lecture has been published in ILIAS.</td>
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<tr>
<th>Code</th>
<th>Title</th>
<th>Type</th>
<th>Credits</th>
<th>Semester</th>
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<tbody>
<tr>
<td>364-1069-00L</td>
<td>Methods of Inference for Spatial Networks</td>
<td>W</td>
<td>2</td>
<td>1G</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>I. Prucha, P. Egger</td>
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</tr>
<tr>
<td>Abstract</td>
<td>The aim of the course is to provide a solid background to Ph.D. students in methods of inference for spatial models. Spatial models have been important tools in economics, regional science and geography in analyzing a wide range of empirical issues. The course will focus, in particular, on Cliff-Ord type spatial models. Those models have the advantage that they only require a measure of distance for modeling interaction between cross sectional units, but do not require for the data to be indexed by location. Since distance is not limited to geographic distance, but could relate to distance in technological space, product space, social distance, etc., those models can be of interest for analyzing a wide range of network generated data. This includes the analysis of peer effects in social networks. The course will discuss generalized methods of moments (GMM) and maximum likelihood (ML) estimation of spatial models from cross-sectional as well as panel data, and will discuss tests for the presence of spatial/network interdependencies.</td>
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<tr>
<td>Objective</td>
<td>Course Catalogue of ETH Zurich</td>
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Doctoral Department of Management, Technology, and Economics - Key for Type

<table>
<thead>
<tr>
<th>W+</th>
<th>Eligible for credits and recommended</th>
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</thead>
<tbody>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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<tr>
<td>O</td>
<td>Compulsory</td>
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Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
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<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Doctoral and Post-Doctoral Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Current advanced research activities in the areas of thermo- and fluid dynamics are presented and discussed, mostly by external speakers. Knowledge of advanced research in the areas of thermo- and fluid dynamics.</td>
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<tr>
<td>151-0111-00L</td>
<td>Research Seminar in Fluid Dynamics</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>P. Jenny, T. Rösgen</td>
</tr>
<tr>
<td>Abstract</td>
<td>Internal research seminar for graduate students and scientific staffs of the IFD</td>
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<tr>
<td>Objective</td>
<td>Current research projects at the Institute of Fluid Dynamics are presented and discussed.</td>
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<tr>
<td>Content</td>
<td>Exchange on current internal research projects. Training of presentation skills.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The final presentation of the project is typically at the MIT (Cambridge, US). Other competing schools include regularly Imperial College, Cambridge University, Harvard University, UC Berkeley, Princeton University, CalTech, etc.</td>
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<tr>
<td>636-0507-00L</td>
<td>Synthetic Biology II</td>
<td>W</td>
<td>4</td>
<td>4A</td>
<td>S. Panke, Y. Benenson, J. Stelling</td>
</tr>
<tr>
<td>Abstract</td>
<td>7 months biological design project, during which the students are required to give presentations on advanced topics in synthetic biology (specifically genetic circuit design) and then select their own biological system to design. The system is subsequently modeled, analyzed, and experimentally implemented. Results are presented at an international student competition at the MIT (Cambridge).</td>
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<tr>
<td>Objective</td>
<td>The students are supposed to acquire a deep understanding of the process of biological design including model representation of a biological system, its thorough analysis, and the subsequent experimental implementation of the system and the related problems.</td>
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<tr>
<td>Content</td>
<td>Presentations on advanced synthetic biology topics (eg genetic circuit design, adaptation of systems dynamics, analytical concepts, large scale de novo DNA synthesis), project selection, modeling of selected biological system, design space exploration, sensitivity analysis, conversion into DNA sequence, (DNA synthesis external), implementation and analysis of design, summary of results in form of scientific presentation and poster, presentation of results at the iGEM international student competition (<a href="http://www.igem.org">www.igem.org</a>).</td>
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<tr>
<td>Lecture notes</td>
<td>Hands on during course</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The final presentation of the project is typically at the MIT (Cambridge, US). Other competing schools include regularly Imperial College, Cambridge University, Harvard University, UC Berkeley, Princeton University, CalTech, etc.</td>
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<tr>
<td>151-0593-00L</td>
<td>Embedded Control Systems</td>
<td>W</td>
<td>4</td>
<td>6G</td>
<td>J. S. Freudenberg, M. Schmid Daners</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course provides a comprehensive overview of embedded control systems. The concepts introduced are implemented and verified on a microprocessor-controlled haptic device.</td>
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<tr>
<td>Objective</td>
<td>Familiarize students with main architectural principles and concepts of embedded control systems.</td>
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<tr>
<td>Content</td>
<td>An embedded system is a microprocessor used as a component in another piece of technology, such as cell phones or automobiles. In this intensive two-week block course the students are presented the principles of embedded digital control systems using a haptic device as an example for a mechatronic system. A haptic interface allows for a human to interact with a computer through the sense of touch. Subjects covered in lectures and practical lab exercises include: - The application of C-programming on a microprocessor - Digital I/O and serial communication - Quadrature decoding for wheel position sensing - Queued analog-to-digital conversion to interface with the analog world - Pulse width modulation - Timer interrupts to create sampling time intervals - System dynamics and virtual worlds with haptic feedback - Introduction to rapid prototyping</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes, lab instructions, supplemental material</td>
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<tr>
<td>Prerequisites / notice</td>
<td>This course is restricted to 33 students due to limited lab infrastructure. Interested students please contact Marianne Schmid (E-Mail: <a href="mailto:schmid@isd.c.mavt.ethz.ch">schmid@isd.c.mavt.ethz.ch</a>) After your reservation has been confirmed please register online at <a href="http://www.mystudies.ethz.ch">www.mystudies.ethz.ch</a>.</td>
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<tr>
<td>151-0563-01L</td>
<td>Dynamic Programming and Optimal Control</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>R. D'Andrea</td>
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<tr>
<td>Objective</td>
<td>Dynamic Programming Algorithm; Deterministic Systems and Shortest Path Problems; Infinite Horizon Problems, Bellman Equation; Deterministic Continuous-Time Optimal Control.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Detailed information can be found on the course website <a href="http://www.idsc.ETHZ.ch/education/lectures/embedded-control-systems.html">http://www.idsc.ETHZ.ch/education/lectures/embedded-control-systems.html</a></td>
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<tr>
<td>151-0906-00L</td>
<td>Frontiers in Energy Research</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>M. Mazzotti, R. S. Abhari, G. Andersson, J. Carmellet, M. Filippini</td>
</tr>
<tr>
<td>Abstract</td>
<td>PhD students at ETH Zurich working in the broad area of energy present their research to their colleagues, to their advisors and to the scientific community. Knowledge of advanced research in the area of energy.</td>
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<tr>
<td>Objective</td>
<td>PhD students at ETH Zurich working in the broad area of energy present their research to their colleagues, to their advisors and to the scientific community. Every week there are two presentations, each structured as follows: 15 min introduction to the research topic, 15 min presentation of the results, 15 min discussion with the audience. Slides will be distributed.</td>
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Data: 06.02.2019 13:00  Autumn Semester 2015  Page 408 of 1434
<table>
<thead>
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<th>Credits</th>
<th>Type</th>
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<tr>
<td>151-1049-00L</td>
<td>Seminar in Fundamentals of Process Engineering</td>
<td>1</td>
<td>W</td>
<td>P. Rudolf von Rohr</td>
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<td></td>
<td>Only for master and doctoral students of Process and Chemical Engineering.</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>This seminar covers actual subjects from the specific research areas of the</td>
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<td>laboratory of transport processes and reactions.</td>
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<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>Scientific discussion on actual research topics</td>
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<td></td>
<td><strong>Content</strong></td>
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<tr>
<td></td>
<td>The contents are announced through the group's webpage.</td>
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<td></td>
<td><strong>Lecture notes</strong></td>
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<td></td>
<td>No textbook</td>
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<tr>
<td>151-0765-00L</td>
<td>Leading and Coaching Focus Project Teams (Basic Course)</td>
<td>0</td>
<td>W</td>
<td>R. P. Haas, I. Goller</td>
</tr>
<tr>
<td></td>
<td>This course is the first part of a two-semester course.</td>
<td>1S</td>
<td>1.5G+0.5A</td>
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<tr>
<td></td>
<td>The course &quot;Leading and Coaching Focus Project Teams (Basic Course)&quot; for</td>
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<td>Autumn Semester is examined together with the course &quot;Leading and Coaching</td>
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<td>Focus Project Teams (Advanced Course)&quot; for Spring Semester with 4 ECTS.</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>Aim is enhancement of knowledge and competency regarding coaching skills.</td>
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<td></td>
<td>Participants should be coaches of focus projects.</td>
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<td></td>
<td>Topics: Overview of the role and mind set of a coach as, introduction</td>
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<td>into coaching methodology, building competencies by doing and exchanging</td>
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<td></td>
<td>good practices from former focus projects.</td>
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<td></td>
<td><strong>Objective</strong></td>
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<td></td>
<td>Basic knowledge about role and mindset of a coach;</td>
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<td></td>
<td>Knowledge and reflection about the classical problems in coaching of a</td>
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<td></td>
<td>focus project; Development of personal coaching skills;</td>
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<td></td>
<td>Knowledge and know-how about coaching methods;</td>
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<td>Reflection and exchange of experiences about personal coaching situations;</td>
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<td>Inspiration and learning from good cases regarding organizational and team</td>
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<td></td>
<td>management aspects.</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
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<tr>
<td></td>
<td>Content of both basic and advanced course (2 semester):</td>
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<tr>
<td></td>
<td>Basic knowledge about role and mindset of a coach</td>
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<tr>
<td></td>
<td>- Introduction into coaching: definition &amp; models</td>
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<td>- Introduction into the coaching process</td>
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<td>- Role of coaches between examiner and &quot;friend&quot;</td>
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<td></td>
<td>Knowledge and reflection about the problems in coaching a focus project</td>
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<td></td>
<td>- Knowledge about team development</td>
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<td>- Reflection about critical phases in the innovation process for an</td>
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<td></td>
<td>innovation team</td>
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<td></td>
<td>- Know-how about reference model for analysis critical situations</td>
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<td></td>
<td>Development of personal coaching competencies, e.g. active listening,</td>
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<td></td>
<td>asking questions, giving feedback</td>
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<td></td>
<td>- Competencies in theoretical models</td>
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<td></td>
<td>- Coaching competencies: exercises and reflection</td>
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<td>Knowledge and know-how about coaching methods</td>
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<td>- Knowledge about basic coaching methods for technical projects/innovations</td>
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<td>projects</td>
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<td></td>
<td>- Know-how about usage of methods in the coaching process</td>
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<td></td>
<td>- Facilitating decisions</td>
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<td></td>
<td>- Using and applying coaches opinions and knowledge</td>
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<td>Reflection and exchange of experiences about personal coaching situations</td>
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<td></td>
<td>- Self-reflection</td>
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<td>- Exchange of experiences in the lecture group</td>
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<td>- Good practice on organizational and management aspects</td>
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<td>- How to do system and concurrent engineering</td>
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<td>- Project planning and replanning</td>
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<td>- Facilitating conflict situations</td>
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<td>- Discussing sample cases from former teams and actual cases of participants.</td>
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<td>(access only for participants registered to this course).</td>
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<td></td>
<td><strong>Lecture notes</strong></td>
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<td></td>
<td>Slides, script and other documents will be distributed via electronically</td>
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<td>(access only for participants registered to this course).</td>
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<td>Please refer to lecture script.</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td></td>
<td>Participants (Students, PhD Students, Postdocs) should be part of the</td>
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<td></td>
<td>coaching team of focus project teams.</td>
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<tr>
<td>151-0115-00L</td>
<td>Academia Industry Modeling Week</td>
<td>2</td>
<td>Dr</td>
<td>P. Koumoutsakos</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>Focused research by teams of Master and PhD students as well as</td>
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<td>post-doctoral fellows on applied problems proposed by industrial</td>
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<td></td>
<td>partners. Industry representatives and participating faculty coordinate</td>
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<tr>
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<td>the formulation of the problem and supervise the research teams.</td>
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<td></td>
<td>Topics can cover all scientific interests and domains represented in the</td>
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<td></td>
<td>PhD program and in particular their interfaces.</td>
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<td><strong>Objective</strong></td>
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<td></td>
<td>Team work on industrial problems. Interfacing academia and industry.</td>
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<td></td>
<td>Permission of the PhD advisor and/or instructor.</td>
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<tr>
<td>151-9011-00L</td>
<td>D-MAVT Distinguished Lecture Series</td>
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<td>Dr</td>
<td>P. Koumoutsakos</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>Talks by distinguished lecturers in the Field of Mechanical and Process</td>
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<td></td>
<td>Engineering, highlighting frontiers in the field of Engineering.</td>
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<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>Become aware of frontiers in the field of Engineering.</td>
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<td></td>
<td><strong>Course Catalogue of ETH Zurich</strong></td>
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<tr>
<td>151-0833-00L</td>
<td>Principles of Nonlinear Finite-Element-Methods</td>
<td>5</td>
<td>W</td>
<td>N. Manopulo, B. Berisha</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>Most problems in engineering are of nonlinear nature. The nonlinearities</td>
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<td></td>
<td>are caused basically due to the nonlinear material behavior, contact</td>
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<td></td>
<td>conditions and instability of structures. The principles of the nonlinear</td>
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<tr>
<td></td>
<td>Finite-Element-Method (FEM) will be introduced in the scope of this</td>
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<tr>
<td></td>
<td>lecture for treating such problems.</td>
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</tbody>
</table>
Objective
The goal of the lecture is to provide the students with the fundamentals of the non linear Finite Element Method (FEM). The lecture focuses on the principles of the nonlinear Finite-Element-Method based on explicit and implicit formulations. Typical applications of the nonlinear Finite-Element-Methods are simulations of:

- Crash
- Collapse of structures
- Materials in Biomechanics (soft materials)
- General forming processes

Special attention will be paid to the modeling of the nonlinear material behavior, thermo-mechanical processes and processes with large plastic deformations. The ability to independently create a virtual model which describes the complex non linear systems will be acquired through accompanying exercises. These will include the Matlab programming of important model components such as constitutive equations.

Content
- Fundamentals of continuum mechanics to characterize large plastic deformations
- Elasto-plastic material models
- Updated-Lagrange (UL), Euler and combined Euler-Lagrange (ALE) approaches
- FEM implementation of constitutive equations
- Element formulations
- Implicit and explicit FEM methods
- FEM formulations of coupled thermo-mechanical problems
- Modeling of tool contact and the influence of friction
- Solvers and convergence
- Modeling of crack propagation
- Introduction of advanced FE-Methods

Lecture notes
yes

Literature

Prerequisites / notice
If we will have a large number of students, two dates for the exercises will be offered.

Doctoral Department of Mechanical and Process Engineering - Key for Type

<table>
<thead>
<tr>
<th>W+</th>
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<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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<td>O</td>
<td>Compulsory</td>
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Key for Hours

<table>
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<tr>
<th>V</th>
<th>lecture</th>
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<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Doctoral and Post-Doctoral Courses

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
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<th>Lecturers</th>
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<tr>
<td>327-0710-00L</td>
<td>Polymer Physics</td>
<td>E</td>
<td>0</td>
<td>2S</td>
<td>H. C. Öttinger</td>
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<tr>
<td>Abstract</td>
<td>Group seminar in polymer physics</td>
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<tr>
<td>Objective</td>
<td>Continued and deeper education in polymer physics, in particular, for Ph.D. students</td>
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<tr>
<td>Content</td>
<td>Presentation and discussion of ongoing research projects by members of the polymer physics group and external speakers</td>
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<tr>
<td>Lecture notes</td>
<td>No script</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Irregular series of presentations (see announcements)</td>
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<tr>
<td>327-0711-00L</td>
<td>Metal Physics and Technology Seminar</td>
<td>E</td>
<td>0</td>
<td>2S</td>
<td>J. F. Löffler</td>
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<tr>
<td>Abstract</td>
<td>Seminar for Ph.D. students and researchers in the area of metal physics and technology.</td>
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<tr>
<td>Objective</td>
<td>Detailed education of researchers in the area of metallic materials.</td>
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<tr>
<td>Content</td>
<td>Presentation and discussion of latest research results concerning basic principles of metals research and development of new metallic materials.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>- Requirements: Involvement in research activities.</td>
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<td></td>
<td>- Lectures are generally in English.</td>
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<td>327-0712-00L</td>
<td>Nanometallurgy</td>
<td>E</td>
<td>0</td>
<td>2S</td>
<td>R. Spolenak</td>
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<tr>
<td>Abstract</td>
<td>Seminar for Ph.D. students and researchers in the area of nanometallurgy.</td>
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<tr>
<td>Objective</td>
<td>Detailed education of researchers in the area of nanometallurgy.</td>
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<tr>
<td>327-0130-00L</td>
<td>Crystallographic Seminar</td>
<td>E</td>
<td>0</td>
<td>2S</td>
<td>W. Steurer</td>
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<tr>
<td>Abstract</td>
<td>Discussion of interesting scientific topics.</td>
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<tr>
<td>Objective</td>
<td>Awareness of topical crystallographic research</td>
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<tr>
<td>327-1300-00L</td>
<td>Joint Group Seminar</td>
<td>E</td>
<td>0</td>
<td>1S</td>
<td>M. Fiebig, N. Spaldin</td>
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<tr>
<td>Abstract</td>
<td>For D-MATL PhD students only</td>
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<tr>
<td>Objective</td>
<td>Seminar for PhD students and researchers in condensed-matter physics.</td>
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<tr>
<td>Content</td>
<td>Improving the interaction of researchers in the participating groups.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Presentation and discussion of contemporary research.</td>
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<td>Own scientific contributions.</td>
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<tr>
<td>327-0721-00L</td>
<td>Writing for Publication in Materials Science</td>
<td>Dr</td>
<td>2</td>
<td>1G</td>
<td>S. Milligan</td>
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<tr>
<td>Abstract</td>
<td>This short course is designed to help junior researchers in Materials Science develop the skills needed to write their first research articles.</td>
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<tr>
<td>Objective</td>
<td>Writing for Publication in Materials Science is a short course (5 x 4-lesson workshops) designed to help junior researchers develop the skills needed to write their first research articles. The course deals with topics such as</td>
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<td></td>
<td>- identifying target readerships and selecting outlets,</td>
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<td></td>
<td>- managing the writing process efficiently,</td>
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<td></td>
<td>- structuring the text effectively,</td>
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<td>- producing logical flow in sentences and paragraphs,</td>
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<td>- editing the text before submission, and</td>
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<td>- revising the text in response to reviewers’ comments.</td>
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<tr>
<td>Content</td>
<td>Participants will be expected to produce a number of short texts as homework assignments and will receive individual feedback on these during the course. Wherever feasible, elements of participants’ future research articles can be developed as assignments within the course, so it is likely to be particularly useful for those who have their data and are about to begin the writing process.</td>
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<td></td>
<td>Part 1: Introduction to the course; the writing context; identifying target readers and targeting journals; using model texts; activating vocabulary; writing clear English sentences; the English verb system in research publications - using tense, aspect, and voice</td>
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<td>Part 2: The writing process; structural decisions (IMRD and variations); from plan to draft; basics of paragraph structure; reader-friendly paragraph structure; patterns and tools for creating logical flow; the English noun phrase in research publications</td>
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<td>Part 3: The experimental narrative; process descriptions, explanation and justification; data commentaries; embedding figures, diagrams, etc.</td>
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<td>Part 4: Introductions; creating a research space (CARS); writing about the literature; reference, citation, paraphrase and quotation; discussion and conclusion sections; overview of abstracts and titles</td>
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<td>Part 5: Managing the strength of the claim - hedging and emphasis; punctuation and style; the editing process; responding to reviewers’ comments; preparing writing portfolios for assessment and research articles for submission.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>This short course is designed to help junior researchers in Materials Science develop the skills needed to write their first research articles.</td>
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**Doctoral Department of Materials Science - Key for Type**

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<td>Dr</td>
<td>Suitable for doctorate</td>
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<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
<td>O</td>
<td>Compulsory</td>
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Data: 06.02.2019 13:00  Autumn Semester 2015  Page 411 of 1434
### Key for Hours

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<td>G</td>
<td>lecture with exercise</td>
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<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<td>P</td>
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<td>diploma thesis</td>
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<td>R</td>
<td>revision course / private study</td>
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</table>

**ECTS**  
European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
Doctoral Department of Mathematics
Official website of the Zurich Graduate School in Mathematics:
www.zurich-graduate-school-math.ch

The list of courses (together with the allocated credit points) eligible for doctoral students is published each semester in the newsletter of the ZGSM. www.zgsm.ch/index.php?id=260&type=2

WARNING: Do not mistake ECTS credits for credit points for doctoral studies!

► Graduate School

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<td>W. Schachermayer</td>
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<td>Nachdiplom lecture</td>
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<tr>
<td>Content</td>
<td>In the traditional no arbitrage theory, which goes back to the seminal work of Black, Scholes, and Merton in the late sixties, one of the idealizing assumptions pertains to the absence of transaction costs. In this classical theory one simply assumes that at any moment of time there is one price for the underlying asset at which one may sell or buy. Since these pioneering papers there is quite some literature on the effects which arise if one deviates from this mathematically convenient but practically sometimes misleading assumption of a frictionless market. In the Nachdiplomvorlesung I shall review these results and will put emphasis on the asymptotic effects when proportional transaction costs are small, but different from zero. Special focus will be given to a series of recent papers with Christoph Czichowsky on this theory. In the course we shall also encounter some challenging issues in stochastic analysis arising from the problems arising in the theory of portfolio optimization under small transaction costs.</td>
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<tr>
<td>401-5005-65L</td>
<td>Statistics Meets Optimization: Randomization and Approximation for High-Dimensional Problems</td>
<td>Z</td>
<td>0</td>
<td>2V</td>
<td>M. Wainwright</td>
</tr>
<tr>
<td>Abstract</td>
<td>Nachdiplom lecture</td>
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<tr>
<td>Content</td>
<td>In the modern era of high-dimensional data, the interface between mathematical statistics and optimization has become an increasingly vibrant area of research. In this course, we provide some vignettes into this interface, including the following topics: (A) Dimensionality reduction via random projection. The naive idea of projecting high-dimensional data to a randomly chosen low-dimensional space is remarkably effective. We discuss the classical Johnson-Lindenstrauss lemma, as well as various modern variants that provide computationally-efficient embeddings with strong guarantees. (B) When is it possible to quickly obtain approximate solutions of large-scale convex programs? In practice, methods based on randomized projection can work very well, and arguments based on convex analysis and concentration of measure provide a rigorous underpinning to these observations. (C) Optimization problems with some form of nonconvexity arise frequently in statistical settings - for instance, in problems with latent variables, combinatorial constraints, or rank constraints. Nonconvex programs are known to be intractable in a complexity-theoretic sense, but the random ensembles arising in statistics are not adversarially constructed. Under what conditions is it possible to make rigorous guarantees about the behavior of simple iterative algorithms for such problems? We develop some general theory for addressing these questions, exploiting tools from both optimization theory and empirical process theory.</td>
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<tr>
<td>401-4589-63L</td>
<td>Calculus of Variations and Conformal Invariance</td>
<td>W</td>
<td>6</td>
<td>3V</td>
<td>T. Rivière</td>
</tr>
<tr>
<td>Abstract</td>
<td>In this course we will present the classical theory as well as more recent developments of the calculus of variation of surfaces. We will expose method mixing functional analysis and differential geometry in order to produce and describe global and local minimizers or saddle points to two dimensional Lagrangians.</td>
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<tr>
<td>Content</td>
<td>In the first part of the class we shall consider the area functional whose critical points are minimal surfaces and study the so called Plateau problem. Introduced originally by Lagrange in the 18th century. Then we will move to the systematic study of 2-dimensional conformally invariant Lagrangians and explain how they are all related to a generalized Plateau problem of prescribed mean curvature surfaces into submanifolds. In the last part of the class we will present a theory merging minimal surface theory and conformal invariance. This theory has been introduced in the early 20th century by Wilhelm Blaschke and is presently a very active field of research in geometric analysis due in particular to numerous applications in many fields of sciences such as general relativity, elasticity theory, cell biology etc.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Requirements: Fundamental knowledge in functional analysis, Fourier analysis and differential geometry (FAI and DGI)</td>
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<tr>
<td>401-4765-65L</td>
<td>Partial Differential Equations</td>
<td>W</td>
<td>7</td>
<td>4V</td>
<td>D. Christodoulou</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course covers elliptic partial differential equations in connection to differential geometry and geometric elliptic variational problems. The main topics are the uniformization theorem for 2-dim Riemannian manifolds, harmonic maps from the unit disc to a n-dim Riemannian manifold, and the theory of parametric minimal surfaces in n-dim Euclidean space.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: Real Analysis and Differential Geometry</td>
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<tr>
<td>401-3109-65L</td>
<td>Probabilistic Number Theory</td>
<td>W</td>
<td>6</td>
<td>2V</td>
<td>E. Kowalski</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course presents some aspects of probabilistic number theory, including distribution properties of the number of prime divisors of integers, probabilistic properties of the zeta function and statistical distribution of exponential sums.</td>
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<tr>
<td>Content</td>
<td>The goal of the course is to present some results of probabilistic number theory in a unified manner. The main concepts will be presented in parallel with the proof of three main theorems: (1) the Erdős-Kac theorem and its variants concerning the number of prime divisors of integers in various sequences; (2) the distribution of values of the Riemann zeta function, including Selberg’s central limit theorem for the Riemann zeta function on the critical line; (3) functional limit theorems for the paths of partial sums of families of exponential sums such as Kloosterman sums.</td>
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<tr>
<td>Literature</td>
<td>H. Iwaniec and E. Kowalski: “Analytic number theory”, and additional lecture notes will be prepared.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: Complex analysis, measure and integral; some probability theory is useful but the main concepts needed will be recalled. Some knowledge of number theory is useful but the main results will be summarized.</td>
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<tr>
<td>401-3225-60L</td>
<td>Introduction to Lie Groups</td>
<td>W</td>
<td>8</td>
<td>4G</td>
<td>M. Einsiedler</td>
</tr>
<tr>
<td>Abstract</td>
<td>Topological groups and Haar measure. Definition of Lie groups, examples of local fields and examples of discrete subgroups; basic properties; Lie subgroups. Lie algebras and relation with Lie groups; exponential map, adjoint representation. Semisimplicity, nilpotency, solvability, compactness: Killing form, Lie's and Engel's theorems. Definition of algebraic groups and relation with Lie groups. The goal is to have a broad though foundational knowledge of the theory of Lie groups and their associated Lie algebras with an emphasis on the algebraic and topological aspects of it.</td>
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<tr>
<td>Objective</td>
<td>Topological groups and Haar measure. Definition of Lie groups, examples of local fields and examples of discrete subgroups; basic properties; Lie subgroups. Lie algebras and relation with Lie groups; exponential map, adjoint representation. Semisimplicity, nilpotency, solvability, compactness: Killing form, Lie's and Engel's theorems. Definition of algebraic groups and relation with Lie groups. The goal is to have a broad though foundational knowledge of the theory of Lie groups and their associated Lie algebras with an emphasis on the algebraic and topological aspects of it.</td>
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</table>
Literature
A. Knapp: "Lie groups beyond an Introduction" (Birkhaeuser)
A.Sagle & R. Walde: "Introduction to Lie groups and Lie algebras" (Academic Press, '73)
F.Warner: "Foundations of differentiable manifolds and Lie groups" (Springer)
H. Samelson: "Notes on Lie algebras" (Springer, '90)
S.Helgason: "Differential geometry, Lie groups and symmetric spaces" (Academic Press, '78)

Prerequisites / notice
Topology and basic notions of measure theory. A basic understanding of the concepts of manifold, tangent space and vector field is useful, but could also be achieved throughout the semester.

Course webpage: http://www.math.ethz.ch/education/bachelor/lectures/hs2014/math/introlg

401-3001-61L Algebraic Topology I W 8 credits 4G P. Biran

Abstract
This is an introductory course in algebraic topology. The course will cover the following main topics: introduction to homotopy theory, homology and cohomology of spaces.

Literature

Book can be downloaded for free at:
http://www.math.cornell.edu/~hatcher/AT/ATpage.html

See also:
http://www.math.cornell.edu/~hatcher/#anchor1772800

Prerequisites / notice
General topology, linear algebra.

Some knowledge of differential geometry and differential topology is useful but not absolutely necessary.

401-4149-65L Reading Course: Geometric Invariant Theory W 2 credits 4A J. Fresán, P. S. Jossen

Abstract
Geometric Invariant Theory (GIT) is concerned with the problem of defining quotients of algebraic varieties by group actions, a crucial step in the construction of moduli spaces. Although some of the ideas go back to Hilbert, it was developed in its present form by Mumford in the 60s.

Objective
The goal of this reading course is to give an introduction to GIT, with emphasis on examples rather than the most general statements.

Content
After a couple of introductory sessions, participants will contribute with talks.

We will cover topics as:
- existence of affine and projective quotients
- the Hilbert-Mumford criterion
- construction of the moduli space of elliptic curves
- semistable vector bundles on curves

Literature


Prerequisites / notice
Basic knowledge of algebraic geometry will be assumed.

401-3523-65L Equidecomposability of Polytopes W 4 credits 2V L. Parapatits

Abstract
A polygon in the plane can be decomposed into finitely many (convex) pieces and reassembled to form another polygon if and only if they have the same area. Hilbert's third problem asks if the analogous is also true for two polyhedra in space. Whether or not it is possible to define volume without the use of approximation arguments depends on the answer to this question.

Objective
We will then describe the connection between equidecomposability and valuation theory. Finally, we will discuss some recent classification results of valuations that are invariant under certain groups of motions.

Prerequisites / notice
Office hours: Thursday 11:00 - 12:00

401-4657-00L Numerical Analysis of Stochastic Ordinary Differential Equations W 6 credits 3V+1U A. Jentzen

Abstract
Course on numerical approximations of stochastic ordinary differential equations driven by Wiener processes. These equations have several applications, for example in financial option valuation. This course also contains an introduction to random number generation and Monte Carlo methods for random variables.

Objective
The aim of this course is to enable the students to carry out simulations and their mathematical convergence analysis for stochastic models originating from applications such as mathematical finance. For this the course teaches a decent knowledge of the different numerical methods, their underlying ideas, convergence properties and implementation issues.

Content
Generation of random numbers
Monte Carlo methods for the numerical integration of random variables
Stochastic processes and Brownian motion
Stochastic ordinary differential equations (SODEs)
Numerical approximations of SODEs
Multilevel Monte Carlo methods for SODEs
Applications to computational finance: Option valuation

Lecture notes
Lecture Notes will be available.
### Literature

### Prerequisites / notice
**Prerequisites:**
- Mandatory: Probability and measure theory, basic numerical analysis and basics of MATLAB programming.
- a) mandatory courses: Elementary Probability, Probability Theory I.
- b) recommended courses: Stochastic Processes.

### 401-3651-00L Numerical Methods for Elliptic and Parabolic Partial Differential Equations
**Course audience at ETH:** 3rd year ETH BSc Mathematics and MSc Mathematics and MSc Applied Mathematics students.
**Other ETH-students are advised to attend the course “Numerical Methods for Partial Differential Equations” (401-0674-00L) in the CSE curriculum during the spring semester.

**Abstract**
This course gives a comprehensive introduction into the numerical treatment of linear and non-linear elliptic boundary value problems, related eigenvalue problems and linear, parabolic evolution problems. Emphasis is on theory and the foundations of numerical methods. Practical exercises include MATLAB implementations of finite element methods.

**Objective**
Participants of the course should become familiar with
- concepts underlying the discretization of elliptic and parabolic boundary value problems
- analytical techniques for investigating the convergence of numerical methods for the approximate solution of boundary value problems
- methods for the efficient solution of discrete boundary value problems
- implementational aspects of the finite element method

**Content**
A selection of the following topics will be covered:
- Elliptic boundary value problems
- Galerkin discretization of linear variational problems
- The primal finite element method
- Mixed finite element methods
- Discontinuous Galerkin Methods
- Boundary element methods
- Spectral methods
- Adaptive finite element schemes
- Singularly perturbed problems
- Sparse grids
- Galerkin discretization of elliptic eigenproblems
- Non-linear elliptic boundary value problems
- Discretization of parabolic initial boundary value problems

**Lecture notes**
Course slides will be made available to the audience.

**Literature**
n.a.

**Prerequisites / notice**
Practical exercises based on MATLAB

### 401-4655-64L Numerical Analysis of High-Dimensional Problems for Uncertainty Quantification
**Abstract**
In many applications of mathematics, efficient numerical methods for PDEs on high dimensional state and/or parameter spaces is required. This course provides succinct surveys of recently developed numerical methods, their computer implementation for model problems, and elements of their mathematical analysis for the efficient approximation of high- and infinite-dimensional PDE problems.
### Content

1. **Infinite-Dimensional Analysis**
   - Probability spaces and measures,
   - Tensor Products,
   - Measures on function spaces,
   - Covariance operators,
   - PCA and KL-expansions,
   - (generalized) polynomial chaos expansions,
   - Kolmogoroff N-widths

2. **Examples**
   - Parametric Approximation Problems.
   - Parametric ODEs (biochemical reaction pathways).
   - Parametric PDEs (diffusion problems with random coefficients).
   - PDEs in Parametric Domains (Scattering from random obstacles).

3. **Sparse Polynomial Chaos Approximations and Sparse Tensor Approximations of parametric PDEs.**

4. **Stochastic Galerkin Methods**

5. **Stochastic Collocation Methods**
   - Smolyak's algorithm and its generalizations;
   - sparse, adaptive interpolation algorithms

6. **Reduced Basis Methods**

7. **Monte Carlo Methods**

8. **Quasi-Monte Carlo Methods**

9. **Applications.**
   - Bayesian Inverse Problems
   - Shape Sensitivity Analysis of PDEs.
   - Optimal Control of parametric ODEs and PDEs.
   - Optimization of Parametric ODEs and PDEs.

### Literature

#### Books and Surveys:


2. F. Y. Kuo and Ch. Schwab and I. H. Sloan


4. Ch. Schwab and C. J. Gittelson

### Prerequisites / notice

**ETH BSc Math or equivalent**

and

**Num. elliptic and Parabolic PDE**

or

**Num. hyperbolic PDE**

or

**ETH Doctoral Studies in applied mathematics or CSE.**

**Programming:**

MATLAB (for MSc MATH)

or

Python and C/C++/MPI programming (MSc CSE).

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<th>Prerequisites / notice</th>
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</table>
| 401-4607-59L | **Percolation Theory**                  | W 4     | 2V   | ETH BSc Math or equivalent and
|         |                                      |         |      | Num. elliptic and Parabolic PDE or
|         |                                      |         |      | Num. hyperbolic PDE or
|         |                                      |         |      | ETH Doctoral Studies in applied mathematics or CSE.
|         |                                      |         |      | Programming:
|         |                                      |         |      | MATLAB (for MSc MATH)
|         |                                      |         |      | or
|         |                                      |         |      | Python and C/C++/MPI programming (MSc CSE).

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<th>Prerequisites / notice</th>
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</table>
| 401-3611-00L | **Advanced Topics in Computational Statistics** | W 4     | 2V   | Preliminaries:
|         |                                      |         |      | 401-2604-00L Probability and Statistics (mandatory)
|         |                                      |         |      | 401-3601-00L Probability Theory (recommended)

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<th>Prerequisites / notice</th>
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</table>
| 401-4607-59L | **Percolation Theory**                  | W 4     | 2V   | An introduction to the percolation theory.
|         |                                      |         |      | The objective is to gain familiarity with the methods of the percolation theory and to learn some of its important results.
|         |                                      |         |      | Definition of percolation, FKG and BK inequalities, Harris-Kesten Theorem, Menshikov's Theorem, uniqueness of the infinite cluster and possibly Smirnov's Theorem on the conformal invariance of the critical percolation.
|         |                                      |         |      | Preliminaries:
|         |                                      |         |      | 401-2604-00L Probability and Statistics (mandatory)
|         |                                      |         |      | 401-3601-00L Probability Theory (recommended)

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<th>Prerequisites / notice</th>
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</table>
| 401-3611-00L | **Advanced Topics in Computational Statistics** | W 4     | 2V   | This lecture covers selected advanced topics in computational statistics, including various classification methods, the EM algorithm, clustering, handling missing data, and graphical modelling.
Overview

The course is roughly divided in three parts: (1) Supervised learning via (variations of) nearest neighbor methods, (2) the EM algorithm and clustering, (3) handling missing data and graphical models.

Prerequisites

We assume a solid background in mathematics, an introductory lecture in probability and statistics, and at least one more advanced course in statistics.

Content

This course deals with modeling and analysis of variables which change randomly in time. Their essential feature is the dependence between successive observations. Applications occur in geophysics, engineering, economics and finance. Topics covered: Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. Implementations in the software R.

Methods

- Non-convex loss functions and l1-regularization
- Stability selection, multiple testing and construction of p-values
- Undirected graphical modeling
- Additive models and many smooth univariate functions
- Spectral and wavelet analysis, ARIMA-, GARCH- and state space models
- The models and techniques are illustrated using the statistical software R.

Lecture notes

Not available

Literature

A list of references will be distributed during the course.

Prerequisites / notice

Basic knowledge in probability and statistics

Content

- Time Series Analysis
  - Does not take place this semester.

Objective

Understanding of the basic models and techniques used in time series analysis and their implementation in the statistical software R.

401-3627-00L

High-Dimensional Statistics

10 credits

401-3833-65L

Chaotically Singular Spacetimes

6 credits

402-0861-00L

Statistical Physics

6 credits

Statistical analysis and modeling of observations in temporal order, which exhibit dependence. Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. Implementations in the software R.

Knowledge of methods and basic theory for high-dimensional statistical inference

Lasso and Group Lasso for high-dimensional linear and generalized linear models; Additive models and many smooth univariate functions; Non-convex loss functions and l1-regularization; Stability selection, multiple testing and construction of p-values; Undirected graphical modeling

Lectures and exercises will be completely self contained. One doesn't need to know anything about general relativity; the Einstein field equations will be introduced from scratch.

Non-convex loss functions and l1-regularization; Stability selection, multiple testing and construction of p-values; Undirected graphical modeling

More, technically, what does a generic singular point, restricting time, in solutions to the Einstein gravitational field equations look like?

Special cosmological solutions, such as Friedman's, do have singularities.

In 1965, Penrose and Hawking formulated and proved 'incompleteness' theorems that convinced even Lifshitz and Khalatnikov that singularities in time ARE a necessary property of cosmological models of the general theory of relativity. Penrose and Hawking proved, that under very general, physically reasonable conditions, a spacetime (that is, a solution to the Einstein equations) has a light ray (null geodesic) that suddenly ends ('incompleteness') sufficiently far in the past. They adroitly sidestep the problem of defining what a singularity actually is, by saying it is the 'place' where their light rays end. The proofs of incompleteness theorems are not hard. That's good.

Unfortunately, they are by their very nature completely non constructive and provide no quantitative information at all about what a 'singularity' really looks like.

In 1965, Penrose and Hawking proved, that under very general, physically reasonable conditions, a spacetime (that is, a solution to the Einstein equations) has a light ray (null geodesic) that suddenly ends ('incompleteness') sufficiently far in the past. They adroitly sidestep the problem of defining what a singularity actually is, by saying it is the 'place' where their light rays end. The proofs of incompleteness theorems are not hard. That's good.

Unfortunately, they are by their very nature completely non constructive and provide no quantitative information at all about what a 'singularity' really looks like.

In 1970, Belinskii, Khalatnikov and Lifshitz revisited the work of 1963 and found that Khalatnikov and Lifshitz had missed something and that '... we shall show that there exists a general solution which exhibits a physical singularity with respect to time.' In 1982 they revised the 1970 proposal. Their work culminates in a series of fascinating, but very, very heuristic, statements about the possible existence of a class of singular solutions to the field equations. These heuristic statements are referred to as the 'BKL Conjectures'.

Next semester, we will rigorously formulate and prove the 'BKL Conjectures' for homogeneous spacetimes. That is, we will construct a set of initial data with positive measure which evolve into homogeneous, chaotically singular spacetimes that exhibit all of the BKL phenomenology. Most importantly, there are chaotic oscillations, growing in magnitude, whose distribution is governed by the continued fraction expansion of a parameter appearing in the initial data.

The lectures will be completely self contained. One doesn't need to know anything about general relativity; the Einstein field equations will be introduced from scratch. We will classify real, three dimensional Lie algebras, introduce tensor analysis and discuss the geometry of homogeneous spacetimes. We will also derive the basic properties of continued fractions and the Gauss map $\phi:\mathbb{R}\to\mathbb{R}$ from $(0,1)\smallsetminus\mathbb{Q}$ to itself.

First year analysis and linear algebra are the only prerequisites.

Lecture notes

There will be lecture notes.

Content

This lecture covers the concepts of classical and quantum statistical physics, and some aspects of kinetic gas theory. In a more advanced part Bose-Einstein condensation, general mean field theory and critical phenomena will be addressed. Finally also various aspects of linear response theory will be discussed.

This gives an introduction in the basic concepts and applications of statistical physics for the general use in physics and, in particular, as a preparation for the theoretical solid state physics education.

Objective

This lecture gives an introduction in the basic concepts and applications of statistical physics for the general use in physics and, in particular, as a preparation for the theoretical solid state physics education.
### Interest Rate Theory

- Gain overview of interest rate markets and the corresponding financial products.

#### Content
- Basics of phenomenological thermodynamics, three laws of thermodynamics.
- Classical statistical physics: microcanonical ensembles, canonical ensembles and grandcanonical ensembles, applications to simple systems.
- Quantum statistical physics: single particle, ideal quantum gases, fermions and bosons.
- Bose-Einstein condensation: Bogolyubov theory, superfluidity.
- Critical phenomena: mean field, series expansions, scaling behavior, universality.
- Renormalization group: fixed points, simple models.
- Linear response theory; general formulation, response in mean field, sum rules, collective modes, fluctuation dissipation theorem.

#### Literature
- No specific book is used for the course. Relevant literature will be cited in the course.

### Stochastic Filtering - Theory and Applications

#### Content
- Filtering is the task of recovering unobserved state variables from noisy observations. This course covers the theoretical foundations of filtering in various levels of generality, as well as numerics and applications in statistics and finance.
- The course starts with linear (Kalman) filtering and progresses to non-linear filtering for semimartingale state and observation processes. The course also includes numerical methods like Markov chain approximations, Galerkin approximations, and particle filtering, as well as applications to financial models of, e.g., interest rates or credit risk.

#### Literature

#### Prerequisites / notice
- Prerequisites: probability theory, basic stochastic processes, basic statistics.

### Equilibrium Models in Financial Economics

#### Content
- This course provides an introduction to the equilibrium models prevalent in Financial Economics. We will start by studying optimisation problems for individual investors, and then move towards equilibrium prices, determined so that supply matches demand. The initial focus will be on conceptual issues in simple one-period models, before moving to more general settings in continuous time.

#### Literature
- None available

#### Prerequisites / notice
- Prerequisites are probability theory and stochastic processes (for which lecture notes are available).

### Mathematical Finance

#### Content
- Advanced introduction to mathematical finance: - absence of arbitrage and martingale measures - option pricing and hedging - optimal investment problems - additional topics

- Advanced level introduction to mathematical finance, presupposing knowledge in probability theory and stochastic processes

### Combinatorics I

- Congruence transformation of the plane, symmetry groups of geometric figures, Euler's function, Cayley graphs, formal power series, permutation groups, cycles, Bunsdie's lemma, cycle index, Polya's theorems, applications to graph theory and isomers.

### Combinatorics II

- Graph theory and isomers.

### Equilibrium Models in Financial Economics

#### Content
- Introduction to equilibrium models:
  1. Understand the conceptual ideas.
  2. Learn about the technical tools.
  3. Gain an overview over the problems that can be studied and solutions that can be obtained using equilibrium models.

#### Literature

#### Prerequisites / notice
- Prerequisites are probability theory and stochastic processes (for which lecture notes are available).

### Stochastic Filtering - Theory and Applications

#### Content

#### Literature

#### Prerequisites / notice
- Prerequisites: probability theory, basic stochastic processes, basic statistics.

### Interest Rate Theory

#### Content
- We introduce and discuss the most important models for interest rate markets. Emphasis will be placed both on theoretical foundations and on numerical implementation and calibration.

#### Literature
- None available

### Mathematical Finance

#### Content
- Advanced introduction to mathematical finance: - absence of arbitrage and martingale measures - option pricing and hedging - optimal investment problems - additional topics

#### Literature
- None available

#### Prerequisites / notice
- Prerequisites are probability theory and stochastic processes (for which lecture notes are available).

### Equilibrium Models in Financial Economics

#### Content
- Introduction to equilibrium models:
  1. Understand the conceptual ideas.
  2. Learn about the technical tools.
  3. Gain an overview over the problems that can be studied and solutions that can be obtained using equilibrium models.

#### Literature
- None available

#### Prerequisites / notice
- Prerequisites are probability theory and stochastic processes (for which lecture notes are available).

### Combinatorics I

#### Content
- Congruence transformation of the plane, symmetry groups of geometric figures, Euler's function, Cayley graphs, formal power series, permutation groups, cycles, Bunsdie's lemma, cycle index, Polya's theorems, applications to graph theory and isomers.

#### Literature
- None available

#### Prerequisites / notice
- Prerequisites are probability theory and stochastic processes (for which lecture notes are available).

### Combinatorics II

#### Content
- Graph theory and isomers.


**401-3953-00L Interest Rate Modeling in Discrete Time**  
W  4 credits  2V  M. V. Wüthrich

**Abstract**  
This course gives an introduction to stochastic interest rate modeling in discrete time. Starting from cash flow valuation with state price deflators, we derive the equivalent martingale measures for pricing financial instruments and derivatives of primary assets. The lecture is supplemented by several examples such as the Vasicek model where we also study model calibration.

**Objective**  
The students are familiar with the basic terminology of stochastic interest rate modeling and he is able to transfer his (financial) mathematical knowledge to real world pricing of cash flows and financial instruments.

**Content**  
The following topics are covered:
1) stochastic discounting with state price deflators  
2) equivalent martingale measures  
3) pricing of cash flows and primary assets  
4) pricing of derivatives, e.g. European put options  
5) (multi-factor) Vasicek state price deflator model  
6) Heath-Jarrow-Morton interest rate modeling framework

**Lecture notes**  
Part I of:

**Literature**  
For further reading:

**Prerequisites / notice**  
The exams ONLY take place during the official ETH examination period.  
Prerequisites: knowledge of probability theory and applied stochastic processes.

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**Seminars**

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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-4600-65L</td>
<td>Student Seminar in Probability: Gaussian Processes on Trees</td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>A.S. Sznitman, J. Bertoin, A. Knowles, P. Nolin, W. Werner</td>
</tr>
</tbody>
</table>

**Abstract**  
The seminar will discuss results concerning branching Brownian motion.

**Content**  
The student seminar in probability is held at times at the undergraduate level (typically during the spring term) and at times at the graduate level (typically during the autumn term). The themes vary each semester.

**Prerequisites / notice**  
The number of participants to the seminar is limited. Registration to the seminar will only be effective once confirmed by email from the organizers.

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**Colloquia**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>401-5000-00L</td>
<td>Zurich Colloquium in Mathematics</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>W. Werner, P. L. Bühlmann, M. Burger, S. Mishra, R. Pandharipande, University lecturers</td>
</tr>
</tbody>
</table>

**Abstract**  
The Graduate Colloquium is an informal seminar aimed at graduate students and postdocs whose purpose is to provide a forum for communicating one's interests and thoughts in mathematics.

---

**Literature**  

---

**Prerequisites / notice**  
- Option pricing and hedging for equity markets as covered, e.g., in "Mathematical Foundations for Finance".
- Itô calculus.
### 401-5600-00L Seminar on Stochastic Processes

<table>
<thead>
<tr>
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<th>Hours</th>
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</thead>
<tbody>
<tr>
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<td>1K</td>
</tr>
</tbody>
</table>

**Abstract**
Research colloquium

**Instructor(s):**
J. Bertoin, A. Knowles, A. Nikeghbali, P. Nolin, B. D. Schlein, A.S. Sznitman, W. Werner

### 401-5620-00L Research Seminar on Statistics

<table>
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<tbody>
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**Abstract**
Research colloquium

**Instructor(s):**

### 401-5910-00L Talks in Financial and Insurance Mathematics

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</thead>
<tbody>
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<td>1K</td>
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</table>

**Abstract**
Research colloquium
Regular research talks on various topics in mathematical finance and actuarial mathematics

**Instructor(s):**
P. Embrechts, M. Schweizer, M. Soner, J. Teichmann, M. V. Wüthrich

### 401-5900-00L Optimization Seminar

<table>
<thead>
<tr>
<th>Type</th>
<th>Credits</th>
<th>Hours</th>
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<tbody>
<tr>
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<td>1K</td>
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</table>

**Abstract**
Lectures on current topics in optimization

**Objective**
Expose graduate students to ongoing research activities (including applications) in the domain of optimization.

**Content**
This seminar is a forum for researchers interested in optimization theory and its applications. Speakers are expected to stimulate discussions on theoretical and applied aspects of optimization and related subjects. The focus is on efficient algorithms for continuous and discrete optimization problems, complexity analysis of algorithms and associated decision problems, approximation algorithms, mathematical modeling and solution procedures for real-world optimization problems in science, engineering, industries, public sectors etc.

**Instructor(s):**
R. Weismantel, R. Zenklusen

### Doctoral Department of Mathematics - Key for Type

<table>
<thead>
<tr>
<th>W+</th>
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<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
</tbody>
</table>

### Key for Hours

| V    | lecture                          |
| G    | lecture with exercise            |
| U    | exercise                         |
| S    | seminar                          |
| K    | colloquium                       |
| P    | practical/laboratory course      |
| A    | independent project              |
| D    | diploma thesis                   |
| R    | revision course / private study   |

### ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
1. Experimental techniques, an overview

After attending this course you understand the dynamics of essential excitation processes which occur in solids and you have an overview.

Ultrafast processes in solids are of fundamental interest as well as relevant for modern technological applications. The dynamics of the lattice, the electron gas as well as the spin system of a solid are discussed. The focus is on time resolved experiments which provide insight into pico- and femtosecond dynamics.

Content
Fundamentals of Solid State Physics: Semiconductor materials, band structures, carrier statistics in intrinsic and doped semiconductors, p-n junctions, low-dimensional structures;
Bulk Material growth of Semiconductors: Czochralski method, floating zone method, high pressure synthesis;
Semiconductor Epitaxy: Fundamentals, MBE, MOCVD, LPE;
In situ characterization: RHEED, LEED, AES, XPS, process control (temperature, thickness)

Lecture notes
https://moodle-app2.let.ethz.ch/course/view.php?id=1044

402-0526-00L Ultrafast Processes in Solids
Abstract
Ultrafast processes in solids are of fundamental interest as well as relevant for modern technological applications. The dynamics of the lattice, the electron gas as well as the spin system of a solid are discussed. The focus is on time resolved experiments which provide insight into pico- and femtosecond dynamics.

Objective
After attending this course you understand the dynamics of essential excitation processes which occur in solids and you have an overview over state of the art experimental techniques used to study fast processes.

Content
1. Experimental techniques, an overview
   2. Dynamics of the electron gas
      2.1 First experiments on electron dynamics and lattice heating
      2.2 The finite lifetime of excited states
      2.3 Detection of lifetime effects
      2.4 Dynamical properties of reactions and adsorbents
   3. Dynamics of the lattice
      3.1 Phonons
      3.2 Non-thermal melting
   4. Dynamics of the spin system
      4.1 Laser induced ultrafast demagnetization
      4.2 Ultrafast spin currents generated by lasers
      4.3 Landau-Lifschitz-Dynamics
      4.4 Laser induced switching
   5. Correlated materials

Lecture notes
will be distributed

Literature
relevant publications will be cited

Prerequisites / notice
The lecture can also be followed by interested non-physics students as basic concepts will be introduced.

This lecture is complementary to the lecture on "ultrafast methods for solid state physics" of the spring semester. Both lectures can be attended independently.

The focus of this lecture is on the physical processes whereas the focus of the "ultrafast methods for solid state physics" lecture is on the experimental techniques.

402-0402-00L Ultrafast Laser Physics
Abstract
Ultrashort pulse generation, few-cycle pulses, frequency combs, ultrafast measurement techniques

Objective
This lecture will introduce students to active ongoing research topics and provide their fundamental background.

Content
Dispersion and dispersion compensation, linear and nonlinear pulse propagation, relaxation oscillations, Q-switching, modelocking, pulse diagnostics, pulse generation in the few-optical-cycle regime (i.e. around 5 fs in the near infrared wavelength regime), carrier-envelope offset control and frequency combs, ultrafast measurement techniques (pump-probe measurements, time-resolved four-wave mixing, THz-Spectroscopy, optical coherence tomography), hot topics such as attosecond pulse generation and supercontinuum generation.

Lecture notes
Class notes will be made available.

Prerequisites / notice
Prerequisites: Basic knowledge of quantum electronics (e.g., 402-0275-00L Quantenelektronik).

402-0415-62L Terahertz Technology and Applications
Abstract
This course gives a practical overview over the generation of THz frequency electromagnetic radiation and over the applications of this radiation in a variety of fields, both scientific and industrial.

Objective
Terahertz frequency electromagnetic radiation lies at the border between electronics and optics, and as such has many unique properties that make it well-suited to study the electronic, magnetic and structural properties of many materials. The course objective is to give students the ability to identify problems that can be addressed using terahertz frequency radiation and to design (on a conceptual level) a way to implement solutions to these problems. These “problems” include both scientific (in physics, chemistry and biology) and industrial (medicine, pharmaceuticals, security) areas.

On the scientific side the applications of THz relate to understanding the electronic, structural and magnetic properties of materials by studying the optical response at low frequencies without the need for physical contact with the sample. The industrial applications tend to be more related imaging (e.g. THz-based airport scanners), but also some spectroscopy is done to identify materials.

Content
Topics to be discussed in the class include:
1) Overview of THz & interactions with matter
2) THz generation methods
3) THz optics and electronics
4) THz detection methods
5) THz applications
   - a) Spectroscopy
   - b) Imaging
The lecture "Introduction to Magnetism" is the regular course on Magnetism for the Master curriculum of the Department of Physics of ETH Zurich. With respect to the similar lecture course in previous semesters we have decided that we need to insist on the fundamental aspects of magnetism -- the Quantum mechanical aspects on one side and the statistical physics aspects on the other, which are often not comprehensively spelled out in conventional lectures on solid state physics.

The preliminary Content of the lecture in this semester is the following:
- Magnetism in Atoms (the role of magnetism in classical physics, the quantum mechanics of atoms, exchange interaction)
- Magnetism in Solids (Stoner Wohlfart model, RKKY oscillations, types of exchange in solids)
- Topological excitations (domains, domain walls, magnetic anisotropy, dipolar interaction)
- Spin Physics in the time Domain

These three Chapters will be given by A. Vindigni and are an essential introduction to more specialized Topics given in selected lectures, such as the one by R. Allenspach in FS16.

The former title of this course unit was "Fundamental Aspects of Magnetism". This lecture insists on the fundamental aspects -- Quantum physics and statistical physics of magnetism.

Applications to nanoscale magnetism will be discussed within this fundamental Approach.

---

**402-0464-00L**

**Optical Properties of Semiconductors**

- **W 8 credits 2V+2U J. Faist, A. Imamoglu**

  This course presents a comprehensive discussion of optical processes in semiconductors.

  **Objective**
  
  The rich physics of the optical properties of semiconductors, as well as the advanced processing available on these material, enabled numerous applications (lasers, LEDs and solar cells) as well as the realization of new physical concepts. Systems that will be covered include quantum dots, exciton-polaritons, quantum Hall fluids and graphene-like materials.

  **Prerequisites / notice**
  
  Prerequisites: Quantum mechanics I, Introduction to Solid State Physics

---

**402-0535-00L**

**Introduction to Magnetism**

- **W 6 credits 2V+1U D. Pescia, A. Vindigni**

  **Abstract**
  
  Atomic paramagnetism and diamagnetism, intra- and inter-atomic exchange, Stoner model, RKKY exchange interaction, Ising and Heisenberg models, the mean field approximation, spin waves, magnetic phase transition, domains and domain walls, dynamical aspects of magnetism.

  **Content**
  
  The lecture "Introduction to Magnetism" is the regular course on Magnetism for the Master curriculum of the Department of Physics of ETH Zurich. With respect to the similar lecture course in previous semesters we have decided that we need to insist on the fundamental aspects of magnetism -- the Quantum mechanical aspects on one side and the statistical physics aspects on the other, which are often not comprehensively spelled out in conventional lectures on solid state physics.

  The preliminary Content of the lecture in this semester is the following:
  - Magnetism in Atoms (the role of magnetism in classical physics, the quantum mechanics of atoms, exchange interaction)
  - Magnetism in Solids (Stoner Wohlfart model, RKKY oscillations, types of exchange in solids)
  - Topological excitations (domains, domain walls, magnetic anisotropy, dipolar interaction)
  - Spin Physics in the time Domain

  These three Chapters will be given by A. Vindigni and are an essential introduction to more specialized Topics given in selected lectures, such as the one by R. Allenspach in FS16.

---

**402-0595-00L**

**Semiconductor Nanostructures**

- **W 6 credits 2V+1U T. M. Ihn**

  The course covers the foundations of semiconductor nanostructures, e.g., materials, band structures, bandgap engineering and doping, field-effect transistors. The physics of the quantum Hall effect and of common nanostructures based on two-dimensional electron gases will be discussed, i.e., quantum point contacts, Aharonov-Bohm rings and quantum dots.

  **Objective**
  
  At the end of the lecture the student should understand four key phenomena of electron transport in semiconductor nanostructures:
  1. The integer quantum Hall effect
  2. Conductance quantization in quantum point contacts
  3. the Aharonov-Bohm effect
  4. Coulomb blockade in quantum dots

  **Content**
  
  1. Introduction and overview
  2. Semiconductor crystals: Fabrication and band structures
  3. k-p-theory, effective mass
  4. Envelope functions and effective mass approximation, heterostructures and band engineering
  5. Fabrication of semiconductor nanostructures
  6. Electrostatics and quantum mechanics of semiconductor nanostructures
  7. Heterostructures and two-dimensional electron gases
  8. Drude Transport
  9. Electron transport in quantum point contacts; Landauer-Büttiker description
  10. Ballistic transport experiments
  11. Interference effects in Aharonov-Bohm rings
  12. Electron in a magnetic field, Shubnikov-de Haas effect
  13. Integer quantum Hall effect
  14. Coulomb blockade and quantum dots

  **Lecture notes**
  

  **Literature**
  
  In addition to the lecture notes, the following supplementary books can be recommended:

  **Prerequisites / notice**
  
  The lecture is suitable for all physics students beyond the bachelor of science degree. Basic knowledge of solid state physics is recommended. Very ambitious students in the third year may be able to follow. The lecture can be chosen as part of the PhD-program. The course is taught in English.

---

**402-0541-65L**

**Accelerator-Based Science from Quantum Information to Biophysics**

- **W 6 credits 2V+1U G. Aeppli, S. Johnson, J. Mesot**

  The readings for the course will be selected from several different texts. All of these are available electronically via the ETH library system. In addition to the lecture notes, the following supplementary books can be recommended.

  **Literature**
  
This course gives a survey of current research topics using accelerator-based probes (photons, neutrons, muons) to study problems in condensed matter and biophysics.

The course aims to give students the ability to follow and explain on a conceptual level the ways in which accelerator-based facilities (photon, neutron and muon sources) enable the study of various problems in a wide range of fields, including for example quantum information theory, solid state dynamics in superconductors and low dimensional systems, quantum phase transitions, as well as structural biology.

The course will discuss several current examples of research using accelerator facilities highlighting different technologies and their applications. Specific attention will be given to x-ray spectroscopy and scattering experiments conducted at synchrotrons and x-ray Free Electron Lasers, as well as neutron scattering experiments at spallation sources and muon spin rotation.

Prerequisites / notice

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Type</th>
<th>Credits</th>
<th>CPs</th>
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<tr>
<td>402-0715-00L</td>
<td>Low Energy Particle Physics</td>
<td>W</td>
<td>6</td>
<td>2+1U</td>
<td>S. Antognini, F. Piegza</td>
</tr>
<tr>
<td>402-0767-00L</td>
<td>Neutrino Physics</td>
<td>W</td>
<td>6</td>
<td>2+1U</td>
<td>A. Rubbia</td>
</tr>
<tr>
<td>402-0883-63L</td>
<td>Symmetries in Physics</td>
<td>W</td>
<td>6</td>
<td>2+1U</td>
<td>N. Beisert</td>
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<td>402-0898-00L</td>
<td>The Physics of Electroweak Symmetry Breaking</td>
<td>W</td>
<td>6</td>
<td>2+1U</td>
<td>not available</td>
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<tr>
<td>402-0899-65L</td>
<td>Higgs Physics</td>
<td>W</td>
<td>6</td>
<td>2+1U</td>
<td>M. Donegà, M. Grazzini</td>
</tr>
</tbody>
</table>
With this course the students will receive a detailed introduction to the physics of the Higgs boson in the Standard Model. They will acquire the necessary theoretical background to understand the main production and decay channels of the Higgs boson at high-energy colliders, and the corresponding experimental signatures.

### Content
- **Theory part:**
  - the Standard Model and the mass problem: WW scattering and the no-lose theorem
  - the Higgs mechanism and its implementation in the Standard Model
  - radiative corrections and the screening theorem
  - theoretical constraints on the Higgs mass; the hierarchy problem
  - Higgs production in e+e- collisions
  - Higgs production at hadron colliders
  - Higgs decays to fermions and vector bosons
  - Higgs differential distributions, rapidity distribution, pt spectrum and jet vetoes
  - Higgs properties and beyond the Standard Model perspective
  - Outlook: The Higgs sector in weakly coupled and strongly coupled new physics scenarios.

- **Experimental part:**
  - Introductory material:
    - reminders of detectors/accelerators
    - reminders of statistics: likelihoods, hypothesis testing
    - reminders of multivariate techniques: Neural Networks, Decision Trees
  - **Main topics:**
    - pre-history (pre-LEP)
    - LEP1: measurements at the Z-pole
    - LEP2: towards the limit mH<114 GeV
    - TeVatron searches
    - LHC:
      - main channels overview
      - dissect on analysis
      - combine information from all channels
      - differential measurements
    - Future:
      - pseudo-observables / EFT
      - Beyond Standard Model

### Literature
- **Hot Topics in Astrophysics**
  
- **Observational Techniques in Astrophysics**
  
- **Statistical Methods in Cosmology and Astrophysics**

### Prerequisites / notice
- Prerequisites: Quantum Field Theory I, Phenomenology of Particle Physics
- Prerequisites: Astrophysics I is required and Astrophysics II is recommended. Some programming skills in Python or similar languages are necessary.
Content
1) Neuroanatomy I
2) Neuroanatomy II
3) Neurogenesis
4) Axon guidance
5) Action and language development
6) Circadian rhythms
7) Synaptic plasticity
8) Synaptic transmission
9) Neural circuits in vivo
10) Visual pathways and visual processing
11) Somatosensory system
12) Vestibular system
13) Sleep
14) Learning and Memory, mice and human

Prerequisites / notice
For doctoral students of the Neuroscience Center Zurich (ZNZ).

W 2 credits 2V

Abstract
The goal of this Advanced Course in Neurobiology is to provide students with a broader knowledge in several important areas of neurobiology. The course consists of four parts: Part I deals with various topics in developmental neurobiology. Part II is devoted to aspects of signal transduction. Part III focuses on synaptic transmission. Part IV gives deeper insights into systems neuroscience.

Objective
This credit point course is designed for doctoral students who have successfully completed the Introductory Course in Neuroscience at the Neuroscience Center Zürich. The goal is to provide students with a broader and deeper knowledge in several important areas of neurobiology.

Prerequisites / notice

402-0620-00L Current Topics in Accelerator Mass Spectrometry and Their Applications M. Christl, S. Willett
E- 0 credits 1S

Abstract
The seminar is aimed at all students who, during their studies, are confronted with age determination methods based on long-living radionuclides found in nature. Basic methodology, the latest developments, and special examples from a wide range of applications will be discussed.

Doctoral Department of Physics - Key for Type

<table>
<thead>
<tr>
<th>Key for Type</th>
<th>Description</th>
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<tbody>
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<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
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</tr>
<tr>
<td>Z</td>
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<td>Dr</td>
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<td>O</td>
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Key for Hours

<table>
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<tbody>
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<td>S</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Observation networks and numerical climate and forecasting models deliver large primary datasets. The use of this data in practice and in research requires specific techniques of statistical data analysis. This lecture introduces a range of frequently used techniques, and enables students to apply them and to properly interpret their results.

### Current Topics in Grassland Sciences (HS)

**Number**: 751-4003-01L  
**Title**: Current Topics in Grassland Sciences (HS)  
**Type**: W  
**ECTS**: 2  
**Hours**: 2S  
**Lecturers**: N. Buchmann

**Abstract**
Research results in agro- and forest ecosystem sciences will be presented by experienced researchers as well as Ph.D. and graduate students. Citation classics as well as recent research results will be discussed. Topics range from plant ecophysiology, biodiversity and biogeochemistry to management aspects in agro- and forest ecosystems.

**Objective**
Students will be able to understand and evaluate experimental design and data interpretation of on-going studies, be able to critically analyze published research results, practice to present and discuss results in the public, and gain a broad knowledge of recent research and current topics in agro- and forest ecosystem sciences.

**Content**
Research results in agro- and forest ecosystem sciences will be presented by experienced researchers as well as Ph.D. and graduate students. Citation classics as well as recent research results will be discussed. Topics range from plant ecophysiology, biodiversity and biogeochemistry to management aspects in agro- and forest ecosystems.

**Lecture notes**
Prerequisites: Basic knowledge of plant ecophysiology, terrestrial ecology and management of agro- and forest ecosystems. Course will be taught in English.

### Challenges in Plant Sciences

**Number**: 551-0205-00L  
**Title**: Challenges in Plant Sciences  
**Type**: W  
**ECTS**: 2  
**Hours**: 2K  
**Lecturers**: W. Gruissem, M. Kreuzer, O. Voinnet, A. Walter, S. C. Zeeman

**Abstract**
The colloquium introduces students to the disciplines in plant sciences and provides integrated knowledge from the molecular level to ecosystems and from basic research to applications, making use of the synergies between the different research groups of the PSC. The colloquium offers a unique chance to approach interdisciplinary topics as a challenge in the field of plant sciences.

**Objective**
Major objectives of the colloquium are:

- introduction of graduate students and Master students to the broad field of plant sciences
- promotion of an interdisciplinary and integrative teaching program
- promotion of active participation and independent work of students
- promotion of presentation and discussion skills
- increased interaction among students and professors

**Content**
Challenges in Plant Sciences will cover the following topics:
- Chemical communication among plants, insect and pathogens.
- Specificity in hormone signaling.
- Genetic networks.
- Plant-plant interactions.
- Resilience of tropical ecosystems.
- Regulatory factors controlling cell wall formation.
- Chlorophyll breakdown.
- Innate immunity.
- Disease resistance genes.
- Sustainable agroecosystems.

### Aerosols I: Physical and Chemical Principles

**Number**: 402-0572-00L  
**Title**: Aerosols I: Physical and Chemical Principles  
**Type**: W  
**ECTS**: 4  
**Hours**: 2V+1U  
**Lecturers**: M. Gysel, U. Baltensperger, H. Burtscher

**Abstract**
Aerosols I deals with basic physical and chemical properties of aerosol particles. The importance of aerosols in the atmosphere and in other fields is discussed.

**Objective**
Knowledge of basic physical and chemical properties of aerosol particles and their importance in the atmosphere and in other fields is discussed.

**Content**

**Literature**
- Material is distributed during the lecture

### Analysis of Climate and Weather Data

**Number**: 701-1253-00L  
**Title**: Analysis of Climate and Weather Data  
**Type**: W  
**ECTS**: 3  
**Hours**: 2G  
**Lecturers**: C. Frei

**Abstract**
Observation networks and numerical climate and forcasting models deliver large primary datasets. The use of this data in practice and in research requires specific techniques of statistical data analysis. This lecture introduces a range of frequently used techniques, and enables students to apply them and to properly interpret their results.

**Objective**
Observation networks and numerical climate and forcasting models deliver large primary datasets. The use of this data in practice and in research requires specific techniques of statistical data analysis. This lecture introduces a range of frequently used techniques, and enables students to apply them and to properly interpret their results.
Introduction into the theoretical background and the practical application of methods of data analysis in meteorology and climatology.

Topics: exploratory methods, hypothesis tests, analysis of climate trends, measuring the skill of climate and forecasting models, analysis of extreme events, principal component analysis and maximum covariance analysis.

The lecture also provides an introduction into R, a programming language and graphics tool frequently used for data analysis in meteorology and climatology. During hands-on computer exercises the student will become familiar with the practical application of the methods.

Lecture notes
Documentation and supporting material include:
- documented view graphs used during the lecture
- exercise sets and solutions
- R-packages with software and example datasets for exercise sessions

All material is made available via the lecture web-page.

Suggested literature:

Prerequisites / notice
Prerequisites: Atmosphäre, Mathematik IV: Statistik, Anwendungsnahes Programmieren.

701-1235-00L Cloud Microphysics W 4 credits 2V+1U U. Lohmann, B. Sierau

Abstract
Clouds are a fascinating climate phenomenon central to the hydrological cycle and the Earth’s radiation balance. Interactions between cloud particles can result in precipitation, glaciation or evaporation of the cloud depending on its microstructure and microphysical processes. In this course the sought-after topic of ice formation in clouds is studied from a theoretical and empirical perspective.

Objective
Students will gain an appreciation and understanding of the complex processes in clouds and the necessary physical phenomenon that are involved and need to be accounted for in order to study cloud and precipitation formation.

Content
Microstructure of clouds and precipitation, aerosol activation to form cloud droplets, ice crystal nucleation (homogeneous freezing of supercooled aerosol and heterogeneous freezing), precipitation formation

Lecture notes
Powerpoint slides will be made available

Literature

Prerequisites / notice
At least one introductory course in Atmospheric Science or Instructor’s consent.

701-1221-00L Dynamics of Large-Scale Atmospheric Flow W 4 credits 2V+1U H. Wernli, S. Pfahl

Abstract
Dynamic, synoptic Meteorology

Objective
Understanding the dynamics of large-scale atmospheric flow

Content
Dynamical Meteorology is concerned with the dynamical processes of the earth’s atmosphere. The fundamental equations of motion in the atmosphere will be discussed along with the dynamics and interactions of synoptic system - i.e. the low and high pressure systems that determine our weather. The motion of such systems can be understood in terms of quasi-geostrophic theory. The lecture course provides a derivation of the mathematical basis along with some interpretations and applications of the concept.

Lecture notes
Dynamics of large-scale atmospheric flow

Literature
- Pichler H., Dynamik der Atmosphäre, Bibliographisches Institut, 456 pp. 1997

Prerequisites / notice
Physics I, II, Environmental Fluid Dynamics

701-1251-00L Land-Climate Interactions W 3 credits 2G S. I. Seneviratne, E. L. Davin

Abstract
The purpose of this course is to provide fundamental background on the role of land surface processes (vegetation, soil moisture dynamics, land energy and water balances) for the climate system. The course consists of 2 contact hours per week, including 2 computer exercises.

Objective
The students can understand the role of land processes and associated feedbacks for the climate system.

Lecture notes
Powerpoint slides will be made available

Prerequisites / notice

701-1237-00L Solar Ultraviolet Radiation W 1 credit 1V J. Gröbner

Abstract
The lecture will introduce the student to the thematics of solar ultraviolet radiation and its effects on the atmosphere and the biosphere. The lecture will cover the modeling and the measurement of solar ultraviolet radiation. The instruments used for solar radiation measurements will also be introduced.

Objective
The lecture should enable the student to understand the specific problematics related to solar ultraviolet radiation and its interaction with the atmosphere and the biosphere.
1) Einführung in die Problematik Motivation
   - Begriffe (UV-C, UV-B, UV-A,...)
   - Einfluss der UV Strahlung auf Biosphäre (Mensch, Tier, Pflanzen)
   - Positive und schädliche Effekte
   - Wirkungsspektrum, Konzept, Beispiele
   UVIndex:

2) Geschichtlicher Rückblick
   - Rayleigh - Himmelsblau
     - 1907: Dorno, PMOD
     - 1970: Bener, PMOD
     - 1980: Berger, Erythemal sunburn meter
     - 1990: State of the Art

3) Extraterrestrische UV Strahlung
   - Spektrum
   - Energieverteilung
   - Variabilität (Spektral, zeitlich, relativ zu Totalstrahlung)
   - Satellitenmessungen, Übersicht

4) Einfluss der Atmosphäre auf die solare UV Strahlung
   - Atmosphärenaufbau
     - Beinflussende Parameter (Ozon, Wolken, ...)
   - Ozon, Stratosphärisches versus troposphärisches
   - Geschichte: Ozondepletion, Polare Ozonlücken und Einfluss auf die UV Strahlung
     - Wolken
     - Aerosole
     - Rayleighstreuung
     - Trends (Ozon, Wolken, Aerosole)
   - Radiation Amplification Factor (RAF)

5-6) Strahlungstransfer
   - Strahlungstransferegliechung
   - Modellierung, DISORT
   - libRadtran, TUV, FASTRT
   - Parameter
   - Sensitivitätsstudien
   - Vergleiche mit Messungen
   - 3-D Modellierung (MYSTIC)
   - Beer-Lambert Gesetz

7) Strahlungsmessungen
   - Instrumente zur Strahlungsmessung
     - Messgrössen: Irradiance (global, direct, diffus), radiance, aktinischer Fluss
     - Horizontale und geneigte Flächen
   - Generelle Problematic: Freiluftmessungen...
   - Qualitätssicherung

8) Solare UV Strahlungsmessungen
   - Problematik: Dynamik, Spektrale Variabilität, Alterung
     - Stabilität
     - Spezifische Instrumente: Filterradiometer, Spektroradiometer, Dosimetrie
     - Übersicht Aufbau und Verwendung

9-10) Solare UV Strahlungsmessgeräte
   - Spektroradiometer, Filterradiometer (Breit und schmalbandig)
   - Charakterisierung
   - Kalibriermethoden (Im Labor, im Feld)
   - Qualitätssicherung, Messkampagnen

11-12) Auswerteverfahren
   - Atmosphärische Parameter aus Strahlungsmessungen
     - Ozon, SO2
     - Albedo (Effektiv versus Lokal)
     - Aerosol Parameter (AOD, SSA, g, Teilchenverteilungen)
   - Zusammenspiel Messungen - Modellierung
   - Aktinische UV-Strahlungsfüsse und Bestimmung von atmosphärischen Photolysefrequenzen

13) UV Klimatologie
   - Trends
   - UV Klimatologie durch Messnetze
   - UV Klimatologie durch Satellitenmessungen am Beispiel von TOMS
   - Modellierung am Beispiel Meteosat-JRC
   - UV Rekonstruktionen

14) Aktuelle Forschungen
   - Internationale Projekte, Stand der Forschung

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**701-1233-00L Stratospheric Chemistry**

**W 4 credits 2V+1U T. Peter, A. Stenke**

**Abstract**


**Objective**

The lecture gives an overview on the manifold reactions which occur in the gas phase, in stratospheric aerosol droplets and in polar cloud particles. The focus is on the chemistry of stratospheric ozone and its influence through natural and anthropogenic effects. Especially the intercontinental air traffic and the ozone depletion caused by FCKW CFC in the mid-latitude and the polar regions as well as coupling with the greenhouse effect.
The course introduces the scientific concepts and typical applications of tracers in biogeochemistry. The course covers stable and isotopic and organic tracers in biogeochemistry. Isotopic and Organic Tracers in Biogeochemistry

R. Kipfer

The students are exposed to different atmospheric science topics and learn how to take part in scientific discussions. In this seminar, the process of writing a scientific proposal will be introduced. The essential elements of a proposal, including the peer review process, will be outlined and class exercises will train scientific writing skills. Knowledge exchange between class participants is promoted through the preparation of a master thesis proposal and evaluation of each other's work.

Prerequisites / notice

Attendance is mandatory.

701-1211-01L Master's Seminar: Atmosphere and Climate 1

Abstract

In this seminar, the process of writing a scientific proposal will be introduced. The essential elements of a proposal, including the peer review process, will be outlined and class exercises will train scientific writing skills. Knowledge exchange between class participants is promoted through the preparation of a master thesis proposal and evaluation of each other's work.

Objective

Training scientific writing skills.

Content

In this seminar, the process of writing a scientific proposal will be introduced. The essential elements of a proposal, including the peer review process, will be outlined and class exercises will train scientific writing skills. Knowledge exchange between class participants is promoted through the preparation of a master thesis proposal and evaluation of each other's work.

Prerequisites / notice

Attendance is mandatory.

651-4095-01L Colloquium Atmosphere and Climate 1

Abstract

The colloquium is a series of scientific talks by prominent invited speakers assembling interested students and researchers from around Zürich. Students take part of the scientific discussions.

Objective

The students are exposed to different atmospheric science topics and learn how to take part in scientific discussions.

Biogeochemistry and Pollutant Dynamics

701-0534-00L Chemical Kinetics in Terrestrial and Aquatic Systems

Abstract

Introduction in mechanisms of kinetically controlled processes in terrestrial and aquatic systems and their quantitative treatment.

Objective

Introduction in mechanisms of kinetically controlled processes in terrestrial and aquatic systems and their quantitative treatment.

Content

Mechanisms of kinetically controlled processes such as reactions in the aquatic phase (complexation, redox processes); mineral surface reactions (adsorption, dissolution, precipitation, redox processes); reactions at gas/water interfaces; photochemical reactions; microbial/enzymatic reactions; reactions in stratified environments (soils, sediments).

Lecture notes

Distribution during lecture and on a course web-page


Prerequisites / notice

Lecture for advanced and doctoral students. Course language is English. Lecture will be taught as a block in February. Exact dates will be announced.

701-1341-00L Water Resources and Drinking Water

Abstract

The course covers quantitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap.

Objective

The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality.

Content

The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. The various water resources, particularly groundwater and surface water, are discussed as part of the natural water cycle influenced by anthropogenic activities such as agriculture, industry, urban water systems. Furthermore legislation related to water resources and drinking water will be discussed. The lecture is focused on industrialized countries, but also addresses global water issues and problems in the developing world. Finally unit processes for drinking water treatment (filtration, adsorption, oxidation, disinfection etc.) will be presented and discussed.

Lecture notes

Handouts will be distributed.

Prerequisites / notice

Will be mentioned in handouts.

701-1313-00L Isotopic and Organic Tracers in Biogeochemistry

Abstract

The course introduces the scientific concepts and typical applications of tracers in biogeochemistry. The course covers stable and radioactive isotopes, geochemical tracers and biomarkers and their application in biogeochemical processes as well as regional and global cycles. The course provides essential theoretical background for the lab course “Isotopic and Organic Tracers Laboratory”.

Objective

The course aims at understanding the fractionation of stable isotopes in biogeochemical processes. Students learn to know the origin and decay modes of relevant radiogenic isotopes. They discover the spectrum of possible geochemical tracers and biomarkers, their potential and limitations and get familiar with important applications.
The goal of this course is to investigate, as a group, a particular set of carbon mitigation/sequestration options and to evaluate their

**ECTS**

The reduction of CO₂ emissions is the only option for keeping future climate change within reasonable bounds. In this course, we will

**3G**

Selected handouts (lecture notes, literature, exercises) will be distributed during the course.

**Biogeochemistry of Trace Elements**

A. Voegelin

The course deals in-depth with the major biogeochemical processes controlling the cycling of different groups of trace elements (heavy metals, redox-sensitive trace elements, chalcophile elements) in the environment. The students gain a detailed understanding of the sources and the cycling of trace elements in the terrestrial and aquatic environment. The interaction of environmentally important trace elements with abiotic and biotic geosphere components as well as their abiotically and biotically driven transformations will be discussed. Relevant methods/techniques to study these processes will be presented.

**Prerequisites / notice**

Students are expected to be familiar with the concepts of aquatic or soil chemistry covered in the respective classes at the bachelor level.

This lecture is a prerequisite for attending the laboratory course "Trace elements laboratory".

The reduction of CO₂ emissions is the only option for keeping future climate change within reasonable bounds. In this course, we will

**Carbon Mitigation**

N. Gruber

The course deals in-depth with the major biogeochemical processes controlling the cycling of different groups of trace elements (heavy metals, redox-sensitive and chalcophile elements) in the environment. Sources and cycling of trace elements as related to interactions with abiotic and biotic geosphere components, and abiotically and biotically driven transformations will be discussed. The techniques most commonly used to study these processes will be presented as well.

**Prerequisites / notice**

Students are expected to be familiar with the concepts of aquatic or soil chemistry covered in the respective classes at the bachelor level.

This lecture is a prerequisite for attending the laboratory course "Trace elements laboratory".

**Ecology and Evolution**

F. Knaus

Birds and plants are used as main example guiding through different case studies. Hosts will include animals, plants and humans. Resistance, metapopulations, networks, and competition will be presented and discussed. Pathogens will include bacteria, viruses and fungi. Hosts will include animals, plants and humans.

**Prerequisites / notice**

Exam: No final exam. Pass/No-Pass is assigned based on the quality of the presentation and ensuing discussion.

**Ecology and Evolution**

F. Knaus

The course provides methods and tools for ecological evaluations dealing with nature conservation or landscape planning. It covers census methods, ecological criteria, indicators, indices and critically appraises objectivity and accuracy of the available methods, tools and procedures. Birds and plants are used as main example guiding through different case studies.

**Prerequisites / notice**

Powerpoint slides are available on the webpage. Additional documents are handed out as copies.

**Literature**

Basic literature and references are listed on the webpage.

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 430 of 1434
### Research Seminar: Ecological Genetics

**W** 2 credits 1S  A. Widmer, S. Fior

*Minimum number of participants is 4.

#### Abstract
In this research seminar we will critically discuss current topics in Ecological Genetics using publications from the leading scientific journals in this field.

#### Objective
It is our aim that participants gain insight into the current research topics and knowledge available in Ecological Genetics and learn to critically assess and appreciate scientific publications in this field.

#### Lecture notes
none

#### Literature
will be distributed

#### Prerequisites / notice
Active participation in the discussions is a prerequisite for this course.

### Genetic Diversity: Techniques

**W** 1 credit 2U  A. M. Minder Pfyl

*Number of participants limited to 8.
Selection of the students: order of registration
Registration until 26.10.15

#### Abstract
This course provides training for advanced students (master, doctoral or post-doctoral level) in how to measure and collect genetic diversity data from populations, experiments, field and laboratory. Different DNA/RNA extraction, genotyping and gene expression techniques will be addressed. Choice of topic by demand and/or availability of data.

#### Objective
To learn and improve on standard and modern methods of genetic data collection. Examples are: use of pyrosequencing, expression analysis, SNP-typing, next-generation sequencing, etc.

A course for practitioners.

#### Content
After an introduction (one afternoon), students will have 3 weeks to work independently or in groups through different protocols. At the end of the whole group meets for another afternoon to present the techniques/results and to discuss the advantages and disadvantages of the different techniques. Techniques addressed are: RNA/DNA extractions and quality control, SNP genotyping, pyrosequencing, real-time qPCR.

#### Lecture notes
Material will be handed out in the course.

#### Literature
Material will be handed out in the course.

#### Prerequisites / notice
Two afternoons are held in the class. The lab work will be done from the students according to their timetable, but has to be finished after 3 weeks. Effort is roughly 1-2 days per week, depending on the skills of the student.

### Landscape Genetics

**W** 2 credits 3G  R. Holderegger, J. Bolliger, F. Gugerli

*Number of participants limited to 14.

#### Abstract
This six-day winter school aims at teaching advanced Master students, PhD students and postdocs on landscape genetics. It provides both theoretical background as well as hands-on exercises on major topics of contemporary landscape genetics and landscape genomics such as landscape effects on gene flow and adaptive genetic variation in a landscape context.

#### Objective
Landscape genetics is an evolving scientific field of both basic and applied interest. Researchers as well as conservation managers make increasing use of landscape genetic thinking and methods. Landscape genetics builds on concepts and methods from landscape ecology and population genetics. This winter school introduces advanced students to major concepts and methods of landscape genetics and genomics, i.e. (i) the study of landscape effects on dispersal and gene flow and (ii) the study of the interactions between the environment and population genetics. The winter school focuses on currently used methods and hands-on exercises. It is specifically aimed at the needs of advanced students (Master, PhD and postdocs).

#### Content
**Themes:**
1. Genetic data: estimates of gene flow; genetic distances; assignment tests and parentage analysis.
2. Landscape data: landscape resistance and least cost paths; transects.
3. Landscape genetic analysis of gene flow: partial Mantel tests and causal modeling; multiple regression on distance matrices and mixed effects models.
4. Networks and graph theory.
5. Landscape genomics: adaptive genetic variation; outlier detection; environmental association.
6. Overlays: Bayesian clustering; barrier detection; kriging.

#### Lecture notes
Hand-outs will be distributed.

#### Literature
The course requires 4 hours of preparatory reading of selected papers on landscape genetics. These papers will be distributed by e-mail.

#### Prerequisites / notice
Grading will be according to a short written report (4 pages) on one of the themes of the course (workload: about 8 hours) and according to student contributions during the course.

#### Prerequisites / notice
Activ participation is a prerequisite for this course. Students should have basic knowledge in population genetics, GIS and R.

### Experimental Ecology: Evolution and Ecology

**W** 2 credits 2K  S. Bonhoeffer

*Interaction seminar. Student-mediated presentations, guests and discussions on current themes in ecology, evolutionary and population biology.

#### Objective
Getting familiar with scientific arguments and discussions. Overview of current research topics. Making contacts with fellow students in other groups.

#### Content
Scientific talks and discussions on changing subjects.

#### Lecture notes
None

#### Literature
None

For information and details: http://www.eco.ethz.ch/news/2is or contact: Lehre-eve@env.ethz.ch

#### Human-Environment Systems

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<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</table>
| 701-1651-00L | Environmental Governance  | W    | 3    | 2G    | E. Lieberherr, G. de Bure

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 431 of 1434
The course addresses environmental policies, focusing on new approaches, which are generally summarized as environmental governance. The course also provides a broader introduction to social science concepts to provide students with tools to analyze environmental policy processes and assess the key features of environmental governance by examining various practical environmental policy examples.

Objective
To understand how an environmental problem may (or not) become a policy and explain political processes, using basic concepts and techniques from political science.

To analyze the evolution as well as the key elements of environmental governance.

To be able to identify the main challenges and opportunities for environmental governance and to critically discuss them with reference to various practical policy examples.

Content
Improvements in environmental quality and sustainable management of natural resources cannot be achieved through technical solutions alone. The quality of the environment and the achievement of sustainable development strongly depend on human behavior and specifically the human uses of nature. To influence human behavior, we rely on public policies and other societal rules, which aim to steer the way humans use natural resources and their effects on the environment. Such steering can take place through government intervention alone. However, this often also involves governance, which includes the interplay between governmental and non-governmental actors, the use of diverse tools such as emission standards or financial incentives to steer actors’ behavior and can occur at the local, regional, national or international level.

In this course, we will address both the practical aspects of as well as the scientific debate on environmental governance. The course gives future environmental experts a strong basis to position themselves in the governance debate, which does not preclude government but rather involves a spectrum from government to governance.

Key questions that this course seeks to answer: What are the core characteristics of environmental challenges from a policy perspective? What are key elements of ’environmental governance’ and how legitimate and effective are these approaches in addressing persistent environmental challenges?

Lecture notes
Lecture slides and additional course material will be provided throughout the semester.

Literature
We will mostly work with readings from the following books:


Prerequisites / notice
A detailed course schedule will be made available at the beginning of the semester.

We recommend that students have (a) Three-years BSc education of a (technical) university; (b) Successfully completed Bachelor introductory course to environmental policy (Entwicklungen nationaler Umweltpolitik (or equivalent)) and (c) Familiarity with key issues in environmental policy and some fundamental knowledge of one social science or humanities discipline (political science, economics, sociology, history, psychology, philosophy)

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<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Prerequisites</th>
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<tr>
<td>851-0589-00L</td>
<td>Technology and Innovation for Development</td>
<td>3</td>
<td>Three-years BSc education of a (technical) university; Successfully completed Bachelor introductory course to environmental policy (Entwicklungen nationaler Umweltpolitik (or equivalent)) and Familiarity with key issues in environmental policy and some fundamental knowledge of one social science or humanities discipline (political science, economics, sociology, history, psychology, philosophy)</td>
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</table>
Prerequisites / notice

This course is recommended for students participating in the Transdisciplinary Case Study 2016.

701-1543-00L Transdisciplinary Methods and Applications  W  3 credits  2G  P. Krütli, M. Stauffacher

Abstract

The course deals with transdisciplinary (td) methods, concepts and their applications in the context of case studies and other problem oriented research projects. Td methods are used in research at the science-society interface and when collaborating across scientific disciplines. Students learn to apply methods within a functional framework. The format of the course is seminar-like, interactive.

Objective

At the end of the course students should:

Know:
- Function, purpose and algorithm of a selected number of transdisciplinary methods

Understand:
- Functional application in case studies and other problem oriented projects

Be able to reflect on:
- Potential, limits, and necessity of transdisciplinary methods

Be prepared for:
- Transdisciplinary Case Study 2016

Content

The lecture is structured as follows:

- Overview of concepts and methods of inter-/transdisciplinary integration of knowledge, values and interests (approx. 20%)  
- Analysis of a selected number of transdisciplinary methods focusing problem framing, problem analysis, and impact (approx. 50%)  
- Practical application of the methods in a broader project setting (approx. 30%)

Lecture notes

Handouts are provided by the lecturers

Literature

Selected scientific articles and book-chapters

Prerequisites / notice

This course is recommended for students participating in the Transdisciplinary Case Study 2016.

701-1551-00L Sustainability Assessment  W  3 credits  2G  P. Krütli, C. E. Pohl

Abstract

The course deals with the concepts and methodologies for the analysis and assessment of sustainable development. A special focus is given to the social dimension and to social justice as a guiding principle of sustainability as well as to trade-offs between the three dimensions of sustainability.

The course is seminar-like, interactive.

Objective

At the end of the course students should

Know:
- core concepts of sustainable development, and;
- the concept of social justice - normatively and empirically - as a core element of social sustainability;
- important empirical methods for the analysis and assessment of local / regional sustainability issues.

Understand and reflect on:
- the challenges of trade-offs between the different goals of sustainable development;
- and the respective impacts on individual and societal decision-making.

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 433 of 1434
The course is structured as follows:
- Overview of rationale, objectives, concepts and origins of sustainable development;
- Importance and application of sustainability in science, politics, society, and economy;
- Sustainable (local / regional) development in different national / international contexts;
- Analysis and evaluation methods of sustainable development with a focus on social justice;
- Tradeoffs in selected examples.

### Lecture notes
Handouts.

### Literature
Selected scientific articles & book chapters

#### Forest and Landscape Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-1615-00L</td>
<td>Advanced Forest Pathology</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>O. Holdenrieder, T. N. Sieber</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>In-depth understanding of concepts, insight into current research and experience with methods of Forest Pathology based on selected pathosystems.</td>
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<td>To know current biological and ecological research on selected diseases, to be able to comment on it and to understand the methods.</td>
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<td>To understand the dynamics of selected pathosystems and disturbance processes.</td>
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<td>To be able to diagnose tree diseases and injuries.</td>
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<td>To know forest protection strategies and to be able to comment on them.</td>
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<td>Stress and disease, virulence and resistance, disease diagnosis and damage assessment, tree disease epidemiology, disease management, ecosystem pathology.</td>
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<td>Systems (examples): Air pollution and trees, endophytic fungi, mycorrhiza, wood decay, conifer- root rot, Phytophthora diseases, chestnut canker and its hypoviruses, urban trees, complex diseases, emerging diseases</td>
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<td>Lecture notes</td>
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<td>no script, the ppt-presentations and specific articles will be made available</td>
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<td>Literature</td>
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<td>among others:</td>
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<tr>
<td>701-1631-00L</td>
<td>Foundations of Ecosystem Management</td>
<td>W</td>
<td>5</td>
<td>3G</td>
<td>J. Ghazoul, C. Garcia</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>This course introduces the broad variety of conflicts that arise in projects focusing on sustainable management of natural resources. It explores case studies of ecosystem management approaches and considers their practicability, their achievements and possible barriers to their uptake.</td>
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<td>Students should be able to</td>
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<td>a) propose appropriate and realistic solutions to ecosystem management problems that integrate ecological, economic and social dimensions across relevant temporal and spatial scales.</td>
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<td>b) identify important stakeholders, their needs and interests, and the main conflicts that exist among them in the context of land and resource management.</td>
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<td>Content</td>
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<td>Traditional management systems focus on extraction of natural resources, and their manipulation and governance. However, traditional management has frequently resulted in catastrophic failures such as, for example, the collapse of fish stocks and biodiversity loss. These failures have stimulated the development of alternative ecosystem management approaches that emphasise the functionality of human-dominated systems. Inherent to such approaches are system-wide perspectives and a focus on ecological processes and services, multiple spatial and temporal scales, as well as the need to incorporate diverse stakeholder interests in decision making. Thus, ecosystem management is the science and practice of managing natural resources, biodiversity and ecological processes, to meet multiple demands of society. It can be local, regional or global in scope, and addresses critical issues in developed and developing countries relating to economic and environmental security and sustainability.</td>
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<td>Literature</td>
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<tr>
<td>701-1651-00L</td>
<td>Environmental Governance</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>E. Lieberherr, G. de Buren</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>The course addresses environmental policies, focusing on new approaches, which are generally summarized as environmental governance. The course also provides a broader introduction to social science concepts to provide students with tools to analyze environmental policy processes and assesses the key features of environmental governance by examining various practical environmental policy examples.</td>
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<td>Objective</td>
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<td></td>
<td>To understand how an environmental problem may (or not) become a policy and explain political processes, using basic concepts and techniques from political science.</td>
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<td>To analyze the evolution as well as the key elements of environmental governance.</td>
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<td>To be able to identify the main challenges and opportunities for environmental governance and to critically discuss them with reference to various practical policy examples.</td>
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</table>
Improvements in environmental quality and sustainable management of natural resources cannot be achieved through technical solutions alone. The quality of the environment and the achievement of sustainable development strongly depend on human behavior and specifically the human uses of nature. To influence human behavior, we rely on public policies and other societal rules, which aim to steer the way humans use natural resources and their effects on the environment. Such steering can take place through government intervention alone. However, this often also involves governance, which includes the interplay between governmental and non-governmental actors, the use of diverse tools such as emission standards or financial incentives to steer actors’ behavior and can occur at the local, regional, national or international level.

In this course, we will address both the practical aspects of as well as the scientific debate on environmental governance. The course gives future environmental experts a strong basis to position themselves in the governance debate, which does not preclude government but rather involves a spectrum from government to governance.

Key questions that this course seeks to answer: What are the core characteristics of environmental challenges from a policy perspective? What are key elements of ‘environmental governance’ and how legitimate and effective are these approaches in addressing persistent environmental challenges?

What are key elements of ‘environmental governance’ and how legitimate and effective are these approaches in addressing persistent environmental challenges?

Students should have a good understanding of the concepts of general sampling theory in a modern framework. They should also master I. Hajnsek

We will mostly work with readings from the following books:


We recommend that students have (a) Three-years BSc education of a technical university; (b) Successfully completed Bachelor introductory course to environmental policy (Entwicklungen nationaler Umweltpolitik (or equivalent)) and (c) Familiarity with key issues in environmental policy and some fundamental knowledge of one social science or humanities discipline (political science, economics, sociology, history, psychology, philosophy)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Prerequisites / Notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-1671-00L</td>
<td>Sampling Techniques for Forest Inventories</td>
<td>W 3 credits 2V</td>
<td>A detailed course schedule will be made available at the beginning of the semester.</td>
</tr>
<tr>
<td>751-5125-00L</td>
<td>Stable Isotope Ecology of Terrestrial Ecosystems</td>
<td>■ W 2 credits 2G</td>
<td>A simulation software will be used throughout the lectures to illustrate the theoretical developments. Upon request a half day field demonstration can be organized at the WSL outside the lecture time. A repertitorium for the exam is also offered.</td>
</tr>
<tr>
<td>102-0675-00L</td>
<td>Earth Observation</td>
<td>Information: As of examination session winter 2015, examination block 3 will be implemented in its new structure (i.e. new, Earth Observation will be examined within examination block 3 instead of within examination block 4). As of examination session summer 2015, examination block 4 will be implemented in its new structure. The new structure is valid for those students NOT having taken exams of examination block 3 nor of examination block 4 for the first time. All other students take the exams of examination block 3 as well as of examination block 4 in the present</td>
<td>W 4 credits 3G</td>
</tr>
</tbody>
</table>
Abstract
The aim of the course is to provide the fundamental knowledge about earth observation sensors, techniques and methods for bio/geophysical environmental parameter estimation.

Objective
The aim of the course is to provide the fundamental knowledge about earth observation sensors, techniques and methods for bio/geophysical environmental parameter estimation. Students should know at the end of the course:
1. Basics of measurement principle
2. Fundamentals of image acquisition
3. Basics of the sensor-specific geometries
4. Sensor-specific determination of environmental parameters

Content
Die Lehrveranstaltung gibt einen Einblick in die heutige Erdbeoachtung mit dem folgenden skizzierten Inhalt:
1. Einführung in die Fernerkundung von Luft- und Weltraum gestützten Systemen
2. Einführung in das Elektromagnetische Spektrum
3. Einführung in optische Systeme (optisch und hyperspektral)
4. Einführung in Mikrowellen-Technik (aktiv und passiv)
5. Einführung in atmosphärische Systeme (meteo und chemisch)
6. Einführung in die Techniken und Methoden zur Bestimmung von Umweltparametern
7. Einführung in die Anwendungen zur Bestimmung von Umweltparametern in der Hydrologie, Glaziologie, Forst und Landwirtschaft, Geologie und Topographie

Lecture notes
Folien zu jeden Vorlesungsblock werden zur Verfügung gestellt.

Literature
Ausgewählte Literatur wird am Anfang der Vorlesung vorgestellt.

701-1681-00L Element Balancing and Soil Functions in Managed Ecosystems

Abstract
Applying element balances of agricultural soils and the assessment of soil functions for real applications in computer exercises to design preventive strategies against soil pollution and to support sustainable management of regional agroecosystems also in the context of spatial planning procedures.

Objective
The students learn to critically assess changes in land use management on element cycles in agro-ecosystems and to assess soil services (soil functions). You design solutions for chemical problems in soil protection at the regional scale and learn to assess soil functions using different methods.

Content
The course will be taught in German. All material will be provided in English. Knowledge of ArcGIS is assumed.

Lecture notes
Literature
Ausgewählte Literatur wird am Anfang der Vorlesung vorgestellt.

Prerequisites / notice
The course consists of lectures and computer exercises. The course take place every 2 weeks à 4 hours. Recommended prerequisites for attending this course:
- Bodenschutz und Landnutzung
- Biochemie von Trace Elements
- Angewandte Bodenökologie

701-1776-00L Geographic Data Processing with Python and ArcGIS

Abstract
The course gives a general introduction into the geoprocessing framework of ArcGIS and shows how to use python scripts to access and automate geoprocessing tasks. Furthermore, the basics of the programming language Python will be communicated which is required for the implementation of multilevel spatial analysis and dynamic models.

Objective
The students learn the basics of geographic data processing based on the programming language Python and ArcGIS (arcpy). They get the ability to implement their own processing sequences and models for geoprocessing.

Content
The course consists of lectures and computer exercises. The course take place every 2 weeks à 4 hours. Recommended prerequisites for attending this course:
- Bodenschutz und Landnutzung
- Biochemie von Trace Elements
- Angewandte Bodenökologie

Lecture notes
Literature
Ausgewählte Literatur wird am Anfang der Vorlesung vorgestellt.

Prerequisites / notice
The course will be taught in German. All material will be provided in English. Knowledge of ArcGIS is assumed.

701-1682-00L Dendroecology

Abstract
The course dendroecology offers theoretical and practical aspects of dendrochronology. The impact of different environmental influences on tree-ring characteristics will be shown. The students learn various methods to date tree rings and they understand how ecological and environmental processes and patterns can be reconstructed using tree rings.

Objective
The students:
- understand, how wood is configured and how tree-ring structures are formed.
- are able to identify and describe different tree-ring structures.
- understand the theoretical and practical aspects of the dating of tree rings.
- know the effects of different abiotic and biotic environmental influences (climate, site, competition, insects, fire, physical-mechanical influences) on trees and tree rings.
- discover a tool for understanding and reconstructing global change processes.
- learn software to date, standardize and analyze tree rings.
- get hands-on experience based on the demonstration of wood (increment cores, stem discs, wedges), sampling in the field, and measuring and dating of tree rings in the tree-ring lab.
- solve R-based exercises (R tutorial will be provided) and answer questions in Moodle.
- work out an independent research question related to a dendroecological topic and write a short literature review based on scientific papers.
Overview and history of dendrochronology
- Principles of dendrochronology
- Evolution of tree rings
- Formation and structure of wood and tree rings
- Intra-seasonal tree-ring growth
- Continuous and discontinuous tree-ring characteristics
- Sampling and measuring
- Crossdating methods (visual, skeleton plots, quantitative)
- Standardization of tree-ring series
- Development of tree-ring chronologies
- Dendrogeomorphology, dendrohydrology, dendroclimatology
- Stable isotopes
- Climate, climate-growth relationships, climate reconstructions
- Age and size structures, forest dynamics (regeneration, growth, competition, mortality)
- Disturbance ecology (fire, insects, blowdown)
- Application of tree-ring research in practice and in interdisciplinary research projects
- Field and lab day (date for one entire day or two half days will be searched together with the students in the beginning of the semester)
- Discussion of different dendroecological questions in the forest; sampling of trees; insight into different tree-ring projects in the lab (Swiss Federal Institute for Forest, Snow and Landscape Research WSL)

Lecture notes
Lecture notes (in English) will be handed out in the class.

The lecture notes and further documents (papers, software) can also be downloaded from Moodle (https://moodle-app2.let.ethz.ch) following registration for the course.

Literature
Literature lists will be handed out in the class.

Prerequisites / notice
Time schedule (total of 90 hours): There will be 12 lectures with each two hours (total of 24 hours presence) as well as a field and lab day (8 hours presence). In addition, the students are expected to put 18 hours into the preparation of the lectures as well as 18 hours for the exercises. 4 hours are reserved for the lab work and 18 hours for the project.

The class language is German and English, on request English only.

Requirements:
- Basics of biology, ecology and forest ecology

701-1695-00L Soil Science Seminar

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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-0015-00L</td>
<td>Seminar on Transdisciplinary Research for Sustainable Development</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>C. E. Pohl, M. Stauffacher</td>
</tr>
</tbody>
</table>

Abstract
The seminar is designed for students and researchers (MA, PhD, PostDoc) who use inter- and transdisciplinary elements in their projects. It addresses the challenges of this research: How to integrate disciplines? How (and in what role) to include societal actors? How to bring results to fruition? We discuss these questions based on case studies and theories and on the participant's projects.

Objective
The participants understand the specific challenges of inter- and transdisciplinary research in general and in the context of sustainable development in particular. They know methods and concepts to address these challenges and apply them to their research projects.

Content
The seminar covers the following topics:
(1) Theories and concepts of inter- and transdisciplinary research
(2) The specific challenges of inter- and transdisciplinary research
(3) Involving stakeholders
(4) Collaborating disciplines
(5) Exploration of tools and methods
(6) Analysing participants' projects to improve inter- and transdisciplinary elements

Literature
Literature will be made available to the participants

Prerequisites / notice
The seminar is specifically suitable for PhD or PostDoc researchers. It is open to master students (minor "global change and sustainability") and further interested people, who preferably are preparing, or working on, a project/thesis.

701-1503-00L CCES Winter School "Science Meets Practice"

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<tr>
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<tr>
<td>701-1503-00L</td>
<td>CCES Winter School &quot;Science Meets Practice&quot;</td>
<td>W</td>
<td>4</td>
<td>9A</td>
<td>C. Adler, P. Krüttli, C. E. Pohl, M. Stauffacher</td>
</tr>
</tbody>
</table>

Abstract
Increasingly scientists need to interact more with people and institutions outside the scientific community. This requires the capability to understand and critically reflect about scientific activities and consequences for society and environment and to communicate with confidence. The CCES Winter School builds capacity to create and manage forms of interactions beyond scientific boundaries.

Objective
1. To acquire knowledge of key aspects of the interplay between science and practice
2. To reflect on and understand the role and consequences of scientific activity in relation to society and environment
3. To acquire skills and learn about a systematic application of methods to create and manage interactions between science and society

Content
The Winter School provides insights into theoretical and methodological foundations on the challenges of knowledge exchange and dialogue between science and practice. It offers media and knowledge management training for enhancing stakeholder involvement. Selected case examples support group work discussions and analysis. Real stakeholder meetings are organized for testing techniques in view of identifying diverse expectations and needs and working towards solutions. Together the Winter School participants and stakeholders experience and develop ways for better linking environmental science and practice.

The course is structured by an intimate interconnection between theoretical inputs, reflection and translation into own topics and projects. The course offers insights into a wide spectrum of crossing boundaries between science and practice (e.g. information, consultation, co-production of knowledge) and provides test fields for reflection of own experiences.

The first block with inputs, individual and group work, and reflection is a preparation for the second block, which focuses on implementation of stakeholder interactions. Between the two blocks coached project work is offered.

The CCES Winter School takes place at Propstei Wislikofen, January 5-8 and February 2-5, 2015. Accommodation is provided.

Lecture notes
Course materials (e.g. slides, articles, toolboxes) are provided for preparatory reading and during the course (on BSCW).

Literature
Collection of key literature in online reader on BSCW

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 437 of 1434
Prerequisites / notice

The CCES Winter School addresses PhD students and postdocs from environmental and natural sciences, engineering, and social sciences related to sustainable development. Participants are required to apply online providing key information about their interest and PhD project - details and application form can be found here: http://www.cces.ethz.ch/winterschool/

The Winter School runs with a maximum of 25 participants.

The Winter School 2015 is delivered by a diverse group of lecturers and experienced intermediaries.
- Carolina Adler (USYS TdLab, environmental philosophy group, ETH Zurich)
- Claudia Frick (sciencetext, HAFL Zollikofen)
- Martina Mittler (corporate communications, ETH Zurich)
- Patricia Fry (Wissensmanagement Umwelt GmbH)
- Pius Krüti (USYS TdLab, Natural and Social Science Interface, ETH Zurich)
- Christian Pohl (USYS TdLab, ETH Zürich & td-net, Bern)
- Michael Stauffacher (USYS TdLab, Natural and Social Science Interface, ETH Zurich)

The total time requirement is in the range of 120 hours, equivalent to 4 ECTS. The learning control focuses on 1) active participation, engagement in case examples, and reflection against the background of own projects and experiences, 2) active team involvement in implementing tasks on information, consultation, and co-production of knowledge, including the design and organization of stakeholder meetings. The course is successfully completed by pass (pass/no pass, thus no marks). The language of the Winter School is English. Stakeholder meetings will be in the local language (Swiss German) and translation into English is provided.

There is a participation fee of 400 CHF for the course, which is a contribution to the costs for the two blocks at the seminar venue Propstei Wislikofen, organizational support as well as material for the stakeholder meetings. Travel expenses to the venue are to be borne by the participants.

701-1505-00L  "Global Water Challenges" Engineering for Development (E4D) Winter School

Does not take place this semester.


Abstract

The E4D winter school 2015 aims at an integrated vision of Global Water Challenges. The programme is designed to present water resources challenges that are of global relevance. Experts will outline the issues and will present their experiences working in different parts of the world. The course will focus on three main topics: Water & Health, Water & Food, and Water & Energy, but it will also

Objective

The E4D winter school will be composed of 30 graduate students, 15 each from ETH Zurich and from other academic institutions, particularly from developing countries. They will be joined by faculty members and external experts from fields of expertise related to the winter school topic. The Master and PhD students will come from different disciplines related to the E4D topic.

During the first week, students will be introduced to fields relevant to the topic at hand through a series of input speeches, lectures and workshops conducted by experts. All participants will stay in a country house eco hotel in Emmental, 2h away from Zurich. During weeks two and three, students will relocate to ETH Zurich and be split into three thematic groups to carry out guided case studies. The case study work will provide them with hands-on opportunities to work in an interdisciplinary and intercultural team and to develop solutions to the chosen topic.
Three case studies will cover the following topics and will be based on modelling solutions in a specific country context:

**WATER, SANITATION AND HYGIENE (WASH)**

WASH is a UNICEF programme that is central to the millennium development agenda. In 2012, UNICEF expanded its support to WASH in Schools, which aims at providing gender-sensitive and child-friendly sanitation, washing, and water facilities to students. The purpose of this group work is to develop an integrated WASH programme for schools in Bolivia which would combine water treatment with hygiene awareness, handwashing, sanitation, etc. The group work will include field testing of existing household water treatment systems such as Sodis, gdm-filters, chlorination, and boiling with different types of water, as well as some lab analysis (microbial analysis).

**WATER ALLOCATION FOR FOOD AND ECOSYSTEM HEALTH**

The Yanqi Basin in Northwest China is an irrigation oasis. Agriculture is the main income of the population, but leads to numerous problems: salinization of soils due to groundwater table rise, increasing salinity of Lake Bosten, a fresh water lake receiving all drainage waters from the basin, diminished river flow in the downstream and die-off of Populus euphratica forests. You are supposed to formulate sustainability goals and find solutions for the allocation of water with regards to quantity and quality in order to have maximum agricultural production under constraints for soil salinity, downstream ecosystem health, lake salinity and lake water level. A MATLAB software is available which allows you to evaluate each course of action. A Pareto front between economic and ecological benefits should be identified and ideas for implementation should be formulated.

**EXPLORING THE ENERGY-WATER NEXUS IN THE KAFUE RIVER BASIN**

In the Kafue Flats, part of the Zambezi River Basin, the operation of two dams built in the seventies has completely altered the hydrological natural regime of this internationally important wetland. Backwater from downstream Katue Gorges reservoir and releases from upstream thezi Thezi dam have created a permanently inundated area within the flats and reduced floods elsewhere, with large impacts on wildlife, vegetation and their dependent livelihoods. The group work will explore the water-energy nexus in the Flats from a multi-stakeholders perspective, by developing, based on the literature available, a set of indicators representing the main interests in the basin, including the ecosystem, the local population and the main economic sectors (sugar cane plantations and hydropower). Using a simplified model of the systems, several alternative operations of the systems (e.g. prioritizing different objectives) will be analysed to explore the tradeoffs among the interests of different stakeholders and explore options for more balanced and sustainable management.

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**Prerequisites / notice**

The Engineering for Development (E4D) Winter School 2015 will invite 30 Master and PhD students from different disciplines related to the topic of "Global Water Challenges". Applicants will be selected based on their academic record and previous work experience, as well as their dedication to solving humanity’s grand challenges. Applicants must send a one-page CV and one-page letter of motivation in PDF format stating their interest in one of the three themes:

- **Theme 1**: Water and Health: Water, Sanitation, and Hygiene (WASH), Bolivia
- **Theme 2**: Water and Food: Water allocation in China
- **Theme 3**: Water and Energy: Exploring the water-energy nexus in the Kafue river basin, Zambia

Admission will be for one of these three themes and cannot be altered once accepted. Please send your full application to catherine.lippuner@sl.ethz.ch (resend your application if you did not receive an acknowledgement of receipt within two days).

Deadline: October 12, 2014
Notification: October 31, 2014

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**Basic and Scientific Skills**

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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-0019-00L</td>
<td>Readings in Environmental Thinking</td>
<td>W</td>
<td>3 credits</td>
<td>2S</td>
<td>J. Ghazoul, C. Garcia, G. Hirsch Hadorn</td>
</tr>
</tbody>
</table>

**Abstract**

This course introduces students to foundational texts that led to the emergence of the environment as a subject of scientific importance, and shaped its relevance to society. Above all, the course seeks to give confidence and raise enthusiasm among students to read more widely around the broad subject of environmental sciences and management both during the course and beyond.

**Objective**

The course will provide students with opportunities to read, discuss, evaluate and interpret key texts that have shaped the environmental movement and, more specifically, the environmental sciences. Students will gain familiarity with the foundational texts, but also understand the historical context within which their academic and future professional work is based. More directly, the course will encourage debate and discussion of each text that is studied, from both the original context as well as the modern context. In so doing students will be forced to consider and justify the current societal relevance of their work.
The course will be run as a book reading club. The first session will provide a short introduction as to how to explore a particular text (that is not a scientific paper) to identify the key points for discussion.

Thereafter, in each week a text (typically a chapter from a book or a paper) considered to be seminal or foundational will be assigned by a course lecturer. The lecturer will introduce the selected text with a brief background of the historical and cultural context in which it was written, with some additional biographical information about the author. He/she will also briefly explain the justification for selecting the particular text.

The students will read the text, with two to four students (depending on class size) being assigned to present it at the next session. Presentation of the text requires the students to prepare by, for example:
- identifying the key points made within the text
- identifying issues of particular personal interest and resonance
- considering the impact of the text at the time of publication, and its importance now
- evaluating the text from the perspective of our current societal and environmental position

Such preparation would be supported by a mid-week tutorial discussion (about 1 hour) with the assigning lecturer.

These students will then present the text (for about 15 minutes) to the rest of the class during the scheduled class session, with the lecturer facilitating the subsequent class discussion (about 45 minutes). Towards the end of the session the presenters will summarise the emerging points (5 minutes) and the lecturer will finish with a brief discussion of how valuable and interesting the text was (10 minutes). In the remaining 15 minutes the next text will be presented by the assigning lecturer for the following week.

The specific texts selected for discussion will vary, but examples include:
- D. R. Johnson: *Basic Concepts of Management*, J. Hering
- R. Schwarzenbach: *Lectures and exercises in: Basic Concepts of Management, Research Ethics*
- R. Schiller: *Lectures and exercises in: Purpose is to discuss and teach the professional skills that are needed in science (or future career in science). Course consists of lectures and practical sessions. Course is organized by Eawag scientists.*
- G. Achermann: *Sharing his experience in several guest lectures.*

## 701-0017-00L

### EAWAG PhD Skills Seminar

**Abstract**

Purpose is to discuss and teach the professional skills that are needed in science (or future career in science). Course consists of lectures and practical sessions. Course is organized by Eawag scientists.

**Objective**

Purpose is to discuss and teach the professional skills that are needed in science (or future career in science). Course consists of lectures and practical sessions.

**Content**

- Lectures and exercises in: Project management
- Application of research grants
- Scientific publishing
- Reviewing
- Writing papers
- Applying jobs
- Job interviews

## 701-0763-00L

### Basic Concepts of Management

**Abstract**

This course deals with fundamental and proven management concepts. The lecturers emphasize the practical applicability of concepts. The course was designed in close cooperation with practitioners; e.g. will Mr. S. Baldenweg, mechanical engineer ETH, MBA Insead, share his experience in several guest lectures.

**Objective**

Students:
- will get to know the basic organisational issues and the essential types of organisations.
- get a rough overview on the concepts of financial management.
- will learn about the strategic positioning of small departments within larger organisations.
- will learn about the fundamental mechanisms for handling change, and will be able to recognise these situations.
- will learn the basic principles of project management and of successful self-management.
- will reflect on customer oriented information representation.

**Content**


**Lecture notes**

Skripten werden elektronisch zur Verfügung gestellt.


**Literature**


**Prerequisites / notice**

- Particularly suitable for students of D-BIOL, D-CHAB, D-HEST

## 851-0180-00L

### Research Ethics

**Abstract**

Purpose is to discuss and teach the professional skills that are needed in science (or future career in science). Course consists of lectures and practical sessions. Course is organized by Eawag scientists.

**Objective**

- will learn the basic principles of project management and of successful self-management.
- will reflect on customer oriented information representation.

**Content**


**Lecture notes**

Skripten werden elektronisch zur Verfügung gestellt.


**Literature**


**Prerequisites / notice**

- Particularly suitable for students of D-BIOL, D-CHAB, D-HEST
This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.

The main goal of this course is to enhance the student’s ability to:
- recognize and identify ethical issues and conflicts,
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.

I. Ethics & The Process of Ethical Inquiry

Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)

Integrity in Research & Research Misconduct
- What is “integrity” in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 R’s (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.
Literature

Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.

► Additional Courses

Course Catalogue of ETH Zurich

Doctoral Department of Environmental Sciences - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
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<tr>
<td>W+</td>
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<tr>
<td>W</td>
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<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<td>Z</td>
<td>Courses outside the curriculum</td>
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<td>Dr</td>
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Key for Hours

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<tr>
<td>V</td>
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<tr>
<td>G</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<td>D</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## First Year Examinations

### 1. Semester

<table>
<thead>
<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tr>
<td>401-0231-10L</td>
<td>Analysis I</td>
<td>O</td>
<td>8</td>
<td>7G</td>
<td>A. Joossi</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Calculus of one variable: Real and complex numbers, vectors, functions, limits, sequences, series, power series, differentiation and integration in one variable, introduction to ordinary differential equations.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Objective</strong></td>
<td>Einfuehrung in die Grundlagen der Analysis</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Christian Blatter: Ingenieur-Analysis (Kapitel I-3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

| 401-0151-00L    | Linear Algebra                     | O    | 4     | 3G+2U | V. C. Gradinaru          |
| **Abstract**    | Contents: Linear systems - the Gaussian algorithm, matrices - LU decomposition, determinants, vector spaces, least squares - QR decomposition, linear maps, eigenvalue problem, normal forms - singular value decomposition; numerical aspects; introduction to MATLAB. |
| **Objective**   | Einfuehrung in die Lineare Algebra für Ingenieure unter Berücksichtigung numerischer Aspekte |
| **Lecture notes** | K. Nipp / D. Stoffer, Lineare Algebra, vdf Hochschulverlag, S. Auflage 2002 |
| **Literature**  | K. Nipp / D. Stoffer, Lineare Algebra, vdf Hochschulverlag, S. Auflage 2002 |

| 252-0835-00L    | Computer Science I                 | O    | 4     | 2V+2U | F. O. Friedrich          |
| **Abstract**    | The course covers the fundamental concepts of computer programming with a focus on systematic algorithmic problem solving. Taught language is C++. No programming experience is required. Primary educational objective is to learn programming with C++. When successfully attended the course, students have a good command of the mechanisms to construct a program. They know the fundamental control and data structures and understand how an algorithmic problem is mapped to a computer program. They have an idea of what happens "behind the scences" when a program is translated and executed. Secondary goals are an algorithmic computational thinking, understanding the possibilities and limits of programming and to impart the way of thinking of a computer scientist. |
| **Objective**   | The course covers fundamental data types, expressions and statements, (Limits of) computer arithmetic, control statements, functions, arrays, structural types and pointers. The part on object orientation deals with classes, inheritance and polymorphism, simple dynamic data types are introduced as examples. In general, the concepts provided in the course are motivated and illustrated with algorithms and applications. |
| **Content**     | A script written in English will be provided during the semester. The script and slides will be made available for download on the course web page. |
| **Lecture notes** | Bjarne Stroustrup: Einführung in die Programmierung mit C++, Pearson Studium, 2010 |
| **Prerequisites / notice** | From AS 2013, an admission to the exam does not any more formally require an attending of the recitation sessions. Handing in solutions to the weekly exercise sheets is thus not mandatory, but we strongly recommend it. |

| 151-0223-10L    | Engineering Mechanics             | O    | 4     | 2V+2U+1K | S. P. Kaufmann, J. Dual |
| **Abstract**    | Introduction to engineering mechanics: kinematics, statics and dynamics of rigid bodies and systems of rigid bodies. Students can solve problems of elementary engineering mechanics. Basic notions: position and velocity of particles, rigid bodies, planar motion, kinematics of rigid body, force, couple, power. Statics: static equivalence, force-couple system, center of forces, centroid, principle of virtual power, equilibrium, constraints, statics, friction. Dynamics: acceleration, inertial forces, d'Alembert's Principle, Newton's Second Law, principles of linear and angular momentum, equations of planar motion of rigid bodies. |
| **Objective**   | yes |
| **Content**     | yes |
| **Prerequisites / notice** | Examination is a one hour-long written test. |

| 227-0001-00L    | Networks and Circuits I           | O    | 4     | 2V+2U | J. W. Kolar              |
| **Abstract**    | Electrostatic field; Stationary electric current flow; Basic electric circuits; current conduction mechanisms; time variant electromagnetic field; alternating voltages and currents. Students can solve problems of basic elements of electric circuits, i.e. capacitors, resistors and inductors should be understood in relation to electric and magnetic fields. Furthermore, the students should be able to mathematically describe, analyze and finally design technical realizations of circuit elements. Students should also be familiar with the calculation of voltage and current distributions of DC circuits. The effect and the mathematical formulation of magnetic induction should be known for technical applications. The fundamentals of complex AC current calculus for description of periodic sinusoidal quantities should be known and students should be able to apply the concept to basic AC circuits. |
| **Objective**   | Electrostatic field; Stationary electric current flow; current conduction mechanisms; time variant electromagnetic field; alternating voltages and currents. |
| **Content**     | Grundlagen der Elektrotechnik, Bd. 1 und 2, M. Albach, and Textbook |
| **Lecture notes** | Grundlagen der Elektrotechnik |

| 227-0003-00L    | Digital Circuits                  | O    | 4     | 2V+2U | G. Tröster              |
| **Abstract**    | Voltage, current and properties of basic elements of electric circuits, i.e. capacitors, resistors and inductors should be understood in relation to electric and magnetic fields. Furthermore, the students should be able to mathematically describe, analyze and finally design technical realizations of circuit elements. Students should also be familiar with the calculation of voltage and current distributions of DC circuits. The effect and the mathematical formulation of magnetic induction should be known for technical applications. The fundamentals of complex AC current calculus for description of periodic sinusoidal quantities should be known and students should be able to apply the concept to basic AC circuits. |
| **Objective**   | Electrostatic field; Stationary electric current flow; current conduction mechanisms; time variant electromagnetic field; alternating voltages and currents. |
| **Content**     | Grundlagen der Elektrotechnik, Bd. 1 und 2, M. Albach, and Textbook |
| **Lecture notes** | Grundlagen der Elektrotechnik |
Abstract | Digital and analogue signals and their representation. Combinational and sequential circuits and systems, boolean algebra, K-maps. Finite state machines. Memory and computing building blocks in CMOS technology, programmable logic circuits.
--- | ---
Objective | Provide basic knowledge and methods to understand and to design digital circuits and systems.
--- | ---
Content | Digital and analogue signals and their representation. Boolean Algebra, circuit analysis and synthesis, the MOS transistor, CMOS logic, static and dynamic behaviour, tristate logic, Karnaugh-Maps, hazards, binary nuber systems, coding. Combinational and sequential circuits and systems (boolean algebra, K-maps, etc.). Memory building blocks and memory structures, programmable logic circuits. Finite state machines, architecture of microprocessors.
--- | ---
Lecture notes | Lecture notes for all lessons, assignments and solutions. Textbook: http://www.ifl.ee.ethz.ch/education/Digitaltechnik
--- | ---
Literature | Literature will be announced during the lessons.
--- | ---
Prerequisites / notice | No special prerequisites

### First Year Compulsory Laboratory Courses

<table>
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<tr>
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<tr>
<td>227-0005-10L</td>
<td>Digital Circuits Laboratory</td>
<td>O</td>
<td>1 credit</td>
<td>1P</td>
<td>G. Tröster</td>
</tr>
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</table>

**Abstract**
- Digital and analogue signals and their representation. Combinational and sequential circuits and systems, boolean algebra, K-maps. Finite state machines. Memory and computing building blocks in CMOS technology, programmable logic circuits.
- The contents of the digital circuits laboratory will deepen and extend the knowledge of the correspondent lecture and exercises. With the help of the logic device design software Quartus II different circuits will be designed and then tested on an evaluation board. You will build up the control for a 7-digit display as well as an adder and you will create different types of latches and flip-flops. At the end of the laboratory a small synthesizer will be programmed that is able to play self-created melodies. At the same time the usage of a modern oscilloscope will be taught in order to analyse the programmed circuits through the digital and analogue inputs.

### 3. Semester

#### Examination Blocks

##### Examination Block 1

<table>
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<tr>
<th>Number</th>
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<tr>
<td>401-0353-00L</td>
<td>Analysis III</td>
<td>O</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>P. S. Jossen</td>
</tr>
</tbody>
</table>

**Abstract**
- In this lecture we treat problems in applied analysis. The focus lies on the simplest cases of three fundamental types of partial differential equations of second order: the Laplace equation, the heat equation and the wave equation.
- 1.) Klassifizierung von PDE's
  - linear, quasilinear, nicht-linear
  - elliptisch, parabolisch, hyperbolisch
- 2.) Quasilineare PDE
  - Methode der Charakteristiken (Beispiele)
- 3.) Elliptische PDE
  - Bsp: Laplace-Gleichung
  - Harmonische Funktionen, Maximumsprinzip, Mittelwerts-Formel.
  - Methode der Variablenseparation
- 4.) Parabolische PDE
  - Bsp: Wärmeleitungsungleichung
  - Bsp: Inverse Wärmeleitungsungleichung
  - Methode der Variablenseparation
- 5.) Hyperbolische PDE
  - Bsp: Wellengleichung
  - Formel von d'Alembert in (1+1)-Dimensionen
  - Methode der Variablenseparation
- 6.) Green'sche Funktionen
  - Rechnen mit der Dirac-Deltafunktion
  - Idee der Green'schen Funktionen (Beispiele)
- 7.) Ausblick auf numerische Methoden
  - 5-Punkt-Diskretisierung des Laplace-Operators (Beispiele)

**Literature**

**Zusätzliche Literatur:**
- Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, Kap. 8, 11, 16 (sehr gutes Buch, als Referenz zu benutzen)
- Norbert Hungerbühler, "Einführung in die partiellen Differentialgleichungen", vdf Hochschulverlag AG an der ETH Zürich.

**Prerequisites / notice**
- Prerequisites: Analysis I and II, Fourier series (Komplexe Analysis)
Content
Die Grundlagen der Quantenphysik

Quantenmechanik
Wellenfunktion und Wahrscheinlichkeitsdichte, Schrödingergleichung, Potentialstufe, Teilchen im Potentialkasten, harmonische Oszillator, Tunneleffekt, zeitabhängige Schrödingergleichung, Übergangswahrscheinlichkeiten und Auswahlregeln

Atome mit einem Elektron
Wasserstoffatom, Quantisierung des Drehimpulses, Einelektronen-Wellenfunktion in Zentralfeldern, Zeeman-Effekt, Elektronenspin, Spin-Bahn-Wechselwirkung

Atome mit vielen Elektronen
Heliumatom, Ausschliessungssprinzip, Elektronenstruktur der Atome, Röntgenspektren

Moleküle
Wasserstoffmolekü-Ion, Molekülwellenfunktion zweiatomiger Moleküle, Kovalente Bindung, Molekulare Rotation und Schwingung

Festkörper
Typen der Festkörper, Bändermodell der Festkörper, "Tight Binding Model" explizit hergeleitet, Modell der freien Elektronen, Elektronenbewegung in einer periodischen Struktur, "effective mass approximation", Leiter, Isolator und Halbleiter, Quantentheorie der elektrischen Leitfähigkeit, Strahlungsübergänge in Festkörpern

Quantenstatistik
Fermi-Dirac Verteilung, Elektronengas, Elektronen in Metallen und Halbleiter (Anwendung der Fermi-Dirac Verteilung), Photonengas, Wärmekapazität von Festkörpern, ideale Gas in der Quantenstatistik

Lecture notes
Option: Phononen
Lehrbuch
Alonso, Marcelo / Finn, Edward J. Quantenphysik und Statistische Physik 5. Auflage aus 2011 978-3-486-71340-4
http://www.degruyter.com/view/product/221450?rskey=JqMV1g&result=1

Literature
Prerequisites / notice
227-0045-00L Signals and Systems I O 4 credits 2V+2U H. Bölcskei
Abstract

Objective
Introduction to mathematical signal processing and system theory.

Content

227-0013-00L Computer Engineering I L 4 credits 2V+1U+1P L. Theile
Abstract
The course provides knowledge about structures and models of digital systems (abstract data types finite state automata, dependence and process graphs), abstraction and hierarchy in computer systems, assembler and compiler, control path and data path, I/O, bus systems, memory hierarchy, operating system, pipelining, speculation techniques, superscalar computer architectures.

Objective
Logical and physical structure of computer systems. Introduction to principles in hardware design, datapath and control path, assembler programming, modern architectures (pipelining, speculation techniques, superscalar architectures), memory hierarchy, software concepts.

Content
Structures and models of digital systems (abstract data types finite state automata, dependence and process graphs), abstraction and hierarchy in computer systems, assembler and compiler, control path and data path, I/O, bus systems, memory hierarchy, operating system, pipelining, speculation techniques, superscalar computer architectures.

Lecture notes
Theoretical and practical exercises using a simulation-based infrastructure.

Literature

Prerequisites / notice
Prerequisites: Physics I.

Examination Block 2

Number Title Type ECTS Hours Lecturers
227-0007-10L Electronic Circuits O 4 credits 2V+1U Q. Huang
Abstract
Introductory lecture on electronic circuits. Transistor fundamentals, analysis and design of transistor based electronic circuits such as amplifiers and filters; A/D- and D/A-converters, function generators, oscillators, PLLs.

Objective
Modern, transistor-based electronics has transformed our lives and plays a crucial role in our economy since the 2nd half of last century. The main objective of this course in electronic circuits is to introduce the concept of active device, including operational amplifiers, and their use in amplification, signal conditioning, switching and filtering to students. In addition to gaining experience with typical electronic circuits that are found in common applications, including their own Gruppenarbeit and Fachpraktikum projects, students sharpen their understanding of linear circuits based on nonlinear devices, imperfections of electronic circuits and the concept of design (as opposed to analysis). The course is a prerequisite for higher semester subjects such as analog integrated circuits, RF circuits for wireless communications, A/D and D/A converters and optoelectronics.

Content

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 445 of 1434
Projects & Seminars for 1 CP (1)

Electronic Circuits Laboratory

Professors

Implementing the knowledge acquired during the basic studies.

2P

Hours

1P

Q. Huang

Type

Abstract

Foundations of Discrete Mathematics; combinatorics (elementary counting), graph theory (paths, walks, euler circuits, matchings, trees, planar graphs), algebra (modular arithmetic, groups, fields), applications (network flows, cryptography, coding theory).

Objective

see above

Discrete Mathematics

ECTS

2 credits

Q. Huang

Type

A. Steger

1 credit

E. Welzl

Lab with principal electronic circuit experiments on the transistor and operational amplifier basis.

General Laboratory II

Only for Electrical Engineering and Information Technology BSc.

Enrolment via Online-Tool (EE-Website: Studies -> Bachelor Program -> Third Year -> Laboratory Courses)

The Laboratory courses in the 5th and 6th semesters enable the students to put the the contents of the courses from the four first semesters to the test and to consolidate the acquired knowledge. Furthermore students have the possibility to gain specific knowledge in certain software packages as MATLAB.

Implementing the knowledge acquired during the basic studies.


Projects & Seminars for 1 CP (2)

Only for Electrical Engineering and Information Technology BSc.

Course can only be registered for once. A repeatedly registration in a later semester is not chargeable.

Procurement of knowledge about the build up of systems as well as enhancement of general knowledge.

Procurement of skills in the area of Electrical Engineering and Information Technology that are useful for the remaining terms as well during ones work life.

Enrollment through the Online-Tool, https://isgapps.ee.ethz.ch/ppsapp/

Projects & Seminars for 1 CP (1)

Only for Electrical Engineering and Information Technology BSc.

Procurement of knowledge about the build up of systems as well as enhancement of general knowledge.

Procurement of skills in the area of Electrical Engineering and Information Technology that are useful for the remaining terms as well during ones work life.

Enrollment through the Online-Tool, https://isgapps.ee.ethz.ch/ppsapp/

Projects & Seminars for 1 CP (2)

Only for Electrical Engineering and Information Technology BSc.

Procurement of knowledge about the build up of systems as well as enhancement of general knowledge.

Procurement of skills in the area of Electrical Engineering and Information Technology that are useful for the remaining terms as well during ones work life.

Enrollment through the Online-Tool, https://isgapps.ee.ethz.ch/ppsapp/
Course can only be registered for once. A repeatedly registration in a later semester is not chargeable.

Abstract
Procurement of knowledge about the build up of systems as well as enhancement of general knowledge.
Procurement of skills in the area of Electrical Engineering and Information Technology that are useful for the remaining terms as well during ones work life.

Objective
see above

Prerequisites / notice
Enrollment through the Online-Tool, https://isgapps.ee.ethz.ch/ppsapp/

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<td>Projects &amp; Seminars for 2 CP (1)</td>
<td>W</td>
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<tr>
<td>Abstract</td>
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<td>Enrollment through the Online-Tool, <a href="https://isgapps.ee.ethz.ch/ppsapp/">https://isgapps.ee.ethz.ch/ppsapp/</a></td>
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</table>

| 227-0085-40L | Projects & Seminars for 2 CP (2)               | W    | 2    | 2P    | Professors      |
|           | Only for Electrical Engineering and Information Technology BSc. |      |      |       |                 |
|           | Course can only be registered for once. A repeatedly registration in a later semester is not chargeable. |      |      |       |                 |
| Abstract  | Procurement of knowledge about the build up of systems as well as enhancement of general knowledge. |      |      |       |                 |
|           | Procurement of skills in the area of Electrical Engineering and Information Technology that are useful for the remaining terms as well during ones work life. |      |      |       |                 |
| Objective | see above                                   |      |      |       |                 |
| Prerequisites / notice | Enrollment through the Online-Tool, https://isgapps.ee.ethz.ch/ppsapp/ |      |      |       |                 |

| 227-0085-50L | Projects & Seminars for 3 CP                  | W    | 3    | 3P    | Professors      |
|           | Only for Electrical Engineering and Information Technology BSc. |      |      |       |                 |
|           | Course can only be registered for once. A repeatedly registration in a later semester is not chargeable. |      |      |       |                 |
| Abstract  | Procurement of knowledge about the build up of systems as well as enhancement of general knowledge. |      |      |       |                 |
|           | Procurement of skills in the area of Electrical Engineering and Information Technology that are useful for the remaining terms as well during ones work life. |      |      |       |                 |
| Objective | see above                                   |      |      |       |                 |
| Prerequisites / notice | Enrollment through the Online-Tool, https://isgapps.ee.ethz.ch/ppsapp/ |      |      |       |                 |

| 227-0085-60L | Projects & Seminars for 4 CP                  | W    | 4    | 4P    | Professors      |
|           | Only for Electrical Engineering and Information Technology BSc. |      |      |       |                 |
|           | Course can only be registered for once. A repeatedly registration in a later semester is not chargeable. |      |      |       |                 |
| Abstract  | Procurement of knowledge about the build up of systems as well as enhancement of general knowledge. |      |      |       |                 |
|           | Procurement of skills in the area of Electrical Engineering and Information Technology that are useful for the remaining terms as well during ones work life. |      |      |       |                 |
| Objective | see above                                   |      |      |       |                 |
| Prerequisites / notice | Enrollment through the Online-Tool, https://isgapps.ee.ethz.ch/ppsapp/ |      |      |       |                 |

★★ Group Projects

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>227-0091-10L</td>
<td>Group Project I</td>
<td>W</td>
<td>6</td>
<td>5A</td>
<td>Lecturers</td>
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<tr>
<td>Abstract</td>
<td>Students must work in groups in supervised projects for 150 to 180 hours minimum. The topics of the group work are open and can be technical of specific nature or more general in the context of engineering.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>see above</td>
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<td></td>
</tr>
</tbody>
</table>

| 227-0092-10L | Group Project II           | W    | 6    | 5A    | Lecturers       |
| Abstract   | Students must work in groups in supervised projects for 150 to 180 hours minimum. The topics of the group work are open and can be technical of specific nature or more general in the context of engineering. |      |      |       |                 |
| Objective  | see above                 |      |      |       |                 |

★★ Internship in Industry

Please note the conditions for Internships in industry as set forward by the "Guidelines for the "Laboratory Courses - Projects - Seminars ", see https://www.ee.ethz.ch/content/dam/ethz/special-interest/let/department/Studies/Bachelor/Regulations/Richtlinien_Praktika-Projekte-Seminarie_v5_final.pdf (German only).

<table>
<thead>
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<tr>
<td>227-0093-10L</td>
<td>Internship in Industry</td>
<td>W</td>
<td>6</td>
<td></td>
<td>external organisers</td>
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<tr>
<td>Only for Electrical Engineering and Information Technology BSc.</td>
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</tbody>
</table>
Abstract
The main objective of the 12-week internship is to expose bachelor's students to the industrial work environment. During this period, students have the opportunity to be involved in on-going projects at the host institution.
Objective
see above
Prerequisites / notice
Please note the conditions for Internships in industry as set forward by the "Guidelines for the "Laboratory Courses - Projects - Seminars ", see http://www.ee.ethz.ch/fileadmin/user_upload/d-ite/neue_website/Factsheets/Reglemente/Richtlinien_Praktika-Projekte-Seminare_v5_final.pdf (German only).

Additional Subjects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0651-00L</td>
<td>Applied Circuit and PCB-Design</td>
<td>W</td>
<td>2 credits</td>
<td>4G</td>
<td>D. Schöni</td>
</tr>
</tbody>
</table>

Abstract
Participants learn how to design a predefined electronic circuit and how to lay out the pertaining circuit board. CAE and CAD activities for design and simulation is carried out with the aid of Altium Designer.

Objective
The goal is to become acquainted with all those practical aspects of electronic circuit and PCB design by working through a modest but complete application example. This involves analysis of specifications, the evaluation of electronic parts, efficient testing and failure search, electromagnetic compatibility (EMC), the usage of industrial CAE/CAD tools for circuit simulation and PCB layout, generating production data for the board manufacturer, board mounting, testing and start up.

Content
- Understanding circuit, system, and product specifications
- Guidelines, standards, and regulations
- Design and development flow
- Introduction to the Altium Designer environment
- Selection of components and circuit sizing
- Preparing schematic symbols and footprints for CAE/CAD
- Working with database component libraries
- Logically structured schematic circuit diagrams
- Capturing a predefined circuit
- Definition of net classes and layout rules in schematics
- Design for EMC
- Checking schematic data
- Simulation of mixed signal circuits using Spice
- Hints for improved testing and debugging
- Component placement on the PCB
- Turning circuit diagrams into a workable layout
- Manual and automatic interconnect routing
- Definition of layout rules
- RF- and EMC-guidelines for circuit wire routing
- Differential pairs and impedance-controlled routing
- Introduction to PCB manufacturing
- Preparation of production and assembly data
- PCB and device assembly (component mounting)
- Final circuit testing and start up

Prerequisites / notice
- The course is recommended to all students who plan to design an electronic circuit or a PCB in an upcoming term project or as part of their master thesis. Attending this course during the term before will ensure they are optimally prepared and will allow them to fully focus on their project.
- The number of participants is limited.
- For their own students and staff, the Department of Information Technology and Electrical Engineering provides electronic components and consumables free of charge. All other participants have to bear a 200 CHF fee for those items.

Third Year Core Courses
Can be freely combined, a list of recommendations is available under www.ee.ethz.ch/bachelor-kernfaecher

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0101-00L</td>
<td>Discrete-Time and Statistical Signal Processing</td>
<td>W</td>
<td>6 credits</td>
<td>4G</td>
<td>H.A. Loeliger</td>
</tr>
</tbody>
</table>

Abstract
The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications: discrete-time linear filters, equalization, DFT, discrete-time stochastic processes, elements of detection theory and estimation theory, LMMSE estimation and LMMSE filtering, LMS algorithm, Viterbi algorithm.

Objective
The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications. The two main themes are "linearity" and "probability". In the first part of the course, we deepen our understanding of discrete-time linear filters. In the second part of the course, we review the basics of probability theory and discrete-time stochastic processes. We then discuss some basic concepts of detection theory and estimation theory, as well as some practical methods including LMMSE estimation and LMMSE filtering, the LMS algorithm, and the Viterbi algorithm.

Content
Discrete-time linear systems and the z-transform.
Discrete time and continuous time: forth and back.
Digital filters.
DFT.
Elements of probability theory.
Discrete-time stochastic processes.
Elements of detection theory and estimation theory.
Linear estimation and filtering.
Wiener filter.
LMS algorithm.
Viterbi algorithm.

Lecture notes
Lecture Notes.
Abstract
Introduction to discrete event systems. We start out by studying popular models of discrete event systems. In the second part of the course we analyze discrete event systems from an average-case and from a worst-case perspective. Topics include: Automata and Languages, Specification Models, Stochastic Discrete Event Systems, Worst-Case Event Systems, Verification, Network Calculus.

Objective
Over the past few decades the rapid evolution of computing, communication, and information technologies has brought about the proliferation of new dynamic systems. A significant part of activity in these systems is governed by operational rules designed by humans. The dynamics of these systems are characterized by asynchronous occurrences of discrete events, some controlled (e.g. hitting a keyboard key, sending a message), some not (e.g. spontaneous failure, packet loss).

The mathematical arsenal centered around differential equations that has been employed in systems engineering to model and study processes governed by the laws of nature is often inadequate or inappropriate for discrete event systems. The challenge is to develop new modeling frameworks, analysis techniques, design tools, testing methods, and optimization processes for this new generation of systems.

In this lecture we give an introduction to discrete event systems. We start out the course by studying popular models of discrete event systems, such as automata and Petri nets. In the second part of the course we analyze discrete event systems. We first examine discrete event systems from an average-case perspective: we model discrete events as stochastic processes, and then apply Markov chains and queueing theory for an understanding of the typical behavior of a system. In the last part of the course we analyze discrete event systems from a worst-case perspective using the theory of online algorithms and adversarial queueing.

Content
1. Introduction
2. Automata and Languages
3. Smarter Automata
4. Specification Models
5. Stochastic Discrete Event Systems
6. Worst-Case Event Systems
7. Network Calculus

Lecture notes
Available

Literature
[bertsekas] Data Networks
Dimitri Bertsekas, Robert Gallager

[borodin] Online Computation and Competitive Analysis
Allan Borodin, Ran El-Yaniv
Cambridge University Press, 1998

[boudec] Network Calculus
J.-Y. Le Boudec, P. Thiran
Springer, 2001

[cassandras] Introduction to Discrete Event Systems
Christos Cassandras, Stéphane Lafortune

[dit] Online Algorithms: The State of the Art
A. Fiat and G. Woeginger

D. Hochbaum

[schickinger] Diskrete Strukturen (Band 2: Wahrscheinlichkeitstheorie und Statistik)
T. Schickinger, A. Steger
Springer, Berlin, 2001

[sipser] Introduction to the Theory of Computation
Michael Sipser

227-0103-00L Control Systems W 6 credits 2V+2U M. Morari, F. Dörfler

Abstract
Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.

Objective
Design of control systems for single input - single output and multivariable systems.

Content

Lecture notes
Slides can be downloaded from the course website. A printed version with additional content is offered via SPOD (student print on demand) for a fee (ca. 10-15 CHF).

Literature

Prerequisites / notice
Prerequisites: Signal and Systems Theory II.
MATLAB is used for system analysis and simulation.

227-0112-00L High-Speed Signal Propagation W 6 credits 2V+2U C. Bolognesi

Abstract
Understanding of high-speed signal propagation in microwave cables and integrated circuits and printed circuit boards.

As clock frequencies rise in the GHz domain, there is a need grasp signal propagation to maintain good signal integrity in the face of symbol interference and cross-talk.

The course is of high value to all interested in high-speed analog (RF, microwave) or digital systems.

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 449 of 1434
Objective
Understanding of high-speed signal propagation in interconnects, microwave cables and integrated transmission lines such as microwave integrated circuits and/or printed circuit boards.

As system clock frequencies continuously rise in the GHz domain, a need urgently develops to understand high-speed signal propagation in order to maintain good signal integrity in the face of phenomena such as inter-symbol interference (ISI) and cross-talk.

Concepts such as Scattering parameters (or S-parameters) are key to the characterization of networks over wide bandwidths. At high frequencies, all structures effectively become "transmission lines." Unless care is taken, it is highly probable that one ends-up with a bad transmission line that causes the designed system to malfunction.

Filters will also be considered because it turns out that some of the problems associated with lossy transmission channels (lines, cables, etc) can be corrected by adequate filtering in a process called "equalization."

Content

Butterworth-, Chebyshev- and Bessel filter approximations: filter synthesis from low-pass filter prototypes.

Lecture notes
Script: Leitungen und Filter (In German).

Prerequisites / notice
Exercises will be held in German, but assistants also speak English.

227-0113-00L
Power Electronics W 6 credits 4G J. W. Kolar

Abstract
Fields of application of power electronic systems. Principle of operation of basic pulse-width-modulated and line-commutated power electronic converters, analysis of the operating behavior and of the control oriented behavior, converter design. Reduction of effects of line-commutated rectifiers on the mains, electromagnetic compatibility.

Objective
Fields of application of power electronic systems. Principle of operation of basic pulse-width-modulated and line-commutated power electronic converters, analysis of the operating behavior and of the control oriented behavior, converter design. Reduction of effects of line-commutated rectifiers on the mains, electromagnetic compatibility.

Content

Lecture notes
Lecture notes and associated exercises including correct answers, simulation program for interactive self-learning including visualization/animation features.

Prerequisites / notice
Prerequisites: Basic knowledge of electric circuit analysis and signal theory.

227-0121-00L
Communication Systems W 6 credits 4G A. Wittneben

Abstract
Information Theory, Signal Space Analysis, Baseband Transmission, Passband Transmission, Example and Channel, Data Link Layer, MAC, Example Layer 2, Layer 3, Internet

Objective
Introduction into the fundamentals of digital communication systems. Selected examples on the application of the fundamental principles in existing and upcoming communication systems

Content
Covered are the lower three layer of the OSI reference model: the physical, the data link, and the network layer. The basic terms of information theory are introduced. After this, we focus on the methods for the point to point communication, which may be addressed elegantly and coherently in the signal space. Methods for error detection and correction as well as protocols for the retransmission of perturbed data will be covered. Also the medium access for systems with shared medium will be discussed. Finally, algorithms for routing and flow control will be treated.

The application of the basic methods will be extensively explained using existing and future wireless and wired systems.

Lecture notes
Lecture Slides

Literature

227-0122-00L
Introduction to Electric Power Transmission: System W 6 credits 4G C. Franck, G. Hug & Technology

Abstract
Introduction to theory and technology of electric power systems.

Objective
At the end of this course, the student will be able to: describe the structure of electric power systems, name the most important components and describe what they are needed for, apply models for transformers and lines, explain the technology of power lines and switchgear, calculate stationary power flows and other basic parameters in simple power systems.

Content
Structure of electric power systems, transformer and power line models, analysis of and power flow calculation in basic systems, symmetrical and unsymmetrical three-phase systems, transient current and voltage processes, technology and principle of electric power systems, HVDC and FACTS.

Lecture notes
Lecture script in English, exercises and sample solutions, translation of important vocabulary: english-german.

227-0145-00L
Solid State Electronics W 6 credits 4G V. Wood

Abstract
"Solid State Electronics" is an introductory condensed matter physics course covering crystal structure, electron models, classification of metals, semiconductors, and insulators, band structure engineering, thermal and electronic transport in solids, magnetoresistance, and optical properties of solids.

Objective
Understand the fundamental physics behind the mechanical, thermal, electric, magnetic, and optical properties of materials.

Lecture notes
Website: http://www.iis.ee.ethz.ch/stud_area/vorlesungen/solidstateelectronics.en.html
Recommended background: Undergraduate physics, mathematics, semiconductor devices

227-0166-00L
Analog Integrated Circuits W 6 credits 2V+2U Q. Huang

Abstract
This course provides a foundation in analog integrated circuit design based on bipolar and CMOS technologies.
Various studies are used to introduce basic sociological concepts, theories and empirical research methods, along with selected Webbs A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011 conversation.

handout.

discussed. The exercise sessions aim to reinforce the lecture material by well guided step-by-step design tasks. The circuit simulator SPECTRE is used to facilitate the tasks. There is also an experimental session on op-amp measurements.

Handouts of presented slides. No script but an accompanying textbook is recommended.

Lecture notes


S. Kozerke

5G

ECTS

Biomedical Imaging

New course. Not to be confused with 227-0385-00L of fall 2014.

Abstract

Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.

Objective

To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

Content

- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

Lecture notes

Lecture notes and handouts

Literature

Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011

Prerequisites / notice

Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

Ejectives

This is but a short selection. Other courses from the ETH course catalogue may be chosen. Please consult the "Richtlinien zu Projekten, Praktika, Seminare" (German only), published on our website (http://www.ee.ethz.ch/pps-richtlinien).

Man-Technology-Environment Electives ("MTU")

Number

227-0802-01L

Title

Social Psychology

Type

W

ECTS

2 credits

2G

Hours

Lecturers

H.D. Daniel, R. Mutz

Abstract

The lecture covers the following main topics: Social perception and interpersonal judgement; attitudes; group dynamics and group performance; leadership behavior and leadership styles.

Objective

The aim of the lecture is to impart a well-founded scientific understanding of social influence processes in individuals, groups, organizations, and social settings.

Content

Im Einzelnen sollen die Teilnehmerinnen und Teilnehmer lernen:
- an den Beispielen von Kaufverhalten oder ökologischem Verhalten zu beschreiben, wie Normen und Einstellungen Einfluss auf das Verhalten nehmen,
- Die Subjektivität und die Fehlerquellen sozialer Wahrnehmung verstehen,
- Prinzipien der Psychologie der Kommunikation zu nutzen für eine Verbesserung der Kommunikation in Studium und Beruf,
- Merkmale und Strukturen von Gruppen zu identifizieren und mit geeigneten Methoden zu analysieren,
- Die Grundlagen von Konformität und Gehorsam gegenüber Autoritäten zu erkennen,
- Gruppenphänomene wie soziales Faulenzen, Risiko- und Konservatismus-Schübe und Gruppendenken entgegenzuwirken,
- Gruppenleistungen und -entscheidungen zu optimieren,
- Führungsstile zu unterscheiden lernen,
- Techniken zur Moderation von interagierenden Gruppen kennen zu lernen.

Lecture notes

kein Skript

Literature


Prerequisites / notice

Es werden für D-ITET-Studierende Gruppenarbeiten (6 Kreditpunkte) in Form eines 3-tätigen computer-unterstützten Assessments fachübergreifender Kompetenzen angeboten. (Teilnehmerzahl beschränkt auf 12 Studierende). Die Teilnehmenden verfassen Berichte, die verfolgen Berichte, die von den zu benoteten werden.

227-0802-02L

Sociology

W

2 credits

2V

A. Diekmann

Abstract

Various studies are used to introduce basic sociological concepts, theories and empirical research methods, along with selected sociological topics. The goal of the course is to provide participants with an understanding of working practice in empirical sociology and the central findings of sociological studies.

Objective

To learn about methods of empirical social research and key results of classic and modern sociological studies.
Content


Folgende Themen werden behandelt:


Gruppenarbeiten

- Schriftliche Arbeit in Soziologie (Durchführung einer kleinen empirischen Studie, Konstruktion eines Simulationsmodells sozialer Prozesse oder Diskussion einer vorliegenden soziologischen Untersuchung).

Literature

- Folien der Vorlesung im Internet
- Further documents will be available online (see https://moodle-app2.let.ethz.ch/course/view.php?id=1596).

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-0621-00L</td>
<td>Microsystems Technology</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>C. Hierold, M. Haluska</td>
</tr>
<tr>
<td>Abstract</td>
<td>Students are introduced to the basics of micromachining and silicon process technology and will learn about the fabrication of microsystems and -devices by a sequence of defined processing steps (process flow).</td>
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<tr>
<td>Objective</td>
<td>Students are able to identify basic structures of the legal system. They understand selected topics of public and private law and are able to apply the fundamentals in more advanced law classes.</td>
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<tr>
<td>Content</td>
<td>This class introduces students into basic features of the legal system. Fundamental issues of constitutional law, administrative law, private law and the law of the EU are covered.</td>
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<tr>
<td>Lecture notes</td>
<td>Handouts (available online)</td>
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<tr>
<td>Literature</td>
<td>- S.M. Sze: Semiconductor Devices, Physics and Technology</td>
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<td></td>
<td>- W. Menz, J. Mohr, O.Paul: Microsystem Technology</td>
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<tr>
<td></td>
<td>- G. Kovacs: Micromachined Transducer Sourcebook</td>
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</table>

Prerequisites / notice

Prerequisites: Physics I and II

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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>376-0021-00L</td>
<td>Introduction to Biomedical Engineering I</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>R. Müller, P. Christen, J. G. Snedeker, M. Zenobi-Wong</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to biomechanics, biomaterials, tissue engineering, medical imaging as well as the history of biomedical engineering.</td>
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<tr>
<td>Objective</td>
<td>Understanding of physical and technical principles in biomechanics, biomaterials, tissue engineering, medical imaging as well as the history of biomedical engineering. Mathematical description and problem solving. Knowledge of biomedical engineering applications in research and clinical practice.</td>
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<tr>
<td>Content</td>
<td>Tissue and Cellular Biomechanics, Molecular Biomechanics and Biopolymers, Computational Biomechanics, Biomaterials, Tissue Engineering, Radiation and Radiographic Imaging, Diagnostic Ultrasound Imaging, Magnetic Resonance Imaging, Biomedical Optics and Lasers.</td>
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<tr>
<td>Lecture notes</td>
<td>Stored on ILIAS.</td>
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<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>363-0305-00L</td>
<td>Empirical Methods in Management</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>A. Scherer</td>
</tr>
</tbody>
</table>

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 452 of 1434
Abstract

Evidence-based management requires valid empirical research. In this course, students will learn the basics of research design, fundamentals of data collection and statistical methods to analyze the data acquired in social science research. Students are expected to apply their knowledge in class discussions and out-of-class assignments.

Objective

- Ability to formulate research questions and designing an appropriate study
- Ability to collect and analyze data using a variety of methods
- Ability to critically assess the quality of empirical research in management
- Applied knowledge of empirical methods through out-of-class assignments

Content

1) Introduction to empirical management research
2) Research designs: exploratory, descriptive, experimental
3) Measurement and scaling
4) Data collection and sampling
5) Data analysis methods
6) Reporting and presenting empirical research

B-i-weekly out-of-class assignments and projects on covered subjects

Prerequisites / notice

Assignments and projects: This course includes out-of-class assignments and projects to give students some hands-on experience in conducting empirical research in management. Projects will focus on one particular aspect of empirical research, like the formulation of a research question or the design of a study. Students will have at least one week to work on each assignment. Students are expected to work on these assignments individually. Duplicate answers will receive no credit and will be subject to a disciplinary review. Assignments will be graded and need to be turned-in on time. Exemplary answers to the assignments will be posted online after the submission date for students to review. Some assignments will also be discussed in class.

Class participation: Class participation is encouraged and can greatly improve students' learning in this class. Class participation will not be graded; however, it will be considered favorably if a student is between grades. Note, however, that quality is more important than quantity. In this spirit, students are expected to attend class regularly and come to class prepared.

363-0503-00L Principles of Microeconomics

Abstract

The course introduces basic principles, problems and approaches of microeconomics.

Objective

The course includes the following main topics:

- Basic principles of demand and supply, market and state in a modern economy, externalities, cost analysis, consumer behaviour, economies of scale and economies of scope, perfect competition, monopoly, oligopoly, monopolistic competition, mathematical treatment of some basic concepts.

Lecture notes

Lecture notes, exercises and reference material can be downloaded from Moodle.

Literature


The book can also be used for the course 'Principles of Macroeconomics' (Sturm)

For students taking only the course 'Principles of Microeconomics' there is a shorter version of the same book:


Complementary:


Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-ITET.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Electrical Engineering and Information Technology Bachelor - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Compulsory</th>
<th>Eligible for credits and recommended</th>
<th>Eligible for credits</th>
<th>Recommended, not eligible for credits</th>
<th>Courses outside the curriculum</th>
<th>Suitable for doctorate</th>
<th>practice/laboratory course</th>
<th>independent project</th>
<th>diploma thesis</th>
<th>revision course / private study</th>
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</table>

Key for Hours

V lecture
G lecture with exercise
U exercise
S seminar
K colloquium

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Educational Science

General course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma, MAS SHE and TC".

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>851-0240-22L</td>
<td>Coping with Psychosocial Demands of Teaching (EW4 W DZ) Number of participants limited to 20.</td>
<td>W</td>
<td>2</td>
<td>3S</td>
<td>A. Deiglmayr, P. Greutmann, S. Hofer</td>
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<tr>
<td></td>
<td>The successful participation in EW1 (&quot;Human Learning&quot;) and EW2 (&quot;Designing Learning Environments for School&quot;) is recommended, but not a mandatory prerequisite.</td>
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<tr>
<td></td>
<td>In this class, students will learn concepts and skills for coping with psychosocial demands of teaching</td>
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<td>(1) They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents).</td>
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<td>(2) They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions).</td>
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<tr>
<td>851-0242-06L</td>
<td>Cognitively Activating Instructions in MINT Subjects Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>R. Schumacher</td>
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<tr>
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<td>Number of participants limited to 30.</td>
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<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<td>This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.</td>
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<td></td>
<td>- Get to know cognitively activating instructions in MINT subjects</td>
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<td></td>
<td>- Get information about recent literature on learning and instruction</td>
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<td>Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.</td>
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<tr>
<td>851-0242-07L</td>
<td>Human Intelligence Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner, B. Rütsche</td>
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<td></td>
<td>Number of participants limited to 30.</td>
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<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<td>The focus will be on the book &quot;Intelligenz: Grosse Unterschiede und ihre Folgen&quot; by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.</td>
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<td></td>
<td>- Understanding of research methods used in the empirical human sciences</td>
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<td>- Getting to know intelligence tests</td>
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<td></td>
<td>- Understanding findings relevant for education</td>
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<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science Number of participants limited to 30.</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler</td>
</tr>
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<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<td>Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and two further meetings will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.</td>
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<td></td>
<td>- Understand research methods used in the empirical educational sciences</td>
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<td></td>
<td>- Understand and critically examine information from scientific journals and media</td>
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<td></td>
<td>- Understand pedagogically relevant findings from the empirical educational sciences</td>
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</table>

Subject Didactics and Professional Training

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0859-00L</td>
<td>Teaching Internship Including Examination Lessons Electrical Engineering and Information Technology Only for students who enrolled before HS 2011 into TC.</td>
<td>W</td>
<td>4</td>
<td>9P</td>
<td>M. Thaler</td>
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<tr>
<td></td>
<td>The teaching internship can only be visited if all other courses of TC have been completed. Repetition of the teaching internship is no possible, also if the examination lessons have to be repeated.</td>
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<td></td>
<td>Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as assessed as Examination Lessons.</td>
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</table>
Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt. Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching. In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.


Anlässlich der Hospitationen erläutert die Praktikumslehrperson ihre fachlichen, fachdidaktischen und pädagogischen Überlegungen, auf deren Basis sie den Unterricht geplant hat und tauscht sich mit dem/der Studierenden aus. Die von dem/der Studierenden gehaltenen Lektionen werden vor- und nachbesprochen.

Die Themen für die beiden Prüfungslektionen am Schluss des Praktikums erfahren die Studierenden in der Regel eine Woche vor dem Prüfungstermin. Sie erstellen eine Vorbereitung gemäss Anleitung und reichen sie bis am Vortrag um 12 Uhr den beiden Prüfungsexperten (Fachdidaktiker/-in, Departementsvertreter/-in) ein. Die gehaltenen Lektionen werden kriteriumsbasiert beurteilt. Die Beurteilung umfasst auch die schriftliche Vorbereitung und eine mündliche Reflexion des Kandidaten/der Kandidatin über die gehaltenen Lektionen im Rahmen eines kurzen Kolloquiums.

Teaching Internship Including Examination Lessons - Electrical Engineering and Information Technology

Only for students who enrolled from HS 2011 on into TC.

Prerequisites: successful completion of FD I and FD II.

In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

The Fachgebiet richtet sich nach dem aktuellen Unterrichtsprogramm des betreuenden FH/BMS-Dozenten. Die anzuwendende grösse didakt. Methode ist zum Stoff und Programm passend auszuwählen aus - (Mini-) Leitprogramm - Gelenktes Entdeckendes Lernen - Puzzle - Werkstatt - Projektarbeit

Zu diesen Themen sind die vorhandenen Manuals aus den IFV zu verwenden, bzw. wo nötig zu adaptieren.

The teaching internship can just be visited if all other courses of TC are completed.

Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as assessed as Examination Lessons.

Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance. They learn the skills of the teaching trade. They learn to assess pupils' work.

The objective for the students:
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They apply the insights, abilities and skills they have acquired within the context of an educational institution.
- They learn to assess pupils' work.
- They learn to assess pupils' work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.
Subject Didactics I for D-MAVT and D-ITET

**Abstract**
Didactical methods in mechanical and electrical engineering.

**Objective**
- The students can plan, conduct and critically reflect single lessons.
- They orient themselves towards the academic goals and take into account existing knowledge, the professional environment and the ambitions of the students.
- They can apply the basic teaching principles meaningfully in their subject and suitably structure the learning phases.
- They can reduce and present complex technical content such that it is in a form suitable for the students to learn.
- They have considered examples of the common conceptual errors encountered by students

**Content**
- Didactic analysis
- Competences and goals
- Preparation and wrap-up of lessons
- Process and structure of a typical lesson
- Teaching techniques (informative introduction to lessons, Advance Organizer, learning assignments, frontal teaching, questions, assignments, feedback)
- Assignments and short tests
- Media and language competence
- Conceptual change, misconceptions,
- Integration of the subcomponents of a lesson.

**Literature**

**Prerequisites / notice**
Voraussetzung: Erziehungswissenschaftliche Lehrveranstaltung schon absolviert oder gleichzeitig.

**Further Subject Didactics**

**Number**
227-0854-00L

**Title**
Mentored Work Subject Didactics Electrical Engineering and Information Technology II

**Description**
Prerequisites: successful completion of FD I and FD II

**Objective**
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

**Content**
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

**Literature**
K. Frey, Allgemeine Didaktik, FH-Skript bzw. Lehrbuch des Praktikumslehrers.

**Prerequisites / notice**
Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

**Electrical Engineering and Information Technology TC - Key for Type**

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
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<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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</tbody>
</table>
### Key for Hours

<table>
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<tr>
<th>Code</th>
<th>Description</th>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
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<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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</table>

**ECTS**

- European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
**Information Theory I**

- **ECTS**: 
- **Signal and Information Processing: Modeling, Filtering, Learning**
- **Type**: 5G
- **Lecturers**: A. Lapidoth
- **Prerequisites**: H. Kaeslin, N. Felber
- **Abstract**: This second course in our VLSI series is concerned with how to turn digital netlists into safe, testable and manufacturable mask layout, taking into account various parasitic effects (clock skew, metastability, ground bounce, IR-drop, electromigration, ESD, latchup). Economic aspects and management issues of VLSI projects are also addressed.
- **Objective**: Know how to design digital VLSI circuits that are safe, testable, durable, and make economic sense.
- **Content**: The second course begins with a thorough discussion of various technical aspects at the circuit and layout level before moving on to economic issues of VLSI. Topics include:
  - Limitations of functional design verification, design for test.
  - Synchronous clocking disciplines compared, clock skew, clock distribution, input/output timing.
  - Synchronization and metastability.
  - CMOS transistor-level circuits of gates, flip-flops and random access memories.
  - Sinks of energy in CMOS circuits.
  - Power estimation and low-power design.
  - Current research in low-energy computing.
  - Layout parasitics, interconnect delay, static timing analysis.
  - Switching currents, ground bounce, IR-drop, power distribution.
  - Floorplanning, chip assembly, packaging.
  - Layout design at the mask level, physical design verification.
  - Electromigration, electrostatic discharge, and latch-up.
  - Models of industrial cooperation in microelectronics.
  - The caveats of virtual components.
  - The cost structures of ASIC development and manufacturing.
  - Market requirements, decision criteria, and case studies.
  - Yield models.
  - Avenues to low-volume fabrication.
  - Marketing aspects and case studies.
  - Management of VLSI projects.
- **Exercises**: Exercises are concerned with back-end design (floorplanning, placement, routing, clock and power distribution, layout verification).
- **Industrial CAD tools**: Industrial CAD tools are being used.
- **Lecture notes**: All written documents in English.

---

**Communication**

- **ECTS**: 
- **Core Subjects**: These core subjects are particularly recommended for the field of "Communication".

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**Core Courses**

- **English lecture notes**: All written documents in English.
- **Literature**: T.M. Cover and J. Thomas, Elements of Information Theory (second edition)
- **Prerequisites**: Additional courses, such as Discrete-Time and Statistical Signal Processing (5. Sem.)
- **Prerequisites**: Passing courses in linear algebra and probability theory.

---

**Further details**: http://www.iis.ee.ethz.ch/stud_area/vorlesungen/vlsi2.en.html
Over the past few decades the rapid evolution of computing, communication, and information technologies has brought about the proliferation of new dynamic systems. A significant part of activity in these systems is governed by operational rules designed by humans. The dynamics of these systems are characterized by asynchronous occurrences of discrete events, some controlled (e.g. hitting a keyboard key, sending a message), some not (e.g. spontaneous failure, packet loss).

The mathematical arsenal centered around differential equations that has been employed in systems engineering to model and study processes governed by the laws of nature is often inadequate or inappropriate for discrete event systems. The challenge is to develop new modeling frameworks, analysis techniques, design tools, testing methods, and optimization processes for this new generation of systems.

In this lecture we give an introduction to discrete event systems. We start out by studying popular models of discrete event systems, in the second part of the course we analyze discrete event systems from an average-case perspective and from a worst-case perspective. Topics include: Automata and Languages, Specification Models, Stochastic Discrete Event Systems, Worst-Case Event Systems, Verification, Network Calculus.

The past few decades have seen a proliferation of new dynamic systems. A significant part of activity in these systems is governed by operational rules designed by humans. The dynamics of these systems are characterized by asynchronous occurrences of discrete events, some controlled (e.g. hitting a keyboard key, sending a message), some not (e.g. spontaneous failure, packet loss).

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These courses are recommended, but you are free to choose courses from any other special field. Please consult your tutor.

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0102-00L</td>
<td>Discrete Event Systems</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>L. Thiele, L. Vanbever, R. Wattenhofer</td>
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</tbody>
</table>

Abstract

Introduction to discrete event systems. We start out by studying popular models of discrete event systems, in the second part of the course we analyze discrete event systems from an average-case perspective and from a worst-case perspective. Topics include: Automata and Languages, Specification Models, Stochastic Discrete Event Systems, Worst-Case Event Systems, Verification, Network Calculus.

Objective

Over the past few decades the rapid evolution of computing, communication, and information technologies has brought about the proliferation of new dynamic systems. A significant part of activity in these systems is governed by operational rules designed by humans. The dynamics of these systems are characterized by asynchronous occurrences of discrete events, some controlled (e.g. hitting a keyboard key, sending a message), some not (e.g. spontaneous failure, packet loss).

Content

1. Introduction
2. Automata and Languages
3. Smarter Automata
4. Specification Models
5. Stochastic Discrete Event Systems
6. Worst-Case Event Systems
7. Network Calculus

Lecture notes

Available

Literature

[bertsekas] Data Networks
Dimitri Bertsekas, Robert Gallager

[borodin] Online Computation and Competitive Analysis
Allan Borodin, Ran El-Yaniv
Cambridge University Press, 1998

[boudec] Network Calculus
J.-Y. Le Boudec, P. Thiran
Springer, 2001

[cassandras] Introduction to Discrete Event Systems
Christos Cassandras, Stéphane Lafortune

[fiat] Online Algorithms: The State of the Art
A. Fiat and G. Woeginger
D. Hochbaum

T. Schickinger, A. Steger
Springer, Berlin, 2001

[sipser] Introduction to the Theory of Computation
Michael Sipser

| 227-0103-00L | Control Systems | W      | 6    | 2V+2U | M. Morari, F. Dörfler |

Data: 06.02.2019 13:00   Autumn Semester 2015
Understanding of high-speed signal propagation in interconnects, microwave cables and integrated transmission lines such as microwave

High-Speed Signal Propagation

An in-depth understanding on how information is transmitted from source to destination. Also the mathematical framework to describe the


J. Leuthold

Transmission line equations of the lossless and lossy TEM-transmission line. Introduction of current and voltage waves. Representation of


C. Bolognesi

Understanding of high-speed signal propagation in microwave cables and integrated circuits and printed circuit boards.

Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of

Integrated circuits are responsible for much of the progress in electronics in the last 50 years, particularly the revolutions in the Information

Analog Integrated Circuits

This course provides a foundation in analog integrated circuit design based on bipolar and CMOS technologies.

Integrated circuits are responsible for much of the progress in electronics in the last 50 years, particularly the revolutions in the Information

Optical Communication Fundamentals

The path of an analog signal in the transmitter to the digital world in a communication link and back to the analog world at the receiver is

The exercise sessions aim to reinforce the lecture material by well guided step-by-step design tasks. The circuit simulator SPECTRE is

MATLAB is used for system analysis and simulation.

Prerequisites / notice

MATLAB is used for system analysis and simulation.

Prerequisites: Signal and Systems Theory II.

Prerequisites / notice

227-0112-00L High-Speed Signal Propagation W 6 credits 2V+2U C. Bolognesi

Abstract

Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.

Objective

Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.

Content


Lecture notes

Slides can be downloaded from the course website. A printed version with additional content is offered via SPOD (student print on demand) for a fee (ca. 10-15 CHF).

Literature


Prerequisites / notice

MATLAB is used for system analysis and simulation.

227-0166-00L Analog Integrated Circuits W 6 credits 2V+2U Q. Huang

Abstract

This course provides a foundation in analog integrated circuit design based on bipolar and CMOS technologies.

Objective

Integrated circuits are responsible for much of the progress in electronics in the last 50 years, particularly the revolutions in the Information and Communications Technologies we witnessed in recent years. Analog integrated circuits play a crucial part in the highly integrated systems that power the popular electronic devices we use daily. Understanding their design is beneficial to both future designers and users of such systems.

The basic elements, design issues and techniques for analog integrated circuits will be taught in this course.

Content

Review of bipolar and MOS devices and their small-signal equivalent circuit models; Building blocks in analog circuits such as current sources, active load, current mirrors, supply independent biasing etc; Amplifiers: differential amplifiers, cascode amplifier, high gain structures, output stages, gain bandwidth product of op-amps; Stability; Comparators; Second-order effects in analog circuits such as mismatch, noise and offset; A/D and D/A converters; Introduction to switched capacitor circuits.

The exercise sessions aim to reinforce the lecture material by well guided step-by-step design tasks. The circuit simulator SPECTRE is used to facilitate the tasks. There is also an experimental session on op-amp measurements.

Lecture notes

Handouts of presented slides. No script but an accompanying textbook is recommended.

Literature


227-0301-00L Optical Communication Fundamentals W 6 credits 2V+1U+1P J. Leuthold

Abstract

This course provides a foundation in analog integrated circuit design based on bipolar and CMOS technologies.

Objective

The path of an analog signal in the transmitter to the digital world in a communication link and back to the analog world at the receiver is discussed. The lecture covers the fundamentals of all important optical and optoelectronic components in a fiber communication system.

This includes the transmitter, the fiber channel and the receiver with the electronic digital signal processing elements. An in-depth understanding on how information is transmitted from source to destination. Also the mathematical framework to describe the important elements will be passed on. Students attending the lecture will further get engaged in critical discussion on societal, economical and environmental aspects related to the on-going exponential growth in the field of communications.
Failures have to be avoided by proper design, material selection and manufacturing. Properties, degradation mechanisms, and expected life of materials are introduced and the basics of failure analysis and analysis equipment are presented. Failures will be demonstrated experimentally and the opportunity is offered to perform a failure analysis with advanced equipment in the laboratory.

**Prerequisites:**
- A good understanding of concepts from linear algebra is sufficient.
- Basic knowledge about functional analysis (Banach and Hilbert spaces, linear operators and linear functionals) is helpful.
- We will, however, explain all these concepts as we go along.

**Content:**
- Time-frequency analysis (Short-time Fourier transform, Gabor frames, Gabor multipliers, best approximation of operators by Gabor multipliers, identification of slowly varying channels using pilot tones, etc.).
- Frequency analysis (Poisson formula, Fourier inversion, etc.).
- The course will introduce and develop a general theory of time-frequency analysis based on the foundations of the Banach Gelfand triple $S_0 \subset L^2 \subset S_0'$ (also called rigged Hilbert space), its use for signal processing and systems theory applications. In addition to classical questions we will also discuss the fundamental results of time-frequency analysis and its discretized version, namely Gabor Analysis.
- The course will focus on the rigorous establishment of basic results in signal processing (sampling theorem, Poisson formula, Fourier inversion, etc.). The course will be centered around the basics of the Banach Gelfand triple $(S_0, L^2, S_0')$ (also called rigged Hilbert space).
- Fourier Analysis and Systems Theory emphasize the analogy between the different settings (continuous&discrete, periodic&non-periodic). The author proposes a simple approach to generalized functions, based on a Banach space of test functions. The course provides the foundations to Banach Gelfand triples, but also concrete applications in signal processing (time-variant systems, sampling).
- Deeper mathematical understanding of the foundations of signal processing and system theory. The setting of Banach Gelfand Triples allows to provide a framework that allows among others to discuss the relations between different settings (e.g. the generalized Fourier transform of functions on the Euclidean space and corresponding FFT-based routines).
- Usually Fourier Analysis and Systems Theory emphasize the analogy between the different settings (continuous&discrete, periodic&non-periodic). The author proposes a simple approach to generalized functions, based on a Banach space of test functions. The course provides the foundations to Banach Gelfand triples, but also concrete applications in signal processing (time-variant systems, sampling).
- Time-Frequency Analysis and its discretized version, namely Gabor Analysis have required to develop a family of function spaces (the so-called modulation spaces, introduced by Feichtinger in the 80th) which is different from the usual Lebesgue spaces. There is a smallest space (called $S_0$) and a largest space (namely the dual space), which is a suitable reservoir of generalized functions relevant for the rigorous establishment of basic results in signal processing (sampling theorem, Poisson formula, Fourier inversion, etc.). The course will be centered around the basics of the Banach Gelfand triple $(S_0, L^2, S_0')$ (also called rigged Hilbert space), its use for signal processing and systems theory applications. In addition to classical questions we will also discuss the fundamental results of time-frequency analysis (Short-time Fourier transform, Gabor frames, Gabor multipliers, best approximation of operators by Gabor multipliers, identification of slowly varying channels using pilot tones, etc.).

**Literature**
- Goedel P. Agrawal; "Fiber-Optic Communication Systems"; Wiley, 2010
- H. G. Feichtinger

**Lecture notes / Prerequisites / notice**
- Comprehensive copy of transparencies
- Course material Script, computer demonstrations, exercises and problem solutions
- Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C.
- The course language is English.
Objective

This lecture provides a wide overview about analog filters (continuous-time and discrete-time), signal-processing systems, and sigma-delta conversion, and gives examples with sensor interfaces and class-D audio drivers. All systems and circuits are treated using a signal-flow view. The lecture is suitable for both analog and digital designers. The way the exam is done allows for the different interests of the two groups.

The learning goal is that the students can apply signal-flow graphs and can understand the signal flow in such circuits and systems (including non-ideal effects) well enough to gain an understanding of further circuits and systems by themselves.

Content

At the beginning, signal-flow graphs in general and driving-point signal-flow graphs in particular are introduced. We will use them during the whole term to analyze circuits and understand how signals propagate through them. The theory and CMOS implementation of active filters is then discussed in detail using the example of Gm-C filters and active-RC filters. The ideal and nonideal behaviour of opamps, current conveyors, and inductor simulators follows. The link to the practical design of circuits and systems is done with an overview over different quality measures and figures of merit used in scientific literature and datasheets. Finally, an introduction to discrete-time and mixed-domain filters and circuits is given, including sensor read-out amplifiers, correlated double sampling, and chopping, and an introduction to sigma-delta A/D and D/A conversion on a system level.

Lecture notes

The base for these lectures are lecture notes and two or three published scientific papers. From these papers we will together develop the technical content.

Details: https://people.ee.ethz.ch/~haschmid/asfwiki/

Prerequisites / notice

Some material is protected by password; students from ETHZ who are interested can write to haschmid@ethz.ch to ask for the password even if they do not attend the lecture.

Prerequisites: Recommended (but not required): Stochastic models and signal processing, Communication Electronics, Analog Integrated Circuits, Transmision Lines and Filters.

Knowledge of the Laplace transform and z transform and their interpretation (transfer functions, poles and zeros, bode diagrams, stability criteria ...) and of the main properties of linear systems is necessary.

Literature


G. DeMicheli, R. Ernst and W. Wolf, Readings in Hw/Sw Co-design, M. Kaufmann, 2003.


Prerequisites / notice

Prerequisites for the course is a basic knowledge in the following areas: computer architecture, digital design, software design, embedded systems

Lecture notes

Material for exercises, copies of transparencies.

227-0477-00L

Acoustics I

W

6 credits

4G

K. Heutschi

Abstract

Introduction to the fundamentals of acoustics in the area of sound field calculations, measurement of acoustical events, outdoor sound propagation and room acoustics of large and small enclosures.

Objective

Introduction to acoustics. Understanding of basic acoustical mechanisms. Survey of the technical literature. Illustration of measurement techniques in the laboratory.

Content

Fundamentals of acoustics, measuring and analyzing of acoustical events, anatomy and properties of the ear. Outdoor sound propagation, absorption and transmission of sound, room acoustics of large and small enclosures, architectural acoustics, noise and noise control, calculation of sound fields.

Lecture notes

yes

227-0778-00L

Hardware/Software Codesign

W

6 credits

2V+2U

L. Thiele

Abstract

The course provides advanced knowledge in the design of complex computer systems, in particular embedded systems. Models and methods are discussed that are fundamental for systems that consist of software and hardware components.

Objective

The course provides advanced knowledge in the design of complex computer systems, in particular embedded systems. Models and methods are discussed that are fundamental for systems that consist of software and hardware components.

Content

The course covers the following subjects: (a) Models for describing hardware and software components (specification), (b) Hardware-Software Interfaces (instruction set, hardware and software components, reconfigurable computing, heterogeneous computer architectures, System-on-Chip), (c) Application specific instruction sets, code generation and retargetable compilation, (d) Performance analysis and estimation techniques, (e) System design (hardware-software partitioning and design space exploration).

Lecture notes

Material for exercises, copies of transparencies.

Literature


G. DeMicheli, R. Ernst and W. Wolf, Readings in Hw/Sw Co-design, M. Kaufmann, 2003.

Prerequisites / notice

Prerequisites for the course is a basic knowledge in the following areas: computer architecture, digital design, software design, embedded systems

252-0535-00L

Machine Learning

W

6 credits

3V+2U

J. M. Buhmann

Abstract

Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

Objective

Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.

Content

The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:

- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

Lecture notes

No lecture notes, but slides will be made available on the course webpage.

Data: 06.02.2019 13:00

Autumn Semester 2015

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Network Security

J. Beutel


A detailed reading list will be made available in the lecture.

Students are aware of current threats that Internet services and networked devices face and can explain appropriate countermeasures.

Designing systems with a low energy footprint is an increasingly important task. There are many applications for low-power systems ranging from mobile devices powered from batteries such as today’s smart phones to energy efficient household appliances and datacenters. Key drivers are to be found mainly in the tremendous increase of mobile devices and the growing integration density requiring to carefully reason about power, both from a provision and consumption viewpoint. Traditional circuit design classes introduce low-power solely from a hardware perspective with a focus on the power performance of a single or at most a hand full of circuit elements. Similarly, low-power aspects are touched in a multitude of other classes, mostly as a side topic. However in successfully designing systems with a low energy footprint it is not sufficient to only look at low-power as an aspect of second class. In modern low-power system design advanced CMOS circuits are of course a key ingredient but successful low-power integration involves many more disciplines such as system architecture, different sources of energy as well as storage and most importantly software and algorithms. In this lecture we will discuss aspects of low-power design as a first class citizen introducing key concepts as well as modeling and measurement techniques focusing mainly on the design of networked embedded systems but of course equally applicable to many other classes of systems. The lecture is further accompanied by a reading seminar as well as exercises and lab sessions.

Due to recent changes in the Swiss law, ETH requires each student of this course to sign a written declaration that he/she will not use the information given in this for illegal purposes. This declaration will have to be signed and submitted no later than at the beginning of the second lesson.

Computers and Networks

Core Subjects

These core subjects are particularly recommended for the field of "Computers and Networks".

Number Title Type ECTS Hours Lecturers
227-0778-00L Hardware/Software Codesign W 6 credits 2V+2U L. Thiele
Abstract The course provides advanced knowledge in the design of complex computer systems, in particular embedded systems. Models and methods are discussed that are fundamental for systems that consist of software and hardware components.
Objective The course provides advanced knowledge in the design of complex computer systems, in particular embedded systems. Models and methods are discussed that are fundamental for systems that consist of software and hardware components.
Content The course covers the following subjects: (a) Models for describing hardware and software components (specification), (b) Hardware-Software Interfaces (instruction set, hardware and software components, reconfigurable computing, heterogeneous computer architectures, System-on-Chip), (c) Application specific instruction sets, code generation and retargetable compilation, (d) Performance analysis and estimation techniques, (e) System design (hardware-software partitioning and design space exploration).
Lecture notes Material for exercises, copies of transparencies.
Prerequisites / notice Prerequisites for the course is a basic knowledge in the following areas: computer architecture, digital design, software design, embedded systems.
227-0781-00L Low-Power System Design W 6 credits 2V+2U J. Beutel
Abstract Introduction to low-power and low-energy design techniques from a systems perspective including aspects both from hard- and software.
Objective Knowledge of the state-of-the-art in low power system design, understanding recent research results and their implication on industrial products.
Content Designing systems with a low energy footprint is an increasingly important. There are many applications for low-power systems ranging from mobile devices powered from batteries such as today’s smart phones to energy efficient household appliances and datacenters. Key drivers are to be found mainly in the tremendous increase of mobile devices and the growing integration density requiring to carefully reason about power, both from a provision and consumption viewpoint. Traditional circuit design classes introduce low-power solely from a hardware perspective with a focus on the power performance of a single or at most a hand full of circuit elements. Similarly, low-power aspects are touched in a multitude of other classes, mostly as a side topic. However in successfully designing systems with a low energy footprint it is not sufficient to only look at low-power as an aspect of second class. In modern low-power system design advanced CMOS circuits are of course a key ingredient but successful low-power integration involves many more disciplines such as system architecture, different sources of energy as well as storage and most importantly software and algorithms. In this lecture we will discuss aspects of low-power design as a first class citizen introducing key concepts as well as modeling and measurement techniques focusing mainly on the design of networked embedded systems but of course equally applicable to many other classes of systems. The lecture is further accompanied by a reading seminar as well as exercises and lab sessions.
Lecture notes Exercise and lab materials, copies of lecture slides.
Literature A detailed reading list will be made available in the lecture.
Prerequisites / notice Knowledge in embedded systems, system software, (wireless) networking, possibly integrated circuits, and hardware software codesign.
252-1414-00L System Security W 5 credits 2V+2U S. Capkun, A. Perrig

Abstract
The first part of the lecture covers individual system's aspects starting with tamperproof or tamperresistant hardware in general over operating system related security mechanisms to application software systems, such as host based intrusion detection systems. In the second part, the focus is on system design and methodologies for large projects.

Objective
In this lecture, students learn about the security requirements and capabilities that are expected from modern hardware, operating systems and other software environments. An overview of available technologies, algorithms and standards is given, with which these requirements can be met.

Content
The first part of the lecture covers individual system's aspects starting with tamperproof or tamperresistant hardware in general over operating system related security mechanisms to application software systems such as host based intrusion detection systems. The main topics covered are: tamper resistant hardware, CPU support for security, protection mechanisms in the kernel, file system security (permissions / ACLs / network filesystems), IPC Security, mechanisms in more modern OS, such as Capabilities and Zones, Libraries and Software tools for security assurance, etc.

In the second part, the focus is on system design and methodologies for large projects. The main question answered is how to get a large secure system. Topics include: patch management, common software faults (buffer overflows, etc.), writing secure software (design, architecture, QA, testing), compiler-supported security, language-supported security (java...), logging and auditing (BSM audit, dtrace, ...), cryptographic support, TCG, secure file systems, dos/windows\windowsXP security issues.

Along the lectures, model cases will be elaborated and evaluated in the exercises.

263-4640-00L Discrete-Time and Statistical Signal Processing W 6 credits 2V+1U+2P A. Perrig, T. P. Dübendorfer, S. Frei

Abstract
This lecture discusses fundamental concepts and technologies in the area of network security. Several case studies illustrate the dark side of the Internet and explain how to protect against such threats. A hands-on computer lab that accompanies the lecture gives a deep dive on firewalls, penetration testing and intrusion detection.

Objective
Students are aware of current threats that Internet services and networked devices face and can explain appropriate countermeasures. Students can identify and assess known vulnerabilities in a software system that is connected to the Internet. Students know fundamental network security concepts. Students have an in-depth understanding of important security technologies. Students know how to configure a real firewall and know some penetration testing tools from their own experience.

Content
Risk management and the vulnerability lifecycle of software and networked services are discussed. Threats like denial of service, spam, worms, and viruses are studied in-depth. Fundamental security related concepts like identity, availability, authentication and secure channels are introduced. State of the art technologies like secure shell, network and transport layer security, intrusion detection and prevention systems, cross-site scripting, secure implementation techniques and more for securing the Internet and web applications are presented. Several case studies illustrate the dark side of the Internet and explain how to protect against current threats. A hands-on computer lab that accompanies the lecture gives a deep dive on firewalls, penetration testing and intrusion detection.

This lecture is intended for students with an interest in securing Internet services and networked devices. Students are assumed to have knowledge in networking as taught in the Communication Networks lecture. This lecture and the exam are held in English.

Due to recent changes in the Swiss law, ETH requires each student of this course to sign a written declaration that he/she will not use the information given in this for illegal purposes. This declaration will have to be signed and submitted no later than at the beginning of the second lesson.

Recommended Subjects
These courses are recommended, but you are free to choose courses from any other special field. Please consult your tutor.

Number Title Type ECTS Hours Lecturers
227-0101-00L Discrete-Time and Statistical Signal Processing W 6 credits 4G H.A. Loeliger

Abstract
The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications: discrete-time linear filters, equalization, DFT, discrete-time stochastic processes, elements of detection theory and estimation theory, LMMSE estimation and LMMSE filtering, LMS algorithm, Viterbi algorithm.

Objective
The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications. The main topics covered are: "linearity" and "probability". In the first part of the course, we deepen our understanding of discrete-time linear filters. In the second part of the course, we review the basics of probability theory and discrete-time stochastic processes. We then discuss some basic concepts of detection theory and estimation theory, as well as some practical methods including LMMSE estimation and LMMSE filtering, the LMS algorithm, and the Viterbi algorithm.

Content

Lecture notes Lecture Notes.

227-0103-00L Control Systems W 6 credits 2V+2U M. Morari, F. Döbler

Abstract
Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.

Objective
Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.

Content

Lecture notes Slides can be downloaded from the course website. A printed version with additional content is offered via SPOD (student print on demand) for a fee (ca. 10-15 CHF).
Become acquainted with models and algorithms for distributed systems. MATLAB is used for system analysis and simulation.

**Literature**

**Prerequisites / notice**
Prerequisites: Signal and Systems Theory II.

**227-0197-00L**
**Wearable Systems I**

**Abstract**
Context recognition in mobile communication systems like mobile phone and wearable computer will be studied using advanced methods from sensor data fusion, pattern recognition, statistics, data mining and machine learning. Context comprises the behavior of individuals and of groups, their activities as well as the local and social environment.

**Objective**
Future mobile systems will act as personal and cooperative assistant by providing the appropriate information and services. The systems consist of a smart phone which communicates with sensors on-body and in the environment. Context comprises user's behavior, his activities, his local and social environment.

In the data path from the sensor level to signal segmentation to the classification of the context, advanced methods of signal processing, pattern recognition and machine learning will be applied. Sensor data generated by crowdsourcing methods are integrated. The validation using MATLAB is followed by implementation and testing on a smart phone.

Context recognition as the crucial function of mobile systems is the main focus of the course. Using Matlab the participants implement and verify the discussed methods also using a smart phone.

**Content**
The next generation of mobile communication systems is integrated in our clothes and act as personal and cooperative assistant providing information we need just now (see www.wearable.ethz.ch). Context recognition - what is the situation of the user, his activity, his environment, how is he doing, what are his needs - as the central functionality of mobile systems constitutes the focus of the course.

The main topics of the course include:

The exercises show concrete design problems like motion and gesture recognition using distributed sensors, detection of activity patterns and identification of the local environment.

Presentations of the PhD students and the visit at the Wearable Computing Lab introduce in current research topics and international research projects.

**Lecture notes**
Lecture notes for all lessons, assignments and solutions.
http://www.ife.ee.ethz.ch/education/wearable_systems_1

**Literature**
Literature will be announced during the lessons.

**227-0377-00L**
**Physics of Failure and Failure Analysis of Electronic Devices and Equipment**

**Abstract**
Failures have to be avoided by proper design, material selection and manufacturing. Properties, degradation mechanisms, and expected lifetime of materials are introduced and the basics of failure analysis and analysis equipment are presented. Failures will be demonstrated experimentally and the opportunity is offered to perform a failure analysis with advanced equipment in the laboratory.

**Objective**
Introduction to the degradation and failure mechanisms and causes of electronic components, devices and systems as well as to methods and tools of reliability testing, characterization and failure analysis.

**Content**
Summary of reliability and failure analysis terminology; physics of failure: materials properties, physical processes and failure mechanisms; failure analysis of ICs, PCBs, opto-electronics, discrete and other components and devices; basics and properties of instruments; application in circuit design and reliability analysis

**Lecture notes**
Comprehensive copy of transparencies

**252-0437-00L**
**Distributed Algorithms**

**Abstract**
Models of distributed computations, time space diagrams, virtual time, logical clocks and causality, wave algorithms, parallel and distributed graph traversal, consistent snapshots, mutual exclusion, election and symmetry breaking, distributed termination detection, garbage collection in distributed systems, monitoring distributed systems, global predicates.

**Objective**
Become acquainted with algorithms and models for distributed systems.

**Content**
Verteilte Algorithmen sind Verfahren, die dadurch charakterisiert sind, dass mehrere autonome Prozesse gleichzeitig Teile eines gemeinsamen Problems in kooperativer Weise bearbeiten und der dabei erforderliche Informationsaustausch ausschliesslich über Nachrichten erfolgt. Derartige Algorithmen kommen im Rahmen verteilter Systeme zum Einsatz, bei denen kein gemeinsamer Speicher existiert und die Übertragungszeit von Nachrichten i.a. nicht vernachlässigt werden kann. Da dabei kein Prozess eine aktuelle konsistente Sicht des globalen Zustands besitzt, führt dies zu interessanten Problemen.

Im einzelnen werden u.a. folgende Themen behandelt:
- Modelle verteilter Berechnungen; Raum-Zeit Diagramme; Virtuelle Zeit; Logische Uhren und Kausalität; Wellenalgorithmen; Verteilte und parallele Berechnung; Berechnung konsistenter Schnappschüsse; Wechselseitiger Ausschluss; Elektion und Symmetriebruch;
- Verteilte Terminierung; Garbage-Collection in verteilten Systemen; Beobachten verteilter Systeme; Berechnung globaler Prädikate.

**Literature**
- F. Mattern: Verteilte Basalgorithmen, Springer-Verlag
- G. Tel: Topics in Distributed Algorithms, Cambridge University Press
- G. Tel: Introduction to Distributed Algorithms, Cambridge University Press, 2nd edition

**227-0447-00L**
**Image Analysis and Computer Vision**

**Abstract**

**Objective**
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.
Lecture notes

Prerequisites / notice
Course material Script, computer demonstrations, exercises and problem solutions

Objective
Become acquainted with pertinent technologies and architectures of fault-tolerant distributed systems.

Content
We discuss fault-tolerance issues (models, consensus, agreement) as well as replication issues (primary copy, 2PC, 3PC, Paxos, quorum systems, distributed storage) and problems with asynchronous multiprocessing (shared memory; spin locks, concurrency).

Prerequisites / notice
This lecture takes place in the second half of the semester; the lecture is the second part of the lecture "Verteilte Systeme" (Distributed Systems, 252-0213-00L). Students may attend at most one of the two lectures.

Prerequisites:
Basics of computer architecture.

Course material
Script and exercises sheets.

Lecture notes

227-0555-00L
Fault Tolerance in Distributed Systems

Abstract
Fault-tolerance (failure models, consensus, agreement), replication (primary copy, 2PC, 3PC, Paxos, quorum systems, shared memory (spin locks, concurrency).

Objective
Become acquainted with pertinent technologies and architectures of fault-tolerant distributed systems.

Content
We discuss fault-tolerance issues (models, consensus, agreement) as well as replication issues (primary copy, 2PC, 3PC, Paxos, quorum systems, distributed storage) and problems with asynchronous multiprocessing (shared memory; spin locks, concurrency).

Prerequisites / notice
This lecture takes place in the second half of the semester; the lecture is the second part of the lecture "Verteilte Systeme" (Distributed Systems, 252-0213-00L). Students may attend at most one of the two lectures.

Prerequisites:
Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C.

The course language is English.

227-0627-00L
Applied Computer Architecture

Abstract
This lecture gives an overview of the requirements and the architecture of parallel computer systems, performance, reliability and costs.

Objective
Understand the function, the design and the performance modeling of parallel computer systems.

Content
The lecture "Applied Computer Architecture" gives technical and corporate insights in the innovative Computer Systems/Architectures (CPU, GPU, FPGA, special processors) and their real implementations and applications. Often the designs have to deal with technical limits.

Prerequisites:

151-0593-00L
Embedded Control Systems

Abstract
This course provides a comprehensive overview of embedded control systems. The concepts introduced are implemented and verified on a microprocessor-controlled haptic device.

Objective
Familiarize students with main architectural principles and concepts of embedded control systems.

Content
An embedded system is a microprocessor used as a component in another piece of technology, such as cell phones or automobiles. In this intensive two-week block course the students are presented the principles of embedded digital control systems using a haptic device as an example for a mechatronic system. A haptic interface allows for a human to interact with a computer through the sense of touch.

Subjects covered in lectures and practical lab exercises include:
- The application of C-programming on a microprocessor
- Digital I/O and serial communication
- Quadrature decoding for wheel position sensing
- Queued analog-to-digital conversion to interface with the analog world
- Pulse width modulation
- Timer interrupts to create sampling time intervals
- System dynamics and virtual worlds with haptic feedback
- Introduction to rapid prototyping

Lecture notes
Lecture notes, lab instructions, supplemental material

Prerequisites / notice
Prerequisite courses are Control Systems I and Informatics I.

Prerequisites:

252-1411-00L
Security of Wireless Networks

Abstract
Core Elements: Wireless communication channel, Wireless network architectures and protocols, Attacks on wireless networks, Protection techniques.

Objective
After this course, the students should be able to: describe and classify security goals and attacks in wireless networks; describe security architectures of the following wireless systems and networks: 802.11, GSM/UMTS, RFID, ad hoc(sensor networks; reason about security protocols for wireless network; implement mechanisms to secure 802.11 networks.

Content

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 466 of 1434
Future mobile systems will act as personal and cooperative assistants by providing the appropriate information and services. The systems will interact with the environment, how is he doing, what are his needs — as the central functionality of mobile systems constitutes the focus of the course.

Context recognition as the crucial function of mobile systems is the main focus of the course. Using MATLAB the participants implement and verify the discussed methods also using a smart phone.

In the data path from the sensor level to signal segmentation to the classification of the context, advanced methods of signal processing, pattern recognition and machine learning will be applied. Sensor data generated by crowdsourcing methods are integrated. The validation of the discussed methods includes the evaluation of the performance of the systems.

The next generation of mobile communication systems is integrated in our clothes and act as personal and cooperative assistants by providing the appropriate information and services. The systems consist of a smartphone which communicates with sensors on-body and in the environment. Context comprises user’s behavior, his activities, his local and social environment.

In the data path from the sensor level to signal segmentation to the classification of the context, advanced methods of signal processing, pattern recognition and machine learning will be applied. Sensor data generated by crowdsourcing methods are integrated. The validation of the discussed methods includes the evaluation of the performance of the systems.

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Neuromorphic circuits are inspired by the organizing principles of biological neural circuits. Their computational primitives are based on

Chapter 1: Introduction: Analog/Digital conversion, The communication channel, Shannon channel capacity, Capacity requirements.


* Chapter 4: The Receiver: Photodiodes, Receiver noise, Detector schemes (direct detection, coherent detection), Bit-error ratios and error estimations.

* Chapter 5: Digital Signal Processing Techniques: Digital signal processing in a coherent receiver, Error detection techniques, Error correction coding.

* Chapter 6: Pulse Shaping and Multiplexing Techniques: WDM/FDM, TDM, OFDM, Nyquist Multiplexing, OCDMA.

* Chapter 7: Optical Amplifiers: Semiconductor Optical Amplifiers, Erbium Doped Fiber Amplifiers, Raman Amplifiers.

Chapter 1: The Wave Equations in Nonlinear Optics

Nonlinear Optics is the study of optical phenomena and techniques on the nanometer scale. It is an emerging field of study motivated by the rapid advance of nanoscience and technology. It embraces topics such as plasmonics, optical antennas, optical trapping and manipulation, and high-resolution imaging and spectroscopy.

Understanding concepts of light localization and light-matter interactions on the nanoscale.

Chapter 2: Nonlinear Effects - An Overview

* Chapter 3: The Nonlinear Optical Susceptibility

* Chapter 4: Second Harmonic Generation

* Chapter 5: The Electro-Optic Effect and the Electro-Optic Modulator

* Chapter 6: Acousto-Optic Effect

* Chapter 7: Nonlinear Effects of Third Order

* Chapter 8: Nonlinear Effects in Media with Gain

Lecture notes are handed out.

Lecture notes are handed out.

Prerequisites / notice


Fundamentals of Electromagnetic Fields (Maxwell Equations) & Bachelor Lectures on Physics.


Fundamentals of Electromagnetic Fields and Principles; various publications.

Prerequisites: Background in basics of semiconductor physics helpful, but not required.
Abstract

From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles. Intermolecular forces, their macroscopic manifestations, and ways to control such interactions. Self-assembly and directed assembly of 2D and 3D structures.

Objective

Familiarize students with basic science and engineering principles governing the nano domain.

Content

The course addresses basic science and engineering principles ruling the nano domain. We particularly work out the links between topics that are traditionally taught separately.

Prerequisites / notice

Course format:

Lectures and Mini-Review presentations: Thursday 10-13, ML F 36

Homework: Mini-Reviews

Students select a paper (list distributed in class) and expand the topic into a Mini-Review that illuminates the particular field beyond the immediate results reported in the paper.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0121-00L</td>
<td>Communication Systems</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>A. Wittneben</td>
</tr>
<tr>
<td>Abstract</td>
<td>Information Theory, Signal Space Analysis, Baseband Transmission, Passband Transmission, Example und Channel, Data Link Layer, MAC, Example Layer 2, Layer 3, Internet</td>
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<tr>
<td>Objective</td>
<td>Introduction into the fundamentals of digital communication systems. Selected examples on the application of the fundamental principles in existing and upcoming communication systems</td>
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<tr>
<td>Content</td>
<td>Covered are the lower three layer of the OSI reference model: the physical, the data link, and the network layer. The basic terms of information theory are introduced. After this, we focus on the methods for the point to point communication, which may be addressed elegantly and coherently in the signal space. Methods for error detection and correction as well as protocols for the retransmission of perturbed data will be covered. Also the medium access for systems with shared medium will be discussed. Finally, algorithms for routing and flow control will be treated.</td>
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<tr>
<td>Literature</td>
<td>Lecture Slides</td>
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<tr>
<td>Notice</td>
<td>Voraussetzungen: Physik I, II, III wünschenswert</td>
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Recommended Subjects

These courses are recommended, but you are free to choose courses from any other special field. Please consult your tutor.

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Lecturers</th>
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<td>227-0157-00L</td>
<td>Semiconductor Devices: Physical Bases and Simulation</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>A. Schenk</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course addresses the physical principles of modern semiconductor devices and the foundations of their modeling and numerical simulation. Necessary basic knowledge on quantum-mechanics, semiconductor physics and device physics is provided. Computer simulations of the most important devices and of interesting physical effects supplement the lectures.</td>
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<tr>
<td>Objective</td>
<td>The course aims at the understanding of the principle physics of modern semiconductor devices, of the foundations in the physical modeling of transport and its numerical simulation. During the course also basic knowledge on quantum-mechanics, semiconductor physics and device physics is provided.</td>
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<tr>
<td>Literature</td>
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<td>Notice</td>
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The main topics are: transport models for semiconductor devices (quantum transport, Boltzmann equation, drift-diffusion model, hydrodynamic model), physical characterization of silicon (intrinsic properties, scattering processes), mobility of cold and hot carriers, recombination (Shockley-Read-Hall statistics, Auger recombination), impact ionization, metal-semiconductor contact, metal-insulator-semiconductor structure, and heterojunctions.

The exercises are focused on the theory and the basic understanding of the operation of special devices, as single-electron transistor, resonant tunneling diode, pn-diode, bipolar transistor, MOSFET, and laser. Numerical simulations of such devices are performed with an advanced simulation package (Sentaurus-Synopsys). This enables to understand the physical effects by means of computer experiments.

Failures have to be avoided by proper design, material selection and manufacturing. Properties, degradation mechanisms, and expected lifetime of materials are introduced and the basics of failure analysis and analysis equipment are presented. Failures will be demonstrated experimentally and the opportunity is offered to perform a failure analysis with advanced equipment in the laboratory.

The abstract filters and mechanisms of failure and mechanisms of failure and fault analysis terminology; physics of failure: materials properties, physical processes and failure mechanisms; failure analysis of ICs, PCBs, opto-electronics, discrete and other components and devices; basics and properties of instruments; application in circuit design and reliability analysis

The learning goal is that the students can apply signal-flow graphs and can understand the signal flow in such circuits and systems (including non-ideal effects) well enough to gain an understanding of further circuits and systems by themselves.

At the beginning, signal-flow graphs in general and driving-point signal-flow graphs in particular are introduced. We will use them during the whole term to analyze circuits and understand how signals propagate through them. The theory and CMOS implementation of active filters is then discussed in detail using the example of Op-CM filters and active-RF filters. The ideal and nonideal behaviour of opamps, current conveyors, and inductor simulators follows. The link to the practical design of circuits and systems is done with an overview over mixed-domain filters and circuits, including sensor read-out amplifiers, correlated double sampling, and chopping, and an introduction to discrete-time and digital signal processing.

The exercises aim to reinforce the lecture material by well guided step-by-step design tasks. The circuit simulator SPECTRE is used to facilitate the tasks. There is also an experimental session on op-amp measurements.

The learning goal is that the students can apply signal-flow graphs and can understand the signal flow in such circuits and systems (including non-ideal effects) well enough to gain an understanding of further circuits and systems by themselves.
This lecture provides theoretical and experimental knowledge on the techniques for the characterization of modern power semiconductor devices, as well as on the related built-in reliability strategies.

The students shall get acquainted with the most important concepts and techniques for characterization, numerical modeling and built-in reliability of modern power semiconductor devices. This knowledge is intended to provide the future engineer with the theoretical background and tools for the design of dependable power devices and systems.

This lecture consists of a theoretical part (50%) and of laboratory exercises and demonstrations (50%).

The theoretical part covers the basic techniques and procedures for characterization, modeling and built-in reliability of modern power semiconductor devices with special attention to MOS and IGBT. The starting part on technology provides an overview on the main device families and includes a review of the most relevant application-oriented aspects of the device physics, thermal management, and packaging. The second section deals with the basic experimental characterization techniques for the definition of the semiconductor material properties, electrical characteristics, safe operating area, and junction temperature of the devices. The following section introduces the basic principles for electrical, thermal, and electro-thermal simulation of power semiconductors by Technology Computed Aided Design (TCAD) and compact modeling. Finally, procedures are methods are presented to implement efficient built-in reliability programs targeted on power semiconductors. They include failure physics, dedicated failure analysis techniques, accelerated testing, defect screening, and lifetime modeling.

During the laboratory activities, selections of the experimental techniques presented in the lecture are demonstrated on the base of realistic examples. Furthermore, schematic power devices will be simulated by the students with advanced TCAD tools and circuit simulators.

Handouts to the lecture (approx. 250 pp.)

Eiichi Ohno: “Introduction to Power Electronics”
B. Murari et al.: “Smart Power ICs”
B. J. Baliga: “Physics Modern Power Devices”
S. K. Ghandi: “Semiconductor Power Devices”

This lecture consists of a theoretical part (50%) and of laboratory exercises and demonstrations (50%).

The characterization of the electronic properties of semiconductor and related materials is fundamental to manufacture integrated devices, which fulfill the required specifications. By this lecture, the students shall get acquainted with the main electrical characterization techniques of the electronic properties of semiconductors and thin film materials used in microelectronics, as well as with their physical principles. This knowledge is intended to provide the future engineer with the theoretical background and experimental tools for process control in semiconductor manufacturing, parameter extraction in device simulation, and design of dependable devices.

This lecture consists of a theoretical part (80%) and of laboratory exercises and demonstrations (20%). In the first section of the lecture, methods and procedures are presented for the experimental characterization of relevant electronic parameters in the bare semiconductor (mainly silicon), like resistivity, carrier and doping density, contact resistance, and Schottky barriers, defect density, carrier lifetime, mobility. The second section deals with techniques involving basic structures and devices (contact chains, MIS capacitors, diodes, gated diodes, BJTs, MOSFET) for the characterization of atomic transport, mechanical stress, dielectric thickness, impact ionization, channel mobility, instabilities, defect formation at interfaces and in thin film dielectrics, carrier transport and trapping in thin film dielectrics, quasi-static and dynamic device characteristics. The list of the covered methods includes among others probing, Kelvin measurements, VanderPauw technique, Hall spectroscopy, SIMS, Raman spectroscopy, spreading resistance, scanning probe techniques, static/high-speed I-V, static/high-frequency C-V, open circuit voltage decay, carrier recombination techniques, Zerbst techniques, deep level transient spectroscopy, split C-V, charge pumping, and inverse modeling techniques using TCAD. All methods are presented in conjunction with the proper test structures. During the laboratory activities, a selection of the experimental techniques discussed in the lecture are demonstrated on the base of realistic examples.

Handouts to the lecture (approx. 200 pp.)

Schroeder D.K, Semiconductor Material and Device Characterization, Wiley Ed.
F. Baleasta Ed., Nanoscale CMOS : innovative materials, modeling and characterization, ISTE

This lecture gives an overview of the requirements and the architecture of parallel computer systems, performance, reliability and costs.

The lecture “Applied Computer Architecture” gives technical and corporate insights in the innovative Computer Systems/Architectures (CPU, GPU, FPGA, special processors) and their real implementations and applications. Often the designs have to deal with technical limits.

Which computer architecture allows the control of the over 1000 magnets at the Swiss Light Source (SLS)?
Which computer architecture is hidden behind the alarm center of the Swiss Railway (SBB)?
Which computer architectures are applied for driver assistance systems?
Which computer architecture allows the control of the over 1000 magnets at the Swiss Light Source (SLS)?
Which computer architecture is hidden behind a professional digital audio mixing desk?
How can data volumes about 30 TByte/s, produced by a proton accelerator, be processed in real time?
Can the weather forecast also be processed with GPUs?
How can a good computer architecture be found?
Which are the driving factors in successful computer architecture design?

Script and exercices sheets.

Prerequisites:
Basics of computer architecture.

In the “Fachseminar IS” the students learn to communicate topics, ideas or problems of scientific research by listening to more experienced authors and by presenting scientific work in a conference-like situation for a specific audience.

The seminar aims at instructing graduate and PhD students in the basics of presentation techniques, i.e. “how to give a professional talk”.

Attendees have the possibility to become acquainted with a current topic by a literature study, and to present the results thereof in a 20 minutes talk in English. The participation at the seminar gives also an overview on current problems in modern nano- and opto-electronics.

The seminar topics’ are simulation of nanoelectronic processes and devices, and the optical as well as electrical simulation of optoelectronic devices as lasers, photodiodes, etc.

Presentation material

First half of the semester: Introduction to the main methods of numerical optimization with focus on stochastic methods such as genetic algorithms, evolutionary strategies, etc.
Second half of the semester: Each participant implements a selected optimizer and applies it on a problem of practical interest.
Numerical optimization is of increasing importance for the development of devices and for the design of numerical methods. The students shall learn to select, improve, and combine appropriate procedures for efficiently solving practical problems.

Typical optimization problems and their difficulties are outlined. Well-known deterministic search strategies, combinatorial minimization, and evolutionary algorithms are presented and compared. In engineering, optimization problems are often very complex. Therefore, new techniques based on the generalization and combination of known methods are discussed. To illustrate the procedure, various problems of practical interest are presented and solved with different optimization codes.

Pdf file see http://alphard.ethz.ch/hafner/Vorles/lect.htm

The document provides sufficient information for the participants to successfully participate in the course.

Physical modelling plays an important role in the analysis and design of new structures, especially for micro and nano devices where fabrication and measurement are difficult. After the fundamentals of electromagnetics, mechanics, and thermodynamics, an introduction to the main concepts and most widely used codes for physical modelling is given and commercial codes are applied.

First, an introduction to the fundamental equations and effects of electromagnetics, mechanics, and thermodynamics is given. This is important for understanding the problems to be analyzed and for validating results obtained from software packages. After this, the main concepts of numerical methods and of the most widely used codes for physical modelling are outlined and compared, which is essential for the adequate selection of software for solving given problems. After this, prominent commercial software packages are applied to various types of problems, ranging from electrodynamics to multiphysics. For becoming able to select appropriate software and to validate the results obtained, different commercial software packages will be used and compared during the exercises in form of small projects.

Physical Modelling and Simulation

Objective: To learn the main concepts and most widely used codes for physical modelling and simulation. Ability 1) to select appropriate software, 2) to apply it for solving given problems, 3) to validate the results, 4) to interactively improve the models until sufficiently accurate results are obtained.

Abstract: Basic knowledge of the fundamental equations and effects of electromagnetics, mechanics, and thermodynamics. Knowledge of the main concepts of numerical methods for physical modelling and simulation. Ability 1) to select appropriate software, 2) to apply it for solving given problems, 3) to validate the results, 4) to interactively improve the models until sufficiently accurate results are obtained.

Lecture notes: PDF file see http://alphard.ethz.ch/hafner/Vorles/lect.htm

Prerequisites / notice: Lecture in the first half of the semester, exercises in form of small projects in the second half, presentation of the results in the last week of the semester.

The course is taught in English.

Theory of Robotics and Mechatronics

Objective: An introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. This course is a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.

Content: Robotics is often viewed from three perspectives: perception (sensing), manipulation (affecting changes in the world), and cognition (intelligence). Robotic systems integrate aspects of all three of these areas. This course provides an introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control.

Lecture notes: The course will be taught in English.

Embedded MEMS Lab

Objective: Practical course: Students are introduced to the process steps required for the fabrication of MEMS (Micro Electro Mechanical System) and carry out the fabrication and testing steps in the clean rooms by themselves. Additionally, they learn the requirements for working in clean rooms. Processing and characterization will be documented and analyzed in a final report. Limited access

Content: Students learn the individual process steps that are required to make a MEMS (Micro Electro Mechanical System). Students carry out the process steps themselves in laboratories and clean rooms. Furthermore, participants become familiar with the special requirements (cleanliness, safety, operation of equipment and handling hazardous chemicals) of working in the clean rooms and laboratories. The entire production, processing, and characterization of the MEMS is documented and evaluated in a final report.

Lecture notes: A document containing theory, background and practical course content is distributed at the first meeting of the course.

Literature: The document provides sufficient information for the participants to successfully participate in the course.

Prerequisites / notice: Participating students are required to attend all scheduled lectures and meetings of the course.

The course provides fundamental knowledge of surface plasmon polaritons and discusses their applications in plasmonics.

Introduction to Plasmonics

Abstract: This course provides fundamental knowledge of surface plasmon polaritons and discusses their applications in plasmonics.
Electromagnetic oscillations known as surface plasmon polaritons have many unique properties that are useful across a broad set of applications in biology, chemistry, physics, and optics. The field of plasmonics has arisen to understand the behavior of surface plasmon polaritons and to develop applications in areas such as catalysis, imaging, photovoltaics, and sensing. In particular, metallic nanoparticles and patterned metallic interfaces have been developed to utilize plasmonic resonances. The aim of this course is to provide the basic knowledge to understand and apply the principles of plasmonics. The course will strive to be approachable to students from a diverse set of science and engineering backgrounds. Fundamentals of Plasmonics
- Basic electromagnetic theory
- Optical properties of metals
- Surface plasmon polaritons on surfaces
- Surface plasmon polariton propagation
- Localized surface plasmons Applications of Plasmonics
- Waveguides
- Extraordinary optical transmission
- Enhanced spectroscopy
- Sensing
- Metamaterials

Lecture notes
Class notes and handouts
Lecture notes will be available on the TIMGROUP website.

Prerequisites
Physics I, Physics II


ECTS
3 credits

Core Subjects

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<tr>
<th>Number</th>
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<th>Type</th>
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<tr>
<td>227-0247-00L</td>
<td>Power Electronic Systems I</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>J. W. Kolar</td>
</tr>
<tr>
<td>Abstract</td>
<td>Basics of the switching behavior, gate drive and snubber circuits of power semiconductors are discussed. Soft-switching and resonant DC/DC converters are analyzed in detail and high frequency loss mechanisms of magnetic components are explained. Space vector modulation of three-phase inverters is introduced and the main power components are designed for typical industry applications. Detailed understanding of the principle of operation and modulation of advanced power electronics converter systems, especially of zero voltage switching and zero current switching non-isolated and isolated DC/DC converter systems and three-phase voltage DC link inverter systems. Furthermore, the course should convey knowledge on the switching frequency related losses of power semiconductors and inductive power components and introduce the concept of space vector calculus which provides a basis for the comprehensive discussion of three-phase PWM converters systems in the lecture Power Electronic Systems II.</td>
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<tr>
<td>Objective</td>
<td>- Detailed understanding of the principle of operation and modulation of advanced power electronics converter systems, especially of zero voltage switching and zero current switching non-isolated and isolated DC/DC converter systems and three-phase voltage DC link inverter systems. Furthermore, the course should convey knowledge on the switching frequency related losses of power semiconductors and inductive power components and introduce the concept of space vector calculus which provides a basis for the comprehensive discussion of three-phase PWM converters systems in the lecture Power Electronic Systems II.</td>
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<tr>
<td>Content</td>
<td>- Basics of the switching behavior and gate drive circuits of power semiconductor devices and auxiliary circuits for minimizing the switching losses are explained. Furthermone, zero voltage switching, zero current switching, and resonant DC/DC converters are discussed in detail; the operating behavior of isolated full-bridge DC/DC converters is detailed for different secondary side rectifier topologies; high frequency loss mechanisms of magnetic components of converter circuits are explained and approximate calculation methods are presented; the concept of space vector calculus for analyzing three-phase systems is introduced; finally, phase-oriented and space vector modulation of three-phase inverter systems are discussed related to voltage DC link inverter systems and the design of the main power components based on analytical calculations is explained.</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes and associated exercises including correct answers, simulation program for interactive self-learning including visualization/animation features.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: Introductory course on power electronics.</td>
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<tr>
<td>227-0517-00L</td>
<td>Electrical Drive Systems II</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>P. Steimer, G. Scheuer, C. A. Stulz</td>
</tr>
<tr>
<td>Abstract</td>
<td>In the course “Drive System II” the power semiconductors are repeated. The creation of converters based on the combination of switches/cells and based topologies is explained. Another main focus is on the 3-level inverter with its switching and transfer functions. Further topics are the control of the synchronous machine, of line-side converters and issues with converter-fed machines. The students establish a deeper understanding in regards of the design of the main components of an electrical drive system. They establish knowledge on the most important interaction with the grid and the machine and their related high dynamic control.</td>
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<tr>
<td>Objective</td>
<td>- In the course “Drive System II” the power semiconductors are repeated. The creation of converters based on the combination of switches/cells and based topologies is explained. Another main focus is on the 3-level inverter with its switching and transfer functions, grid side harmonics, modeling and control of synchronous machines (including permanent magnet machines), control of line-side converters, reflection effects with power cables, winding isolation and bearing stress. Field trip to ABB Semiconductors.</td>
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<tr>
<td>Content</td>
<td>- Converter topologies (switch or cell based), multi-pulse diode rectifiers, system aspects of transformer and electrical machines, 3-level inverter with its switching and transfer functions, grid side harmonics, modeling and control of synchronous machines (including permanent magnet machines), control of line-side converters, reflection effects with power cables, winding isolation and bearing stress. Field trip to ABB Semiconductors.</td>
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<tr>
<td>Lecture notes</td>
<td>Skrit is sold at the beginning of the lectures or can be downloaded from Ilias</td>
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### Design of Power Electronic Systems

**Abstract**
Complete design process: from given specifications to a complete power electronic system; selection / design of suitable passive power components; static and dynamic properties of power semiconductors; optimized EMI filter design; heat sink optimization; additional circuitry, e.g. gate driver; system optimization.

**Objective**
Basic knowledge of design and optimization of a power electronic system; furthermore, lecture and exercises thoroughly discuss key subjects of power electronics that are important with respect to a practical realization, e.g. how to select suitable power components, how to determine switching losses, calculation of high frequency losses, EMI filter design and realization, thermal considerations.

**Content**
- Selection and / or design of suitable passive power components: specific properties, parasitic components, tolerances, high frequency losses, thermal considerations, reliability.
- Static and dynamic characteristics of power semiconductors.
- Optimized design of the EMI filter.
- Thermal characterization of the converter, optimized heat sink design.
- Additional circuitry: gate driver, measurement, control.
- Converter start up: typical sequence of events, circuitry required.
- Overall system optimization: identifying couplings between different components of the considered power electronic system, optimization targets and issues.

**Lecture notes**
Lecture notes and complementary exercises including correct answers.

**Prerequisites / notice**
Prerequisites: Introductory course on power electronics.

### Power Market I - Portfolio and Risk Management

**Abstract**
Portfolio and risk management in the electrical power business, Pan-European power market and trading, futures and forward contracts, hedging, options and derivatives, performance indicators for the risk management, modelling of physical assets, cross-border trading, ancillary services, balancing power market, Swiss market model, strategy development and positioning.

**Objective**

**Content**
1. Pan-European power market and trading
   - 1.1. Power trading
   - 1.2. Development of the European power markets
   - 1.3. Energy economics
   - 1.4. Spot and OTC trading
   - 1.5. European energy exchange EEX
2. Market model
   - 2.1. Market place and organisation
   - 2.2. Balance groups / balancing energy
   - 2.3. Ancillary services
   - 2.4. Market for ancillary services
   - 2.5. Cross-border trading
   - 2.6. Capacity auctions
3. Portfolio and Risk management
   - 3.1. Portfolio management 1 (introduction)
   - 3.2. Forward and futures contracts
   - 3.3. Risk management 1 (m2m, VaR, hpfc, volatility, cVaR)
   - 3.4. Risk management 2 (PaR)
   - 3.5. Contract valuation (HPFC)
   - 3.6. Portfolio management 2
   - 3.7. Risk Management 3 (enterprise wide)
4. Energy & Finance I
   - 4.1. Options 1 basics
   - 4.2. Options 2 hedging with options
   - 4.3. Introduction to derivatives (swaps, cap, floor, collar)
   - 4.4. Financial modelling of physical assets
   - 4.5. Trading and hydro power
   - 4.6. Incentive regulation
5. Strategy
   - 5.1. Strategic Positioning
   - 5.2. Development of strategies and examples
   - 5.3. Cases for team work

**Lecture notes**
Handouts of the lecture

**Prerequisites / notice**
1 excursion per semester, 2 case studies, guest speakers for specific topics
Covered are the lower three layer of the OSI reference model: the physical, the data link, and the network layer. The basic terms of

<table>
<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>227-0101-00L</td>
<td>Discrete-Time and Statistical Signal Processing</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>H.A. Loeliger</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications: discrete-time linear filters, equalization, DFT, discrete-time stochastic processes, elements of detection theory and estimation theory, LMMSE estimation and LMMSE filtering, LMS algorithm, Viterbi algorithm.</td>
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</tr>
<tr>
<td>Objective</td>
<td>The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications. The two main themes are &quot;linearity&quot; and &quot;probability&quot;. In the first part of the course, we deepen our understanding of discrete-time linear filters. In the second part of the course, we review the basics of probability theory and discrete-time stochastic processes. We then discuss some basic concepts of detection theory and estimation theory, as well as some practical methods including LMMSE estimation and LMMSE filtering, the LMS algorithm, and the Viterbi algorithm.</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture Notes.</td>
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</tr>
</tbody>
</table>

227-0121-00L Communication Systems W 6 credits 4G A. Wittneben

Abstract: Information Theory, Signal Space Analysis, Baseband Transmission, Passband Transmission, Example und Channel, Data Link Layer, MAC, Example Layer 2, Layer 3, Internet

Objective: Introduction into the fundamentals of digital communication systems. Selected examples on the application of the fundamental principles in existing and upcoming communication systems

Content: Covered are the lower three layer of the OSI reference model: the physical, the data link, and the network layer. The basic terms of information theory are introduced. After this, we focus on the methods for the point to point communication, which may be addressed elegantly and coherently in the signal space. Methods for error detection and correction as well as protocols for the retransmission of perturbed data will be covered. Also the medium access for systems with shared medium will be discussed. Finally, algorithms for routing and flow control will be treated.

Lecture notes: Lecture Slides


227-0225-00L Linear System Theory W 6 credits 5G J. Lygeros, M. Kamgarpour

Abstract: The course is intended to provide a comprehensive overview of the theory of linear dynamical systems, their use in control, filtering, and estimation and their applications to areas ranging from avionics to systems biology.

Objective: By the end of the class students should be comfortable with the fundamental results in linear system theory and the mathematical tools used to derive them.


Prerequisites: Control systems (227-0216-00 or equivalent) and sufficient mathematical maturity.

227-0523-00L Railway Systems I W 6 credits 4G M. Meyer

Abstract: Basic characteristics of railway vehicles and their interfaces with the railway infrastructure:
- Transportation tasks and vehicle types
- Running dynamics
- Mechanical part of rail vehicles
- Brakes
- Traction chain and auxiliary supply
- Railway power supply
- Signalling systems
- Traffic control and maintenance

Objective: Overview of the technical characteristics of railway systems
- Know-how about the design and construction principles of rail vehicles
- Interrelationship between different fields of engineering sciences (mechanics, electro and information technology, transport systems)
- Understanding tasks and opportunities of engineers working in an environment which has strong economical and political boundaries
- Insight into the activities of the railway vehicle industry and railway operators in Switzerland
- Motivation of young engineers to start a career in the railway industry or with railway operators
Content

EST I (Frühjahsemester) - Begriffen, Grundlagen, Merkmale

1 Einführung:
1.1 Geschichte und Struktur des Bahnsystems
1.2 Fahrdynamik

2 Vollbahnbahnverkehr:
2.1 Mechanik: Kasten, Drehgestelle, Lauftechnik, Adhäsion
2.2 Bremsen
2.3 Traktionsantriebssysteme
2.4 Hilfsbetriebe und Komfortanlagen
2.5 Steuerung und Regelung

3 Infrastruktur:
3.1 Fahrweg
3.2 Bahnstromversorgung
3.3 Sicherungsanlagen

4 Betrieb:
4.1 Interoperabilität, Normen und Zulassung
4.2 RAMS, LCC
4.3 Anwendungsbeispiele

Voraussichtlich ein oder zwei Gastreferate

Geplante Exkursionen:
Betriebzentrals SBZ, Würzburg
Reparatur und Unterhalt, SS, Zürich Altstetten
Fahrzeugfertigung, Stadler Bussnang

Lecture notes Abgabe der Unterlagen (gegen eine Schutzgebühr) zu Beginn des Semesters. Rechtzeitig eingeschriebene Teilnehmer können die Unterlagen auf Wunsch und gegen eine Zusatzgebühr auch in Farbe beziehen.

Prerequisites / notice

Dozent: Dr. Markus Meyer, Emkamatik GmbH

Voraussichtlich ein oder zwei Gastvorträge von anderen Referenten.

EST I (Herbstsemester) kann als in sich geschlossene einsemestrigke Vorlesung besucht werden. EST II (Frühjahrssemester) dient der weiteren Vertiefung der Fahrzeugtechnik und der Integration in die Bahninfrastruktur.

227-0618-00L Modeling, Characterization and Reliability of Power Semiconductors

W 6 credits 4G M. P. M. Ciappa

Abstract
This lecture provides theoretical and experimental knowledge on the techniques for the characterization and numerical modeling of power semiconductors, as well as on the related built-in reliability strategies.

Objective
The students shall get acquainted with the most important concepts and techniques for characterization, numerical modeling and built-in reliability of modern power semiconductor devices. This knowledge is intended to provide the future engineer with the theoretical background and tools for the design of dependable power devices and systems.

Content
This lecture consists of a theoretical part (50%) and of laboratory exercises and demonstrations (50%). The theoretical part covers the basic techniques and procedures for characterization, modeling and built-in reliability of modern power semiconductor devices with special attention to MOS and IGBT. The starting part on technology provides an overview on the main device families and includes a review of the most relevant application-oriented aspects of the device physics, thermal management, and packaging. The second section deals with the basic experimental characterization techniques for the definition of the semiconductor material properties, electrical characteristics, safe operating area, and junction temperature of the devices. The following section introduces the basic principles for electrical, thermal, and electro-thermal simulation of power semiconductors by Technology Computed Aided Design (TCAD) and compact modeling. Finally, procedures are presented to implement efficient built-in reliability programs targeted on power semiconductors. They include failure physics, dedicated failure analysis techniques, accelerated testing, defect screening, and lifetime modeling. During the laboratory activities, selections of the experimental techniques presented in the lecture are demonstrated on the base of realistic examples. Furthermore, schematic power devices will be simulated by the students with advanced TCAD tools and circuit simulators.

Lecture notes Handouts to the lecture (approx. 250 pp.)

Literature
S. K. Ghandi: "Semiconductor Power Devices"
B. J. Baliga: "Physics Modern Power Devices"
S. K. Ghandi: "Semiconductor Power Devices"

227-0697-00L Industrial Process Control

W 4 credits 3G G. Maier, A. Horch

Abstract
Introduction to process automation and its application in process industry and power generation

Objective
Knowledge of process automation and its application in industry and power generation

Content
Introduction to process automation: system architecture, data handling, communication (fieldbusses), process visualization, engineering, etc. Analysis and design of open loop control problems: discrete automata, petri-nets, decision tables, drive control and object oriented function group automation philosophy, RT-UML. Engineering: Application programming in IEC61131-3 (function blocks, sequence control, structured text); Process visualization and operation; engineering integration from sensor, cabling, topology design, function, visualization, diagnosis, to documentation; Industry standards (e.g., OPC, Profibus) Ergonomic design, safety (IEC61508) and availability, supervision and diagnosis. Practical examples from process industry, power generation and newspaper production. Slides will be available as .PDF documents, see "Learning materials" (for registered students only)

Exercises: Tuesday 15-16

Lecture notes Practical examples will illustrate some topics, especially some control software coding using industry standard programming tools based on IEC61131-3.

227-0707-00L Optimization Methods for Engineers

W 3 credits 2G C. Hafner, P. Leuchtmann

Abstract
First half of the semester: Introduction to the main methods of numerical optimization with focus on stochastic methods such as genetic algorithms, evolutionary strategies, etc.

Second half of the semester: Each participant implements a selected optimizer and applies it on a problem of practical interest.
### Systems and Control

#### Core Subjects

These core subjects are particularly recommended for the field of "Systems and Control".

<table>
<thead>
<tr>
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<td>W</td>
<td>6</td>
<td>5G</td>
<td>J. Lygeros, M. Kamgarpou</td>
</tr>
<tr>
<td>227-0697-00L</td>
<td>Industrial Process Control</td>
<td>W</td>
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<td>3G</td>
<td>G. Maier, A. Horch</td>
</tr>
<tr>
<td>151-0563-01L</td>
<td>Dynamic Programming and Optimal Control</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>R. D’Andrea</td>
</tr>
</tbody>
</table>

#### 227-0225-00L: Linear System Theory
- Objective: The class is intended to provide a comprehensive overview of the theory of linear dynamical systems, their use in control, filtering, and estimation. Students will learn to use areas ranging from avionics to systems biology.
- Content: By the end of the class students should be comfortable with the fundamental results in linear system theory and the mathematical tools used to derive them.
  - Rings, fields and linear spaces, normed linear spaces and inner product spaces.
  - Ordinary differential equations, existence and uniqueness of solutions.
  - Continuous and discrete time, time varying linear systems.
  - Time domain solutions.
  - Time invariant systems treated as a special case.
  - Controllability and observability, canonical forms, Kalman decomposition.
  - Time invariant systems treated as a special case.
  - Stability and stabilization, observers, state and output feedback, separation principle.
  - Realization theory.

#### Literature

- Prerequisites: Control systems (227-0216-00 or equivalent) and sufficient mathematical maturity.

### 227-0697-00L: Industrial Process Control
- Objective: Introduction to process automation and its application in process industry and power generation.
- Content: Knowledge of process automation and its application in industry and power generation.
- Lecture notes
- Prerequisites / notice

### 151-0563-01L: Dynamic Programming and Optimal Control
- Objective: Introduction to Dynamic Programming and Optimal Control.
- Content: Covers the fundamental concepts of Dynamic Programming & Optimal Control.
- Literature

- Prerequisites / notice
## Discrete Event Systems

**Abstract**
Introduction to discrete event systems. We start out by studying popular models of discrete event systems, and in the second part of the course we analyze discrete event systems from an average-case and from a worst-case perspective. Topics include: Automata and Languages, Specification Models, Stochastic Discrete Event Systems, Worst-Case Event Systems, Verification, Network Calculus.

**Objective**
Over the past few decades the rapid evolution of computing, communication, and information technologies has brought about the proliferation of new dynamic systems. A significant part of activity in these systems is governed by operational rules designed by humans. The dynamics of these systems are characterized by asynchronous occurrences of discrete events, some controlled (e.g., hitting a keyboard key, sending a message), some not (e.g., spontaneous failure, packet loss).

The mathematical arsenal centered around differential equations that has been employed in systems engineering to model and study processes governed by the laws of nature is often inadequate or inappropriate for discrete event systems. The challenge is to develop new modeling frameworks, analysis techniques, design tools, testing methods, and optimization processes for this new generation of systems.

In this lecture we give an introduction to discrete event systems. We start out the course by studying popular models of discrete event systems, such as automata and Petri nets. In the second part of the course we analyze discrete event systems. We first examine discrete event systems from an average-case perspective: we model discrete events as stochastic processes, and then apply Markov chains and queuing theory for an understanding of the typical behavior of a system. In the last part of the course we analyze discrete event systems from a worst-case perspective using the theory of online algorithms and adversarial queuing.

**Content**
1. Introduction
2. Automata and Languages
3. Smarter Automata
4. Specification Models
5. Stochastic Discrete Event Systems
6. Worst-Case Event Systems
7. Network Calculus

**Lecture notes**
Available

**Literature**
- [bertsekas] Data Networks
  Dimitri Bertsekas, Robert Gallager
- [borodin] Online Computation and Competitive Analysis
  Allan Borodin, Ran El-Yaniv
  Cambridge University Press, 1998
- [boudec] Network Calculus
  J.-Y. Le Boudec, P. Thiran
  Springer, 2001
- [cassandras] Introduction to Discrete Event Systems
  Christos Cassandras, Stéphane Lafortune
- [fiat] Online Algorithms: The State of the Art
  A. Fiat and G. Woeginger
  Springer, 2001
- [schickinger] Diskrete Strukturen (Band 2: Wahrscheinlichkeitstheorie und Statistik)
  T. Schickinger, A. Steger
  Springer, Berlin, 2001
- [sipser] Introduction to the Theory of Computation
  Michael Sipser

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## Image Analysis and Computer Vision

**Abstract**

**Objective**
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

**Content**
1. Introduction
2. Automata and Languages
3. Smarter Automata
4. Specification Models
5. Stochastic Discrete Event Systems
6. Worst-Case Event Systems
7. Network Calculus

**Lecture notes**
Available

**Prerequisites / notice**
Course material Script, computer demonstrations, exercises and problem solutions

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## Power System Analysis

**Abstract**
Power System Analysis

**Objective**
The mathematical arsenal centered around differential equations that has been employed in systems engineering to model and study processes governed by the laws of nature is often inadequate or inappropriate for discrete event systems. The challenge is to develop new modeling frameworks, analysis techniques, design tools, testing methods, and optimization processes for this new generation of systems.

In this lecture we give an introduction to discrete event systems. We start out the course by studying popular models of discrete event systems, such as automata and Petri nets. In the second part of the course we analyze discrete event systems. We first examine discrete event systems from an average-case perspective: we model discrete events as stochastic processes, and then apply Markov chains and queuing theory for an understanding of the typical behavior of a system. In the last part of the course we analyze discrete event systems from a worst-case perspective using the theory of online algorithms and adversarial queuing.

**Content**
1. Introduction
2. Automata and Languages
3. Smarter Automata
4. Specification Models
5. Stochastic Discrete Event Systems
6. Worst-Case Event Systems
7. Network Calculus

**Lecture notes**
Available

**Prerequisites / notice**
Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C. The course language is English.
The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the development of stationary models of the electrical network, their mathematical representation and solution methods of large linear and non-linear systems of equations related to electrical power networks.

Objective

The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the development of stationary models of the electrical network, their mathematical representation and solution methods of large linear and non-linear systems of equations related to electrical power networks.

Content

The electrical power transmission system, the energy management system, requirements of the electrical power transmission (demand oriented, operationally, economically), network planning and network operation, models of N-nport network components (line, cables, shunts, transformers), the p.u. computation, computer oriented network models, linear networks (solution methods - direct, iterative), algorithms for the solution of non-linear sets of equations, derived from the electrical power system (Newton-Raphson), power flow computation (problem definition, solution methods), three phase short-circuit computation, application of power flow algorithms. Introduction to power system stability.

Lecture notes

Lecture notes. Course is supported by WWW-teaching system.

227-0689-00L  System Identification  W  4 credits  2V+1U  R. Smith

Abstract

Theory and techniques for the identification of dynamic models from experimentally obtained system input-output data.

Objective

To provide a series of practical techniques for the development of dynamical models from experimental data, with the emphasis being on the development of models suitable for feedback control design purposes. To provide sufficient theory to enable the practitioner to understand the trade-offs between model accuracy, data quality and data quantity.

Content

Introduction to modeling: Black-box and grey-box models; Parametric and non-parametric models; ARX, ARMAX (etc.) models.

Predictive, open-loop, black-box identification methods. Time and frequency domain methods. Subspace identification methods.

Optimal experimental design, Cramer-Rao bounds, input signal design.

Parametric identification methods. On-line and batch approaches.

Literature


Prerequisites / notice

Control systems (227-0216-00L) or equivalent.

227-0945-00L  Cell and Molecular Biology for Engineers I  W  3 credits  3G  C. Frei

Abstract

This course is part 1 of a two-semester course.

The course gives an introduction into cellular and molecular biology, specifically for students with a background in engineering. The focus will be on the basic organization of eukaryotic cells, molecular mechanisms and cellular functions. Textbook knowledge will be combined with results from recent research and technological innovations in biology.

Objective

After completing this course, engineering students will be able to apply their previous training in the quantitative and physical sciences to modern biology. Students will also learn the principles how biological models are established, and how these models can be tested.

Content

Lectures will include the following topics: DNA, chromosomes, RNA, protein, genetics, gene expression, membrane structure and function, vesicular traffic, cellular communication, energy conversion, cytokskeleton, cell cycle, cellular growth, apoptosis, autophagy, cancer, development and stem cells.

In addition, three journal clubs will be held, where one/two publictions will be discussed. For each journal club, students (alone or in groups of up to three students) have to write a summary and discussion of the publication. These written documents will be graded, and count as 25% for the final grade.

Lecture notes

Scripts of all lectures will be available.

Literature

Abstract
This course provides an introduction and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. Its a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.

Objective
Robotics is often viewed from three perspectives: perception (sensing), manipulation (affecting changes in the world), and cognition (intelligence). Robotic systems integrate aspects of all three of these areas. This course provides an introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. This course is a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.

Content
An introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control.

Lecture notes available.

Prerequisites / notice
The course will be taught in English.

151-0563-01L Dynamic Programming and Optimal Control  W  4 credits  3G  R. D'Andrea
Abstract
Dynamic Programming and Optimal Control
Objective
Introduction to Dynamic Programming and Optimal Control.
Content
Covers the fundamental concepts of Dynamic Programming & Optimal Control.
Literature
Prerequisites / notice
Requirements: Knowledge of advanced calculus, introductory probability theory, and matrix-vector algebra.

376-1219-00L Rehabilitation Engineering II: Rehabilitation of Sensory and Vegetative Functions  W  3 credits  2V  R. Riener, R. Gassert, L. Marchal Crespo
Abstract
Rehab. Engineering is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.
Objective
Provide knowledge on the anatomy and physiology of the human sensory system, related dysfunctions and pathologies, and how rehabilitation engineering can provide sensory restoration and substitution.
Content
Introduction, problem definition, overview
- Rehabilitation of visual function
  - Anatomy and physiology of the visual sense
  - Technical aids (glasses, sensor substitution)
  - Retina and cortex implants
- Rehabilitation of hearing function
  - Anatomy and physiology of the auditory sense
  - Hearing aids
  - Cochlea Implants
- Rehabilitation and use of kinesthetic and tactile function
  - Anatomy and physiology of the kinesthetic and tactile sense
  - Tactile/haptic displays for motion therapy (incl. electrical stimulation)
  - Role of displays in motor learning
- Rehabilitation of vestibular function
  - Anatomy and physiology of the vestibular sense
  - Rehabilitation strategies and devices (e.g. BrainPort)
- Rehabilitation of vegetative Functions
  - Cardiac Pacemaker
  - Phrenic stimulation, artificial breathing aids
  - Bladder stimulation, artificial sphincter
  - Brain stimulation and recording
  - Deep brain stimulation for patients with Parkinson, epilepsy, depression
  - Brain-Computer Interfaces
**Literature**

**Introductory Books:**

**Selected Journal Articles and Web Links:**
- VideoTact, ForeThought Development, LLC. http://my.execpc.com/~dwysocki/videotac.html

**Prerequisites / notice**

This course is meant for students who did not already attend the course "Mathematical Optimization", which is a more advance lecture covering similar topics and more.

**401-0647-00L**

**Abstract**
Introduction to Mathematical Optimization

**Objective**
The goal is to get a good understanding of some of the most important mathematical optimization techniques used to solve linear programs and basic combinatorial optimization problems.

**Content**
Topics covered in this course include:
- Linear programming (simplex method, duality theory, shadow prices, ...).
- Basic combinatorial optimization problems (spanning trees, network flows, knapsack problem, ...).

**Literature**
Information about relevant literature will be given in the lecture.

**401-3901-00L**

**Abstract**
Mathematical Optimization

**Objective**
Advanced optimization theory and algorithms.

**Content**
1. Linear optimization: The geometry of linear programming, the simplex method for solving linear programming problems, Farkas' Lemma and infeasibility certificates, duality theory of linear programming.
3. Integer optimization: Ties between linear and integer optimization, total unimodularity, complexity theory, cutting plane theory.
4. Combinatorial optimization: Network flow problems, structural results and algorithms for matroids, matchings and, more generally, independence systems.
**Subjects of General Interest**

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<thead>
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</thead>
<tbody>
<tr>
<td>227-0377-00L</td>
<td>Physics of Failure and Failure Analysis of Electronic Devices and Equipment</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>U. Sennhauser</td>
</tr>
<tr>
<td>363-0790-00L</td>
<td>Technology Entrepreneur</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>U. Claesson, P. Baschera, F. Hacklin</td>
</tr>
<tr>
<td>151-0317-00L</td>
<td>Visualization, Simulation and Interaction - Virtual Reality II</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>A. Kunz</td>
</tr>
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<td><strong>Semester Projects</strong></td>
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<tr>
<td>227-1101-00L</td>
<td>How to Write Scientific Texts in Engineering Sciences</td>
<td>E-</td>
<td>0</td>
<td></td>
<td>J. Leuthold</td>
</tr>
</tbody>
</table>

**Abstract**

*The course consists of lectures and exercises.*

**Objective**

*The goal is to provide a strong knowledge on Virtual Reality for a possible future use in business processes.*

**Content**

*Introduction into Virtual Reality; basics of augmented reality; interaction with digital data, tangible user interfaces (TUI); basics of simulation; compression procedures of image-, audio-, and video signals; new materials for force feedback devices; introduction into data security; cryptography; definition of free-form surfaces; digital factory; new research fields of virtual reality*

**Lecture notes**

*Lecture slides and case material*

**Prerequisites / notice**

*"Visualization, Simulation and Interaction - Virtual Reality II" is recommended.*

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**Literature**

- J. Stelling

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**Semester Projects**

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<td>E-</td>
<td>0</td>
<td></td>
<td>J. Leuthold</td>
</tr>
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</table>

**Abstract**

*The 4 hour lecture covers the basics of writing & presenting a scientific text. The focus will be on the structure and elements of a scientific text and not on the language. Citation rules, good practice of scientific writing and an overview on software tools will be part of the training. The lecture will be thought on two afternoons. Some exercises will be built into the lecture.*

**Objective**

*Knowledge on structure and content of a scientific text. The course further is arranged to stimulate a discussion on how to properly write a legible scientific text versus writing an interesting novel. We will further discuss the practice of properly citing and critically reflect on recent plagiarism allegations.*
**Content**

* Topic 1: Structure of a Scientific Text (The Title, the author list, the abstract, State-of-the Art, the "in this paper" paragraph, the scientific part, the summary, Equations, Figures).

* Topic 2: Power Point Presentations.

* Topic 3: Citation Rules and Citation Software.

* Topic 4: Guidelines for Research Integrity.

**Literature**

ETH "Citation Etiquette", see www.plagiate.ethz.ch.


**Prerequisites / notice**

Students should already have a Bachelor degree and plan to do either a semester project or a master thesis in the immediate future.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1572-01L</td>
<td>Semester Project (Nr 1)</td>
<td>W</td>
<td>8</td>
<td>20A</td>
<td>Professors</td>
</tr>
<tr>
<td>Abstract</td>
<td>Semester projects are designed to train the students for independent scientific work. A project uses the student's technical and social skills acquired during the master's program. The semester project comprises 280 hours of work and is supervised by a professor.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| 227-1572-02L | Semester Project (Nr 2)              | W    | 8    | 20A   | Professors |
| Abstract   | Semester projects are designed to train the students for independent scientific work. A project uses the student's technical and social skills acquired during the master's program. The semester project comprises 280 hours of work and is supervised by a professor. |

**Compulsory Electives in Humanities, Social and Political Sciences**

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses

ETH/UZH

Recommended GESS compulsory elective courses (Type B) for D-ITET.

**Industrial Internship**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1550-00L</td>
<td>Internship in Industry</td>
<td>Z</td>
<td>0</td>
<td></td>
<td>external organisers</td>
</tr>
<tr>
<td>Abstract</td>
<td>The main objective of the 12-week internship is to expose master's students to the industrial work environment. During this period, students have the opportunity to be involved in on-going projects at the host institution.</td>
<td></td>
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</tbody>
</table>

**Master Thesis**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1101-00L</td>
<td>How to Write Scientific Texts in Engineering Sciences</td>
<td>E-</td>
<td>0</td>
<td></td>
<td>J. Leuthold</td>
</tr>
<tr>
<td>Abstract</td>
<td>The 4 hour lecture covers the basics of writing &amp; presenting a scientific text. The focus will be on the structure and elements of a scientific text and not on the language. Citation rules, good practice of scientific writing and an overview on software tools will be part of the training. The lecture will be thought on two afternoons. Some exercises will be built into the lecture.</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

| Literature | ETH "Citation Etiquette", see www.plagiate.ethz.ch. |

| Prerequisites / notice | Students should already have a Bachelor degree and plan to do either a semester project or a master thesis in the immediate future. |

<p>| 227-1501-00L | Master's Thesis | O    | 30   | 68D   | Supervisors |</p>
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>
| Admission only if A L L. of the following apply:  
a) bachelor program successfully completed;  
b) acquired (if applicable) all credits from additional requirements for admission to master program;  
c) successfully completed both semester projects.  

Note: the conditions above are not applicable to incoming exchange students.

Data: 06.02.2019 13:00  
Autumn Semester 2015  
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Registration in mystudies required!
The Master Program finishes with a 6-months Master Thesis which is directed by a Professor of the Department or a Professor of another Department who is associated with the D-ITET. Students gain the ability to conduct independent scientific research on a specific research problem.

see above

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0919-00L</td>
<td>Knowledge-Based Image Interpretation</td>
<td>Z</td>
<td>0</td>
<td>2S</td>
<td>G. Székely, L. Van Gool</td>
</tr>
<tr>
<td>Abstract</td>
<td>With the lecture series on special topics of Knowledge based image interpretation we sporadically offer special talks. To become acquainted with selected, recent results in image analysis and interpretation.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>see above</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>227-0920-00L</td>
<td>Seminar in Systems and Control</td>
<td>Z</td>
<td>0</td>
<td>1S</td>
<td>F. Dörfler, R. D’Andrea, J. Lygeros, R. Smith</td>
</tr>
<tr>
<td>Abstract</td>
<td>Current topics in Systems and Control presented mostly by external speakers from academia and industry</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>see above</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>227-0955-00L</td>
<td>Seminar in Electromagnetics</td>
<td>Z</td>
<td>3</td>
<td>2K</td>
<td>J. Leuthold</td>
</tr>
<tr>
<td>Abstract</td>
<td>Selected topics of the current research activities of the IFH and closely related institutions are discussed.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>Have an overview on the research activities of the IFH.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>227-0950-00L</td>
<td>Acoustics</td>
<td>Z</td>
<td>0</td>
<td>0.5K</td>
<td>K. Heutschi</td>
</tr>
<tr>
<td>Abstract</td>
<td>Current topics in Acoustics presented mostly by external speakers from academia and industry.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>see above</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>227-0970-00L</td>
<td>Research Topics in Biomedical Engineering</td>
<td>Z</td>
<td>0</td>
<td>2K</td>
<td>M. Rudin, S. Kozerke, K. P. Prüssmann, M. Stampanoni, K. Stephan, J. Vörös</td>
</tr>
<tr>
<td>Abstract</td>
<td>Current topics in Biomedical Engineering presented by speakers from academia and industry.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>Getting insight into actual areas and problems of Biomedical Engineering an Health Care.</td>
<td></td>
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</tr>
<tr>
<td>227-0980-00L</td>
<td>Seminar on Biomedical Magnetic Resonance</td>
<td>Z</td>
<td>0</td>
<td>2K</td>
<td>K. P. Prüssmann, S. Kozerke, M. Rudin</td>
</tr>
<tr>
<td>Abstract</td>
<td>Actual developments and problems of magnetic resonance imaging (MRI)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>Getting insight to advanced topics in Magnetic Resonance Imaging</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**Course Units for Additional Admission Requirements**

The courses below are only available for MSc students with additional requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0101-AAL</td>
<td>Discrete-Time and Statistical Signal Processing</td>
<td>E-</td>
<td>6</td>
<td>8R</td>
<td>H.A. Loeliger</td>
</tr>
<tr>
<td>Abstract</td>
<td>Fundamental topics of digital signal processing with a bias towards applications in communications: discrete-time linear filters, equalization, DFT, discrete time stochastic processes, elements of detection theory and estimation theory, LMMSE estimation and LMMSE filtering, LMS algorithm, Viterbi algorithm.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Through self study the participant is introduced to some fundamental topics of digital signal processing with a bias towards applications in communications. The two main themes are &quot;linearity&quot; and &quot;probability&quot;. In the first part of the course, we deepen our understanding of discrete-time linear filters. In the second part of the course, we review the basics of probability theory and discrete-time stochastic processes. We then discuss some basic concepts of detection theory and estimation theory, as well as some practical methods including LMMSE estimation and LMMSE filtering, the LMS algorithm, and the Viterbi algorithm.</td>
<td></td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Lecture Notes.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>227-0103-AAL</td>
<td>Control Systems</td>
<td>E-</td>
<td>6</td>
<td>8R</td>
<td>M. Morari, F. Dörfler</td>
</tr>
<tr>
<td>Abstract</td>
<td>Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Objective</td>
<td>Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lecture notes</td>
<td>Slides can be downloaded from the course website. A printed version with additional content is offered via SPOD (student print on demand) for a fee (ca. 10-15 CHF).</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
Prerequisites / notice
MATLAB is used for system analysis and simulation.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0166-AAL</td>
<td>Analog Integrated Circuits</td>
<td>E- 6</td>
<td>8R</td>
<td>Q. Huang</td>
</tr>
<tr>
<td></td>
<td>Enrolment only for MSc students who need this course as additional admission requirement.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Course offered only in the autumn semester with an examination only in winter.

Abstract
This course provides a foundation in analog integrated circuit design based on bipolar and CMOS technologies.

Objective
Integrated circuits are responsible for much of the progress in electronics in the last 50 years, particularly the revolutions in the Information and Communications Technologies we witnessed in recent years. Analog integrated circuits play a crucial part in the highly integrated systems that power the popular electronic devices we use daily. Understanding their design is beneficial to both future designers and users of such systems. The basic elements, design issues and techniques for analog integrated circuits will be taught in this course.

Content
Review of bipolar and MOS devices and their small-signal equivalent circuit models; Building blocks in analog circuits such as current sources, active load, current mirrors, supply independent biasing etc; Amplifiers: differential amplifiers, cascode amplifier, high gain structures, output stages, gain bandwidth product of op-amps; Stability; Comparators; Second-order effects in analog circuits such as mismatch, noise and offset; A/D and D/A converters; Introduction to switched capacitor circuits.

Lecture notes
Handouts of slides. No script but an accompanying textbook is recommended.

Literature

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<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0117-AAL</td>
<td>High Voltage Technology</td>
<td>E- 6</td>
<td>8R</td>
<td>C. Franck</td>
</tr>
<tr>
<td></td>
<td>Enrolment only for MSc students who need this course as additional admission requirement.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Abstract
Understanding of the fundamental phenomena and principles connected with the occurrence of extensive electric field strengths. This knowledge is applied to the dimensioning of high-voltage equipment. Methods of computer-modeling in use today are presented and applied within a workshop in the framework of the exercises.

Objective
The students know the fundamental phenomena and principles connected with the occurrence of extensive electric field strengths. They comprehend the different mechanisms leading to the failure of insulation systems and are able to apply failure criteria on the dimensioning of high voltage components. They have the ability to identify weak spots in insulation systems and to name possibilities for improvement. Further they know the different insulation systems and their dimensioning in practice.

Content
- discussion of the field equations relevant for high voltage engineering.
- analytical and numerical solutions/solving of this equations, as well as the derivation of the important equivalent circuits for the description of the fields and losses in insulations
- introduction to kinetic theory of gases
- mechanisms of the breakdown in gaseous, liquid and solid insulations, as well as insulation systems
- methods for the mathematical determination of the electric withstand of gaseous, liquid and solid insulations
- application of the expertise on high voltage components
- excursions to manufacturers of high voltage components
- exercise to learn on computer-modeling in high voltage engineering

Lecture notes
Handouts

Literature
# Energy Science and Technology Master

### Core Subjects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1633-00L</td>
<td>Energy Conversion in association with Energy Conversion</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>H. G. Park</td>
</tr>
</tbody>
</table>

**Abstract**
- Fundamentals of Thermal Sciences in association with Energy Conversion
- To become acquainted and familiarized with basic principles of fundamental thermal sciences (Thermodynamics, Heat Transfer, etc.) as well as their linkage to energy conversion technologies.

**Objective**
- Thermodynamics (first and second laws), Heat Transfer (conduction/convection/radiation), Technical Applications
- Slides will be distributed by e-mail every week.

**Content**
- Introduction to Thermodynamics and Heat Transfer, 2nd ed. by Cengel, Y. A., McGraw Hill;
- Fundamentals of Engineering Thermodynamics, 6th ed. by Moran & Shapiro, Wiley

**Literature**
- This course is intended for students outside of D-MAVT.

**Prerequisites / notice**
- A list of the basic literature will be offered on a specific online platform, that could be used by all students attending the lectures.

### Compulsory core courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1633-00L</td>
<td>Energy Conversion in association with Energy Conversion</td>
<td>O</td>
<td>4</td>
<td>3G</td>
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</tr>
</tbody>
</table>

**Abstract**
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**Content**
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- Fundamentals of Engineering Thermodynamics, 6th ed. by Moran & Shapiro, Wiley

**Literature**
- This course is intended for students outside of D-MAVT.

### Elective Core Courses

**These courses are particularly recommended, other ETH-courses from the field of Energy Science and Technology at large may be chosen in accordance with your tutor.**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0577-00L</td>
<td>An Introduction to Sustainable Development in the Built Environment</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>G. Habert</td>
</tr>
</tbody>
</table>

**Abstract**
- This year the UN Conference in Paris will shape future world objectives to tackle climate change.
- This course provides an introduction to the notion of sustainable development when applied to our built environment.

**Objective**
- At the end of the semester, the students have an understanding of the term of sustainable development, its history, the current political and scientific discourses and its relevance for our built environment.

**Content**
- The course aims to promote an integral view and understanding of sustainability and describing different spheres (social/cultural, ecological, economical, and institutional) that influence our built environment.
- Students will acquire critical knowledge and understand the role of involved stakeholders, their motivations and constraints, learn how to evaluate challenges, identify deficits and define strategies to promote a more sustainable construction.
- After the course students should be able to define the relevance of specific local, regional or territorial aspects to achieve coherent and applicable solutions toward sustainable development.
- The course offers an environmental, socio-economic and socio-technical perspective focussing on buildings, cities and their transition to resilience with sustainable development. Students will learn on theory and application of current scientific pathways towards sustainable development.

**Lecture notes**
- Lecture script in English, exercises and sample solutions, translation of important vocabulary: english-german.

**Literature**
- All relevant information will be online available before the lectures. For each lecture slides of the lecture will be provided.
- A list of the basic literature will be offered on a specific online platform, that could be used by all students attending the lectures.

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**Data:** 06.02.2019 13:00

**Autumn Semester 2015**

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<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Prerequisite Courses</th>
</tr>
</thead>
</table>
| 151-0163-00L| Nuclear Energy Conversion | 4 | -

**Abstract**
The course presents an overview of measurement tasks in engineering environments. Different concepts for the acquisition and processing of typical measurement quantities are introduced. Following an initial in-class introduction, laboratory exercises from different application areas (especially in thermofluidics and process engineering) are attended by students in small groups.

**Objective**
- Introduction to various aspects of measurement techniques, with particular emphasis on thermo-fluid applications.
- Understanding of various sensing technologies and analysis procedures.
- Exposure to typical experiments, diagnostics hardware, data acquisition and processing.

**Content**
- Physical fundamentals of the fission reaction and the sustainable chain reaction, thermal design, construction, function and operation of nuclear reactors and power plants, light water reactors and other reactor types, conversion and breeding.
- Nuclear physics of fission and chain reaction. Thermodynamics of nuclear reactors. Design of the reactor core. Introduction into the dynamic behaviour of nuclear reactors. Overview on types of nuclear reactors, differences between thermal reactors and fast breeders. Construction and operation of nuclear power plants with pressurized and boiling water reactors, role and function of the most important safety systems, special features of the energy conversion, Development tendencies of reactor technology.
- The analysis of realistic reactive flow systems necessitates the use of detailed computer models that can be constructed starting from first principles i.e. thermodynamics, fluid mechanics, chemical kinetics, and heat mass transport. In this course, the focus will be on combustion theory and modeling. The reacting flow governing equations and the combustion chemistry are firstly reviewed, setting the ground for the analysis of homogeneous gas-phase mixtures, laminar diffusion and premixed flames. Catalytic combustion and its coupling with homogeneous combustion are dealt in detail, and turbulent combustion modeling approaches are presented. Available numerical codes will be used for modeling.

**Literature**
- E. Frouzakis, I. Mantzarakis

**Lecture notes**
- Handouts will be distributed. Additional information on the website of the lab:

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<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Prerequisite Courses</th>
</tr>
</thead>
</table>
| 151-0185-00L| Radiation Heat Transfer | 4 | -

**Abstract**
Advanced course in radiation heat transfer.

**Objective**
Fundamentals of radiative heat transfer for high-temperature applications. Examples are combustion and solar thermal/thermochemical processes, and other applications in the field of energy conversion and material processing.

**Content**

**Literature**

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<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Prerequisite Courses</th>
</tr>
</thead>
</table>
| 151-0203-00L| Turbomachinery Design | 4 | -

**Abstract**
Introduction to the understanding of a broad range of turbomachinery devices. Learn the steps of turbomachinery design.

**Objective**
Learn the principles, and learn the design procedures and the behaviour of turbomachines.

**Content**

**Lecture notes**
- Lecture notes

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<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Prerequisite Courses</th>
</tr>
</thead>
</table>
| 151-0207-00L| Theory and Modeling of Reactive Flows | 4 | -

**Abstract**
The course first reviews the governing equations and combustion chemistry, setting the ground for the analysis of homogeneous gas-phase mixtures, laminar diffusion and premixed flames. Catalytic combustion and its coupling with homogeneous combustion are dealt in detail, and turbulent combustion modeling approaches are presented. Available numerical codes will be used for modeling.

**Objective**
Theory of combustion with numerical applications.

**Content**
The analysis of realistic reactive flow systems necessitates the use of detailed computer models that can be constructed starting from first principles i.e. thermodynamics, fluid mechanics, chemical kinetics, and heat mass transport. In this course, the focus will be on combustion theory and modeling. The reacting flow governing equations and the combustion chemistry are firstly reviewed, setting the ground for the analysis of homogeneous gas-phase mixtures, laminar diffusion and premixed flames. Catalytic (catalytic) combustion, an area of increased importance in the last years, will be dealt in detail along with its coupling with homogeneous combustion. Finally, approaches for the modeling of turbulent combustion will be presented. Available numerical codes will be used to compute the above described phenomena. Familiarity with numerical methods for the solution of partial differential equations is expected.

**Literature**
- E. Frouzakis, I. Mantzarakis

**Lecture notes**
- Handouts
<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
<th>NEW course</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0216-00L</td>
<td>Wind Energy</td>
</tr>
<tr>
<td>Abstract</td>
<td>The objective of this course is to introduce the students to the fundamentals, technologies, modern day application, and economics of wind energy. These subjects are introduced through a discussion of the basic principles of wind energy generation and conversion, and a detailed description of the broad range of relevant technical, economic and environmental topics.</td>
</tr>
<tr>
<td>Objective</td>
<td>The objective of this course is to introduce the students to the fundamentals, technologies, modern day application, and economics of wind energy.</td>
</tr>
<tr>
<td>Content</td>
<td>This mechanical engineering course focuses on the technical aspects of wind turbines; non-technical issues are not within the scope of this technically oriented course. On completion of this course, the student shall be able to conduct the preliminary aerodynamic and structural design of the wind turbine blades. The student shall also be more aware of the broad context of drivetrains, dynamics and control, electrical systems, and meteorology, relevant to all types of wind turbines.</td>
</tr>
</tbody>
</table>

| 151-0251-00L | IC-Engines and Propulsion Systems I | W | 4 credits | 2V+1U | K. Boulouchos, G. Georges, J. W. Kolar |
| Abstract | The students should become familiar with the fundamentals and with application examples of chemically reactive processes in energy conversion (combustion engines in particular) as well as the synthesis of new materials. The lecture introduces to basic concepts, operating maps and work processes of internal combustion engines. Thermodynamic analysis and design, scavenging methods, heat transfer mechanisms, turbulent flow field in combustion chambers, turbocharging. Energy systemic role of IC engines: conventional and electrified vehicle propulsion systems and decentralized power generation. |
| Objective | The students learn the basic concepts of an internal combustion engine by means of the topics mentioned in the abstract. This knowledge is applied in several calculation exercises and two lab exercises at the engine test bench. The students get an insight in alternative power train systems. |
| Literature | in English |

| 151-0293-00L | Combustion and Reactive Processes in Energy and Materials Technology | W | 4 credits | 2V+1U+2A | K. Boulouchos, F. Ernst, Y. M. Wright |
| Abstract | The students should become familiar with the fundamentals and with application examples of chemically reactive processes in energy conversion (combustion engines in particular) as well as the synthesis of new materials. The lecture introduces to basic concepts, operating maps and work processes of internal combustion engines. Thermodynamic analysis and design, scavenging methods, heat transfer mechanisms, turbulent flow field in combustion chambers, turbocharging. Energy systemic role of IC engines: conventional and electrified vehicle propulsion systems and decentralized power generation. Reaction kinetics, fuel oxidation mechanisms, premixed and diffusion laminar flames, two-phase-flows, turbulence and turbulent combustion, pollutant formation, applications in combustion engines, Synthesis of materials in flame processes; particles, pigments and nanoparticles. Fundamentals of design and optimization of flame reactors, effect of reactant mixing on product characteristics. Tailoring of products made in flame spray pyrolysis. |
| Objective | The students should become familiar with the fundamentals and with application examples of chemically reactive processes in energy conversion (combustion engines in particular) as well as the synthesis of new materials. The lecture introduces to basic concepts, operating maps and work processes of internal combustion engines. Thermodynamic analysis and design, scavenging methods, heat transfer mechanisms, turbulent flow field in combustion chambers, turbocharging. Energy systemic role of IC engines: conventional and electrified vehicle propulsion systems and decentralized power generation. Reaction kinetics, fuel oxidation mechanisms, premixed and diffusion laminar flames, two-phase-flows, turbulence and turbulent combustion, pollutant formation, applications in combustion engines, Synthesis of materials in flame processes; particles, pigments and nanoparticles. Fundamentals of design and optimization of flame reactors, effect of reactant mixing on product characteristics. Tailoring of products made in flame spray pyrolysis. |
| Lecture notes | HANDBOUTS are EXCLUSIVELY IN GERMAN ONLY, however recommendations for English text books will be provided. |

| 151-0567-00L | Engine Systems | W | 4 credits | 3G | C. Onder, P. Kytaratos |
| Abstract | Introduction to current and future engine systems and their control systems. |
| Objective | Introduction to control and optimization of dynamic systems. Application to real engines. Understand the structure and behavior of drive train systems and their quantitative descriptions. |
| Content | Case studies of model-based optimal design and control of engine systems with the goal of minimizing fuel consumption and emissions. |
| Lecture notes | Introduction to Modeling and Control of Internal Combustion Engine Systems |
| ISBN: 978-3-642-10774-0 |
| Prerequisites / notice | Combined homework and testbench exercise (air-to-fuel-ratio control or idle-speed control) in groups |

| 151-0569-00L | Vehicle Propulsion Systems | W | 4 credits | 3G | C. Onder, P. Elbert |
| Abstract | Introduction to current and future propulsion systems and the electronic control of their longitudinal behavior. |
| Objective | Introduction to methods of system optimization and controller design for vehicles. Understanding the structure and working principles of conventional and new propulsion systems. Quantitative descriptions of propulsion systems. |
| Content | Presentation of mathematical methods, CAE tools and case studies for the model-based design and control of propulsion systems with the goal of minimizing fuel consumption and emissions. |
| Lecture notes | Vehicle Propulsion Systems -- Introduction to Modeling and Optimization |
| ISBN: 978-3-642-35912-5 |
| Prerequisites / notice | Lectures of Dr. Ch. Onder are also possible to be held in German |

| 227-0247-00L | Power Electronic Systems I | W | 6 credits | 4G | J. W. Kolar |
| Abstract | Basics of the switching behavior, gate drive and snubber circuits of power semiconductors are discussed. Soft-switching and resonant DC/DC converters are analyzed in detail and high frequency loss mechanisms of magnetic components are explained. Space vector modulation of three-phase inverters is introduced and the main power components are designed for typical industry applications. |
| Objective | Detailed understanding of the principle of operation and modulation of advanced power electronics converter systems, especially of zero voltage switching and zero current switching non-isolated and isolated DC/DC converter systems and three-phase voltage DC link inverter systems. Furthermore, the course should convey knowledge on the switching frequency related losses of power semiconductors and inductive power components and introduce the concept of space vector calculus which provides a basis for the comprehensive discussion of three-phase PWM converters systems in the lecture Power Electronic Systems II. |
Basics of the switching behavior and gate drive circuits of power semiconductor devices and auxiliary circuits for minimizing the switching losses are explained. Furthermore, zero voltage switching, zero current switching, and resonant DC/DC converters are discussed in detail; the operating behavior of isolated full-bridge DC/DC converters is detailed for different secondary side rectifier topologies; high frequency loss mechanisms of magnetic components of converter circuits are explained and approximate calculation methods are presented; the concept of space vector calculus for analyzing three-phase systems is introduced; finally, phase-oriented and space vector modulation of three-phase inverter systems are discussed related to voltage DC link inverter systems and the design of the main power components based on analytical calculations is explained.

Lecture notes
Lecture notes and associated exercises including correct answers, simulation program for interactive self-learning including visualization/animation features.

Prerequisites / notice
Prerequisites: Introductory course on power electronics.

227-0523-00L  Railway Systems I

| W | 6 credits | 4G | M. Meyer |

Abstract
Basic characteristics of railway vehicles and their interfaces with the railway infrastructure:
- Transportation tasks and vehicle types
- Running dynamics
- Mechanical part of rail vehicles
- Brakes
- Traction chain and auxiliary supply
- Railway power supply
- Signaling systems
- Traffic control and maintenance

Objective
- Overview of the technical characteristics of railway systems
- Know-how about the design and construction principles of rail vehicles
- Interrelationship between different fields of engineering sciences (mechanics, electro and information technology, transport systems)
- Understanding tasks and opportunities of engineers working in an environment which has strong economical and political boundaries
- Insight into the activities of the railway vehicle industry and railway operators in Switzerland
- Motivation of young engineers to start a career in the railway industry or with railway operators

Content
EST I (Frühjahrsemester) - Begriffen, Grundlagen, Merkmale

1. Einführung:
   1.1 Geschichte und Struktur des Bahnsystems
   1.2 Fahrdynamik

2. Vollbahnräder:
   2.1 Mechanik: Kasten, Drehgestelle, Lauftechnik, Adhäsion
   2.2 Bremsen
   2.3 Traktionsantriebssysteme
   2.4 Hilfsbetriebe und Komfortanlagen
   2.5 Steuerung und Regelung

3. Infrastruktur:
   3.1 Fahrweg
   3.2 Bahnstromversorgung
   3.3 Sicherungsanlagen

4. Betrieb:
   4.1 Interoperabilität, Normen und Zulassung
   4.2 RAMS, LCC
   4.3 Anwendungsbeispiele

Voraussichtlich ein oder zwei Gastvorträge

Lecture notes
Abgabe der Unterlagen (gegen eine Schutzgebühr) zu Beginn des Semesters. Rechtzeitig eingeschriebene Teilnehmer können die Unterlagen auf Wunsch und gegen eine Zusatzgebühr auch in Farbe beziehen.

Prerequisites / notice
Dozent:
Dr. Markus Meyer, Emkamatik GmbH

Voraussichtlich ein oder zwei Gastvorträge von anderen Referenten.

EST I (Herbstsemester) kann als in sich geschlossene einsemestrige Vorlesung besucht werden. EST II (Frühjahrssemester) dient der weiteren Vertiefung der Fahrzeugeotechnik und der Integration in die Bahinfrastruktur.

227-0526-00L  Power System Analysis

| W | 6 credits | 4G | G. Andersson |

Abstract
The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the development of stationary models of the electrical network, their mathematical representation and special characteristics and solution methods of large linear and non-linear systems of equations related to electrical power networks.

Objective
The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the development of stationary models of the electrical network, their mathematical representation and special characteristics and solution methods of large linear and non-linear systems of equations related to electrical power networks.

Content
The electrical power transmission system, the energy management system, requirements of the electrical power transmission (demand oriented, operationally, economically), network planning and network operation, models of N-port network components (line, cables, shunts, transformers), the p.u. computation, computer oriented network models, linear networks (solution methods - direct, iterative), algorithms for the solution of non-linear sets of equations, derived from the electrical power system (Newton-Raphson), power flow computation (problem definition, solution methods), three phase short-circuit computation, application of power flow algorithms. Introduction to power system stability.

Lecture notes
Lecture notes. Course is supported by WWW-teaching system.

227-0731-00L  Power Market I - Portfolio and Risk Management

| W | 6 credits | 4G | D. Reichelt, G. A. Koeppel |

Abstract
Portfolio and risk management in the electrical power business, Pan-European power market and trading, futures and forward contracts, hedging, options and derivatives, performance indicators for the risk management, modelling of physical assets, cross-border trading, ancillary services, balancing power market, Swiss market model, strategy development and positioning.
Objective


Content

1. Pan-European power market and trading
   1.1. Power trading
   1.2. Development of the European power markets
   1.3. Energy economics
   1.4. Spot and OTC trading
   1.5. European energy exchange EEX

2. Market model
   2.1. Market place and organisation
   2.2. Balance groups / balancing energy
   2.3. Ancillary services
   2.4. Market for ancillary services
   2.5. Cross-border trading
   2.6. Capacity auctions

3. Portfolio and Risk management
   3.1. Portfolio management 1 (introduction)
   3.2. Forward and futures contracts
   3.3. Risk management 1 (m2m, VaR, hpfc, volatility, cVaR)
   3.4. Risk management 2 (PaR)
   3.5. Contract valuation (HPFC)
   3.6. Portfolio management 2
   2.8. Risk Management 3 (enterprise wide)

4. Energy & Finance I
   4.1. Options 1 basics
   4.2. Options 2 hedging with options
   4.3. Introduction to derivatives (swaps, cap, floor, collar)
   4.4. Financial modelling of physical assets
   4.5. Trading and hydro power
   4.6. Incentive regulation

5. Strategy
   5.1. Strategic Positioning
   5.2. Development of strategies and examples
   5.3. Cases for team work

Prerequisites / notice

1 excursion per semester, 2 case studies, guest speakers for specific topics

227-0759-00L International Business Management for Engineers W 3 credits 2V W. Hofbauer

Objective

Globalization of markets increases global competition and requires enterprises to continuously improve their performance to sustainably survive. Engineers substantially contribute to the success of an enterprise provided they understand and follow fundamental international market forces, economic basics and operational business management.

Content

The first part of the course provides an overview about the development of international markets, the expected challenges and the players in the market. The second part is focusing on the economic aspects of an enterprise, their importance for the long term success and how to effectively manage an international business. Based on these fundamentals the third part of the course explains how an innovative product portfolio of a company can be derived from considering the most important external factors and which consequences in respect of product innovation, competitive product pricing, organization and business processes emerge. Each part of the course includes practical examples to demonstrate the procedure.

Prerequisites / notice

A script is provided for this lecture.

Lecture notes

The lecture will be held in three blocks each of them on a Saturday. Each block will focus on one of the three main topics of the course. Between the blocks the students will work on specific case studies to deepen the subject matter. About two weeks after the third block a written examination will be conducted.

529-0193-00L Renewable Energy Technologies I W 4 credits 3G A. Wokaun, A. Steinfeld

Abstract


Objective

Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals.

Content


Lecture notes

Lecture notes will be distributed during the course.

Literature

Prerequisites / notice
Fundamentals of chemistry and physics are a prerequisite for this course.

Topics are available to carry out a Project Work (Semesterarbeit) on the contents of this course.

### Other Elective Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>102-0307-00L</td>
<td>Advanced Environmental, Social and Economic Assessments</td>
<td>W</td>
<td>6</td>
<td>3G+2U+2P</td>
<td>A. E. Braunschweig, S. Hellweg, S. Pfister, R. Frischknecht</td>
</tr>
</tbody>
</table>

**Abstract**
This course deepens students' knowledge of environmental, economic, and social assessment methodologies and their various applications.

**Objective**
This course has the aim of deepening students' knowledge of the environmental, economic, and social assessment methodologies and their various applications.

- In particular, students completing the course should have the
- ability to judge the scientific quality and reliability of environmental assessment studies, the appropriateness of inventory data and modelling, and the adequacy of life cycle impact assessment models and factors
- knowledge about the current state of the scientific discussion and new research developments
- ability to properly plan, conduct and interpret environmental assessment studies

**Content**

Part I (Advanced Environmental Assessments)
- Inventory database developments, transparency, data quality, data completeness, and data exchange formats, uncertainties
- Software tools (MFA, LCA)
- Allocation (multioutput processes and recycling)
- Hybrid LCA methods.
- Consequential and marginal analysis
- Impact assessment of waterborne chemical emissions, sum parameters, mixture toxicity
- Spatial differentiation in Life Cycle Assessment
- Workplace and indoor exposure in Risk and Life Cycle Assessment
- Subjectivity in environmental assessments
- Case Studies

Part II (Implementation of Environmental and other Sustainability Goals):
- Sustainability problems of the current economic system and its measuring units;
- The structure of a management system, and elements to integrate environmental management (ISO 14001) and social management (SA8000 as well as ISO 26000), especially into strategy development, planning, controlling and communication;
- Sustainability Opportunities and Innovation
- The concept of Continuous Improvement
- Life Cycle Costing, Life Cycle Management
- environmental performance measurement of an organisation, including 'organisational LCA' (Ecobalance), based on practical examples of companies and new concepts
- single score env. assessment methods (Swiss ecopoints)
- stakeholder management and sustainability oriented communication
- an intro into sustainability issues of supply chain management

Students will get small exercises related to course issues.

**Lecture notes**
Part I: (-)
Part II: Documents will be available on Ilias
Part III Lab: (-)

**Prerequisites / notice**
Will be made available in class.

This course should only be elected by students of environmental engineering with the Major in ESD, Air Quality Control and Waste Management. All other students should take the individual courses in Advanced Environmental Assessment and/or Implementation of Environmental goals (with or without exercise and lab).

Basic knowledge of environmental assessment tools is a prerequisite for this class. Students who have not yet had classwork in this topic are required to read an appropriate textbook before or at the beginning of this course (e.g. Baumann&Tillman, The Hitchhiker's Guide to LCA: An Orientation in Life Cycle Assessment Methodology and Applications, Studentlitteratur, Lund, 2004).

**Lecture notes**
Part I: (Computer Lab): this is an exercise and software lab to apply the methods from Part I and II of this lecture.

**Literature**
Will be made available in class.

### 151-0360-00L

**Procedures for the Analysis of Structures**

**Abstract**
Basic theories for structure integrity calculations are presented with focus on strength, stability, fatigue and elasto-plastic structural analysis.

**Objective**
Basic principles applied in structural mechanics. Introduction to the theories of planar structures. Development of an understanding of the relationship between material properties, structural theories and design criteria.

**Inhalt:**
1. Basic problem of continuum mechanics and energy principles: structural theories, homogenization theories; finite elements; fracture mechanics.
3. Strength of material theories and material properties: ductile behaviour, plasticity, von Mises, Tresca, principal stress criterion; brittle behaviour; viscoplastic behaviour, creep resistance.
4. Structural design: fatigue and dynamic structural analysis.

**Lecture notes**
Yes

### 151-0524-00L

**Continuum Mechanics 1**

**Abstract**
The lecture deals with constitutive models that are relevant for design and calculation of structures. These include anisotropic linear elasticity, linear viscoelasticity, plasticity, viscoplasticity. Homogenization theories and laminate theory are presented. Theoretical models are complemented by examples of engineering applications and experiments.
Fundamentals of plant and apparatus design, materials in the process industries, mechanical design and design rules of main components; We introduce the concept of corporate sustainability; discuss its implications focusing on strategy, technology, and financial markets; and understand the limits and the potential of corporate sustainability for sustainable development.

Handouts during the class

- Rate-Controlled Separations in Fine Chemistry
- System Modeling
- Embedded Control Systems
- Process Design and Safety
- Process Design and Safety
- Corporate Sustainability

Objectives

- Develop critical thinking skills that are useful for corporate sustainability (argumentation, communication, evaluative judgment)
- Be able to recognize and realize opportunities for corporate sustainability in a business environment

Literature

<table>
<thead>
<tr>
<th>Course</th>
<th>Overview of the grand sustainability challenges of Water, Energy, Mobility, and Food</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Business implications of sustainable development, in particular for corporate strategy, marketing &amp; leadership, technology &amp; innovation, and financial markets.</td>
</tr>
<tr>
<td></td>
<td>Critical thinking skills for corporate sustainability</td>
</tr>
<tr>
<td></td>
<td>In-depth case study of concrete corporate sustainability challenge in the group project phase, such as: How to deal with environmental pressure groups? How to use the strengths of business to solve pressing sustainability problems? How to catalyze radical innovations for sustainability? How to invest money in a sustainable way?</td>
</tr>
</tbody>
</table>

**Lecture notes**
Presentation slides will be distributed prior to lectures.

**Literature**
Literature recommendations will be distributed during the lecture

### Resource and Environmental Economics

**W 3 credits 2G**
L. Bretschger, A. Brausmann

#### Abstract
Relationship between economy and environment, market failure, external effects and public goods, contingent valuation, internalisation of externalities; economics of non-renewable resources, economics of renewable resources, cost-benefit analysis, sustainability, and international aspects of resource and environmental economics.

#### Objective
Understanding of the basic issues and methods in resource and environmental economics; ability to solve typical problems in the field using the appropriate tools, which are concise verbal explanations, diagrams or mathematical expressions.

#### Topics are:
- Introduction to resource and environmental economics
- Importance of resource and environmental economics
- Main issues of resource and environmental economics
- Normative basis
- Utilitarianism
- Fairness according to Rawls
- Economic growth and environment
- Externalities in the environmental sphere
- Governmental internalisation of externalities
- Private internalisation of externalities: the Coase theorem
- Free rider problem and public goods
- Types of public policy
- Efficient level of pollution
- Tax vs. permits
- Command and Control Instruments
- Empirical data on non-renewable natural resources
- Optimal price development: the Hotelling-rule
- Effects of exploration and Backstop-technology
- Effects of different types of markets.
- Biological growth function
- Optimal depletion of renewable resources
- Social inefficiency as result of over-use of open-access resources
- Cost-benefit analysis and the environment
- Measuring environmental benefit
- Measuring costs
- Concept of sustainability
- Technological feasibility
- Conflicts sustainability / optimality
- Indicators of sustainability
- Problem of climate change
- Cost and benefit of climate change
- Climate change as international ecological externality
- International climate policy: Kyoto protocol
- Implementation of the Kyoto protocol in Switzerland
- Optimal depletion of renewable resources
- Social inefficiency as result of over-use of open-access resources
- Cost-benefit analysis and the environment
- Measuring environmental benefit
- Measuring costs
- Concept of sustainability
- Technological feasibility
- Conflicts sustainability / optimality
- Indicators of sustainability
- Problem of climate change
- Cost and benefit of climate change
- Climate change as international ecological externality
- International climate policy: Kyoto protocol
- Implementation of the Kyoto protocol in Switzerland

**Content**
- Economy and natural environment, welfare concepts and market failure, external effects and public goods, measuring externalities and contingent valuation, internalising external effects and environmental policy, economics of non-renewable resources, renewable resources, cost-benefit-analysis, sustainability issues, international aspects of resource and environmental problems, selected examples and case studies.

**Lecture notes**
Learning material and script can be found here: [https://moodle-app2.let.ethz.ch/course/view.php?id=328](https://moodle-app2.let.ethz.ch/course/view.php?id=328)

**Literature**
Overview of process simulation and flowsheeting

- Definition and fundamentals
- Classification: stationary (steady-state) versus dynamic (transient state) systems
- Fields of application
- Case studies

Process modeling

- Modeling strategies of process systems
- Mass conservation
- Species balance
- Energy conservation
- Momentum balance
- Multiphase-systems: equilibrium & non-equilibrium models
- Process system model

Process simulation

- Process specification
- Introduction to process specification
- Classification of mathematical models: AMS, DOE, DAE, PDE
- Model validation
- Software tools
- Solution methods for process flowsheeting
- Simultaneous methods
- Sequential methods
- Dynamic simulation
- Numerical solution: explicit and implicit methods
- Continuous-discrete simulation: handling of discontinuities

Commercial software for simulation: Aspen Plus
- Thermodynamic property methods
- Reaction and reactors
- Separation / columns
- Convergence & debugging

An exemplary literature list is provided below:


A basic understanding of material and energy balances, thermodynamic property methods and typical unit operations (e.g., reactors, flash separations, distillation/absorption columns etc.) is required.
Abstract

The lecture Energy and Transportation imparts profound knowledge of energy- and environment-related difficulties of the intersection of energy and transportation with focus on the motorized individual traffic. The students gain the ability to approach energy- and environment-related problems with special consideration of the demand side, and to evaluate possible solutions.

Objective

The main objectives of this lecture are:

(i) The students gain profound knowledge of energy- and environment-related difficulties of the intersection of energy and transportation, and learn strategies to cope with these difficulties.

(ii) The students are able to approach energy- and environment-related problems with special consideration of the demand side, and to evaluate possible solutions.

Content

The lecture Energy and Transportation deals with the intersection of energy and transportation with focus on the motorized individual traffic.

Main topics are:

(i) Fundamentals of energy use in the transportation sector, today's present state and future developments.

(ii) Technical potentials for the reduction of greenhouse gas (GHG) emissions and the dependence on fossil fuels: Evaluation of (a) alternative fuels, and (b) alternative propulsion systems.

(iii) The relevance of demand on efforts to reduce GHG emissions and the dependence on fossil fuels.

(iv) Strategies and measures for influencing the demand side.

Multidisciplinary Courses

The listed courses are specially recommended. Beyond these, the students are free to choose individually from the entire course offer of ETH Zürich, ETH Lausanne and the Universities of Zürich and St. Gallen.

Semester Project

227-1101-00L How to Write Scientific Texts in Engineering Sciences E- 0 credits J. Leuthold

Abstract

The 4 hour lecture covers the basics of writing & presenting a scientific text. The focus will be on the structure and elements of a scientific text and not on the language. Citation rules, good practice of scientific writing and an overview on software tools will be part of the training. The lecture will be thought on two afternoons. Some exercises will be built into the lecture.

Objective

Knowledge on structure and content of a scientific text. The course further is arranged to stimulate a discussion on how to properly write a legible scientific text versus writing an interesting novel. We will further discuss the practice of properly citing and critically reflect on recent plagiarism allegations.

Content

* Topic 1: Structure of a Scientific Text (The Title, the author list, the abstract, State-of-the Art, the "in this paper" paragraph, the scientific part, the summary, Equations, Figures).

* Topic 2: Power Point Presentations.

* Topic 3: Citation Rules and Citation Software.

* Topic 4: Guidelines for Research Integrity.

Literature

ETH "Citation Etiquette", see www.plagiate.ethz.ch.


Prerequisites / notice

Students should already have a Bachelor degree and plan to do either a semester project or a master thesis in the immediate future.

Industrial Internship

227-1650-00L Internship in Industry

Abstract

The main objective of the 12-week internship is to expose master's students to the industrial work environment. During this period, students have the opportunity to be involved in on-going projects at the host institution.

Objective

see above

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-ITET.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Master Thesis

227-1101-00L How to Write Scientific Texts in Engineering Sciences E- 0 credits J. Leuthold
The 4 hour lecture covers the basics of writing & presenting a scientific text. The focus will be on the structure and elements of a scientific text and not on the language. Citation rules, good practice of scientific writing and an overview on software tools will be part of the training. The lecture will be thought on two afternoons. Some exercises will be built into the lecture.

Knowledge on structure and content of a scientific text. The course further is arranged to stimulate a discussion on how to properly write a legible scientific text versus writing an interesting novel. We will further discuss the practice of properly citing and critically reflect on recent plagiarism allegations.

Students should already have a Bachelor degree and plan to do either a semester project or a master thesis in the immediate future.

Only students who fulfill the following criteria are allowed to begin with their master thesis:

a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to gain admission to the master programme.

Registration in mystudies required!

The master program in Energy Science and Technology culminates in a six months research project which addresses a scientific research questions on one’s chosen area of specialization. The masters thesis is supervised by a program-affiliated faculty member and the topic must be approved in advance by the tutor.

see above

Master's Thesis
Only students who fulfill the following criteria are allowed to begin with their master thesis:

a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to gain admission to the master programme.

Registration in mystudies required!

The master program in Energy Science and Technology culminates in a six months research project which addresses a scientific research questions on one’s chosen area of specialization. The masters thesis is supervised by a program-affiliated faculty member and the topic must be approved in advance by the tutor.

see above

Energy Science and Technology Master - Key for Type

<table>
<thead>
<tr>
<th>W</th>
<th>Eligible for credits</th>
<th>Dr</th>
<th>Suitable for doctorate</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Earth Sciences Bachelor

### 1. Semester

#### First Year Examinations

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tbody>
<tr>
<td>529-2001-02L</td>
<td>Chemistry I</td>
<td>O</td>
<td>4</td>
<td>2V+2U</td>
<td>W. Uhlig, J. E. E. Buschmann, S. Canonica, P. Funck, E. C. Meister, R. Verel</td>
</tr>
</tbody>
</table>

**Abstract**
- General Chemistry I: Chemical bond and molecular structure, chemical thermodynamics, chemical equilibrium.

**Objective**
- Introduction to general and inorganic chemistry. Basics of the composition and the change of the material world. Introduction to the thermodynamically controlled physico-chemical processes. Macroscopic phenomena and their explanation through atomic and molecular properties. Using the theories to solve qualitatively and quantitatively chemical and ecologically relevant problems.

**Content**
1. Stoichiometry
2. Atoms and Elements (Quantenmechanical Model of the Atom)
3. Chemical Bonding
4. Thermodynamics
5. Chemical Kinetics
6. Chemical Equilibrium (Acids and Bases, Solubility Equilibria)

**Lecture notes**
- ca. 360 Seiten mit vielen Figuren und durchgerechneten Beispielen.

**Literature**

**Weiterführende Literatur:**
- Brown, LeMay, Bursten CHEMIE (deutsch)
- Housecroft and Constable, CHEMISTRY (englisch)
- Oxtoby, Gillis, Nachtrieb, MODERN CHEMISTRY (englisch)

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<tbody>
<tr>
<td>401-0251-00L</td>
<td>Mathematics I</td>
<td>O</td>
<td>6</td>
<td>4V+2U</td>
<td>A. Cannas da Silva</td>
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</table>

**Abstract**
- This course covers mathematical concepts and techniques necessary to model, solve and discuss scientific problems - notably through ordinary differential equations.

**Objective**
- Mathematics is of ever increasing importance to the Natural Sciences and Engineering. The key is the so-called mathematical modelling cycle, i.e. the translation of problems from outside of mathematics into mathematics, the study of the mathematical problems (often with the help of high level mathematical software packages) and the interpretation of the results in the original environment.

**The goal of Mathematics I and II is to provide the mathematical foundations relevant for this paradigm. Differential equations are by far the most important tool for modelling and are therefore a main focus of both of these courses.**

**Content**
1. Single-Variable Calculus:
   - review of differentiation, linearisation, Taylor polynomials, maxima and minima, antiderivative, fundamental theorem of calculus, integration methods, improper integrals.
2. Linear Algebra and Complex Numbers:
   - systems of linear equations, Gauss-Jordan elimination, matrices, determinants, eigenvalues and eigenvectors, cartesian and polar forms for complex numbers, complex powers, complex roots, fundamental theorem of algebra.
3. Ordinary Differential Equations:
   - separable ordinary differential equations (ODEs), integration by substitution, 1st and 2nd order linear ODEs, homogeneous systems of linear ODEs with constant coefficients, introduction to 2-dimensional dynamical systems.

**Literature**
- Bretscher, O.: Linear Algebra with Applications (Pearson Prentice Hall).

**Prerequisites / notice**
- Prerequisites: familiarity with the basic notions from Calculus, in particular those of function and derivative.
- Assistance:
  - Mondays 12-13, Tuesdays 17-19, Wednesdays 17-19, in Room HG E 41.

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<tr>
<td>551-0001-00L</td>
<td>General Biology</td>
<td>O</td>
<td>3</td>
<td>3V</td>
<td>U. Sauer, A. Widmer</td>
</tr>
</tbody>
</table>

**Abstract**
- Basics of structure, formation and function of cells and biomacromolecules, principles of metabolism, as well as basic classical and molecular genetics and evolutionary biology. First in a series of two lectures given over two semesters for students of agricultural and food sciences, as well as of environmental sciences.

**Objective**
- The understanding of some basic principles of biology: the hierarchy of the structural levels of biological organisation, with particular emphasis on the cell and its functions, as well as metabolism, inheritance and evolution.
The structure and function of biomacromolecules; basics of metabolism; cell biology; membrane structure and function; basic energetics of cellular processes; respiration, photosynthesis; cell cycle, meiosis and sexual life cycles; Mendelian and molecular genetics; animal reproduction and behavior; sensory and motor mechanisms; population biology and evolution; principles of phylogeny.

The Campbell Chapters 1-4 (10th edition) under the heading “The role of chemistry in biology” are expected. We will treat the following Campbell chapters:

- Biochemistry: Biological Macromolecules and Lipids
- Cell biology: Cell Structure and Function
- Cell biology: Cell Membranes
- Cell biology: Cellular Respiration: An Introduction to Metabolism
- Cell biology: Cellular Respiration
- Cell biology: Photosynthesis
- Cell Biology: Mitosis
- The Genetic Basis of Life: Sexual Life Cycles and Meiosis
- The Genetic Basis of Life: Mendelian Genetics
- The Genetic Basis of Life: Linkage and Chromosomes
- The Genetic Basis of Life: The Evolution of Genomes
- Evolution: How Evolution Works
- Evolution: Phylogenetic Reconstruction
- Evolution: Microevolution
- Evolution: Species and Speciation
- Evolution: Macroevolution

**Lecture notes**
- no script

**Literature**
- Prerequisites / notice

---

**First Year Additional Compulsory Courses**

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<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>252-0839-00L</td>
<td>Informatics</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>L. E. Fässler, H.J. Böckenhauer, M. Dahinden, D. Komm</td>
</tr>
</tbody>
</table>
Students learn to apply selected concepts and tools from computer science for working on interdisciplinary projects. The following topics are covered: publishing over the internet, processing and visualizing time series, visualizing multi-dimensional data, managing data with lists and tables and with relational databases, introduction to macro programming, universal methods for algorithm design.

The students learn to:

- choose and apply appropriate tools from computer science,
- process and analyze real-world data from their subject of study,
- handle the complexity of real-world data,
- know universal methods for algorithm design.

**Content**

1. Simulation and Modeling
2. Visualizing multidimensional data
3. Data management with lists and tables
4. Data management with a relational database
5. Introduction to macro programming
6. Introduction to programming with Python

**Prerequisites / notice**

This course is based on application-oriented learning. The students spend most of their time working through electronic tutorials and discussing their results with teaching assistants.

**529-0030-00L Laboratory Course: Elementary Chemical Techniques**

**Objective**

This practical course provides an introduction to elementary laboratory techniques. The experiments cover a wide range of techniques, including analytical and synthetic techniques (e.g. investigation of soil and water samples or the preparation of simple compounds). Furthermore, the handling of gaseous substances is practised.

**Content**

- The classification and analysis of natural and artificial compounds is a key subject of this course.
- It provides an introduction to elementary laboratory techniques, and the experiments cover a wide range of analytic and synthetic tasks:
- Selected samples (e.g. soil and water) will be analysed with various methods, such as titrations, spectroscopy or ion chromatography. The chemistry of aqueous solutions (acid-base equilibria and solvation or precipitation processes) is studied.
- The synthesis of simple inorganic complexes or organic molecules is practised.
- Furthermore, the preparation and handling of environmentally relevant gaseous species like carbon dioxide or nitrogen oxides is a central subject of the Praktikum.

**Lecture notes**

The script will be published on the web. Details will be provided on the first day of the semester.

**Literature**

A thorough study of all script materials is requested before the course starts.

### 3. Semester

#### Compulsory Basic Courses II

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<tr>
<th>Number</th>
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<tr>
<td>701-0033-04L</td>
<td>Laboratory Course in Physics for Students in Earth Sciences</td>
<td>O</td>
<td>2</td>
<td>4P</td>
<td>A. Biland, M. Münich</td>
</tr>
</tbody>
</table>

**Abstract**

This laboratory course aims to provide basic knowledge of:
- the setup of a physics experiment,
- the use of measurement instruments,
- various measuring techniques,
- the analysis or measurement errors,
- and the interpretation of the measured quantities.

**Content**

Fehlerrechnung, 9 ausgewählte Versuche zu folgenden Themen:

- Transversalschwingung einer Saite, Mechanische Resonanz, Innere Reibung in Flüssigkeiten, Absoluter Nullpunkt der Temperaturskala,

**Lecture notes**

Die Auswahl der Versuche kann zwischen den verschiedenen Studiengängen variieren.

#### General Courses in Earth Sciences

The general courses in Earth Sciences are offered in the 3rd and 4th semester. Out of 40 offered credits, 35 credits have to be acquired.

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<tr>
<th>Number</th>
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<tr>
<td>651-3301-00L</td>
<td>Crystals and Minerals</td>
<td>W+</td>
<td>3</td>
<td>2V+1U</td>
<td>P. Brack, E. Reusser</td>
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</tbody>
</table>

**Abstract**

To understand, qualitatively and semi-quantitatively, crystal and mineral formation, the interdependence between crystals structure, chemical composition and physical properties. This dependence is especially the case for the structural dependence of optical anisotropy and the elastic properties of the minerals as well as for the growth of crystals and their defect structures.

**Objective**

Qualitatives und teilweise quantitatives Verständnis für den Aufbau von Kristallen und Mineralien, für die Zusammenhänge zwischen chemischer Zusammensetzung, Kristallstruktur und physikalischen Eigenschaften, für das Wachstum von Kristallen sowie wichtiger identifikationsrelevanter makroskopischer Eigenschaften; selbständige Identifikation der rund 70 wichtigsten Mineralarten.

**Content**

- Symmetrien und Ordnung, Punktguppen, Translationsgruppen, Raumgruppen.
- einfache Strukturtypen, dichte Kugelpackungen, Strukturbestimmende Faktoren
- Chemisch Bindungen, Beziehungen zwischen Struktur und Eigenschaften eine Kristalls.
- Grundlagen von Thermodynamik und Computersimulationen in der Kristallographie.
- Einführung in die Mineralogie und Mineralisystematik.
- Praktikum in Mineralbestimmen aufgrund makroskopischer Eigenschaften.
Literature

651-3321-00L Interpretation of Geological Maps I
W 2 credits 2P M. Frehner
Abstract
Introduction to reading and construction of simple geologic maps.
Construction of geological cross-sections.
Introduction to Lambert projection and Schmidt net (i.e., stereoplots).

Objective
This course is mainly a hands-on-training, where students solve exercises under supervision.

To improve the ability to understand geological structures in three dimensions and visualize them.

Content
strike lines, symbols
true and apparent thickness of geological units
true and apparent dip
V-rule
3-Point-Problems
unconformities
faults
introduction to the Lambert projection
folds
migmatic structures

Lecture notes
Exercises and instructions are handed out and are available online in Moodle.

Literature
Semester literature can be found in the ERDW-library.

Prerequisites / notice
This course is not a prerequisite, but nevertheless extremely helpful for the Terrainkurs II.

651-3323-00L Earth and Climate History
W+ 3 credits 2G G. Haug
Abstract
The goal of the course is to give the students a perception of the major aspects of planetary history and to add to their curiosity about methods which can be applied in the investigations of more specific problems and to planetary features.


Objective

Content
Frühe Geschichte der Erde, der Litho-, Atmo- und Biosphäre; Phanerozoische Platten und Terranes; Entwicklung des Lebens im Phanerozän, Mesozoische Anoxie, Kreide-Tertiär-Grenze, Tertiäre Abkühlung, Messin-Salinitätskrise, Hominidenevolution, Quartäre Klimaschwankungen.

Lecture notes
Unterlagen werden abgegeben.

Literature

Examining Blocks
Examining Block 1

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<tr>
<th>Number</th>
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<tr>
<td>402-0063-00L</td>
<td>Physics II</td>
<td>O</td>
<td>5</td>
<td>3V+1U</td>
<td>A. Vaterlaus</td>
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<tr>
<td>Abstract</td>
<td>Introduction to the &quot;way of thinking&quot; and the methodology in Physics, with the help of demonstration experiments. The Chapters treated are Electromagnetism, Refraction and Diffraction of Waves, Elements of Quantum Mechanics with applications to Spectroscopy, Thermodynamics, Phase Transitions, Transport Phenomena. Whenever possible, examples relevant to the students' main field of study are given.</td>
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<td>Objective</td>
<td>Introduction to the scientific methodology. The student should develop his/her capability to turn physical observations into mathematical models, and to solve the latter.</td>
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<td>Content</td>
<td>Elektromagnetismus, Elektromagnetische Wellen, Wellenoptik, Strahlenoptik, Quantenoptik, Quantenmechanik, Thermische Eigenschaften, Transportphänomene, Wärmestrahlung</td>
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<td>Literature</td>
<td>Friedhelm Kuypers</td>
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<td></td>
<td>Physik für Ingenieure und Naturwissenschaftler</td>
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<td>Band 2 Elektrizität, Optik, Wellen</td>
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<td>Verlag Wiley-VCH, 2003, Fr. 77.-</td>
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<td></td>
<td>Douglas C. Giancoli</td>
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<td>Physik</td>
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<td>Pearson Studium</td>
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<td></td>
<td>Hans J. Paus</td>
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<td>Physik in Experimenten und Beispielen</td>
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<td>Carl Hanser Verlag, München, 2002, 1068 S.</td>
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<td></td>
<td>Paul A. Tipler</td>
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<td>Physik</td>
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<td>Spektrum Akademischer Verlag, 1998, 1522 S., ca Fr. 120.-</td>
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<td>David Halliday Robert Resnick Jearl Walker</td>
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<td>Wiley-VCH, 2003, 1388 S., Fr. 87. - (bis 31.12.03)</td>
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<td>dazu gratis Online Ressourcen (z.B. Simulationen): <a href="http://www.halliday.de">www.halliday.de</a></td>
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651-3341-00L Lithosphere
O 3 credits 2V S. Wiemer, E. Kissling
Prerequisite: successful completion of Dynamic Earth I and II is mandatory.
Comprehensive understanding of role and evolution of oceanic and continental lithosphere in global plate tectonics and evolution of earth. Understanding principles of theoretical and experimental geothermics and fundamentals of mantle and lithosphere rheologies.

Objective
Comprehensive understanding of role and evolution of oceanic and continental lithosphere in global plate tectonics and evolution of earth. Understanding principles of theoretical and experimental geothermics and fundamentals of mantle and lithosphere rheologies.

Content

Lecture notes
Detailed scriptum in digital form and additional learning module (www.lead.ethz.ch) available on intranet.

ECTS
Suggested literature.

Overhead slides:
see list in scriptum.

701-0023-00L Atmosphere O 3 credits 2V H. Wernli, T. Peter

Abstract
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

Objective
Understanding of basic physical and chemical processes in the atmosphere. Understanding of mechanisms of and interactions between weather - climate, atmosphere - ocean - continents, troposphere - stratosphere. Understanding of environmentally relevant structures and processes on vastly differing scales. Basis for the modelling of complex interrelations in the atmosphere.

Content
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

Lecture notes
Written information will be supplied.

Literature

Examination Block 2

Number Title Type ECTS Hours Lecturers
701-0071-00L Mathematics III: Systems Analysis O 4 credits 2V+1U N. Gruber, P. Landschützer

Abstract
The objective of the systems analysis course is to deepen and illustrate the mathematical concepts on the basis of a series of very concrete examples. Topics covered include: linear box models with one or several variables, non-linear box models with one or several variables, time-discrete models, and continuous models in time and space.

Objective
Learning and applying concepts (models) and quantitative methods to address concrete problems of environmental relevance. Understanding and applying the systems-analytic approach, i.e., Recognizing the core of the problem - simplification - quantitative approach - prediction.

Content
Content of lectures:
http://www.up.ethz.ch/education/system_analysis/index_DE

Lecture notes
Overhead slides:
http://www.up.ethz.ch/education/system_analysis/index_DE

Literature

701-0401-00L Hydrosphere O 3 credits 2V P. Bayer, R. Kipfer

Abstract
Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.

Objective
Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.

Content
Topics of the course.
- Physical properties of water (i.e. density and equation of state)
- Global water resources
- Exchange at boundaries
- Energy (thermal & kinetic), gas exchange
- Mixing and transport processes in open waters
- Vertical stratification, large scale transport
- Turbulence and mixing
- Mixing and exchange processes in rivers
- Groundwater and its dynamics
- Ground water as part of the terrestrial water cycle
- Ground water hydraulics, Darcy's law
- Aquifers and their properties
- Hydrochemistry and tracer
- Ground water use
- Case studies
- 1. Water as resource, 2. Water and climate

Lecture notes
In addition to the suggested literature handouts are distributed.

Literature
Suggested literature.

Prerequisites / notice
The case studies and the analysis of the questions and problems are integral part of the course.

5. Semester Majors

Major in Geology

Advisor of the major in Geology is Prof. Stefano Bernasconi

Major in Geology: Core Courses

From the offered core courses in autumn and spring semester, 27 credits have to be acquired.
651-3501-00L Isotope Geochemistry and Isotope Geology  W+  3 credits  2G  S. Bernasconi, D. Vance

Abstract
The course focuses on the most important systems of radioactive and stable isotopes used in geochemistry and geology. Applications of isotope geochemistry for solving fundamental geological problems are discussed on the basis of case studies.

Objective
Development of a basic knowledge and understanding of the applications of the most important systems of stable and radiogenic isotopes.

Content
The following methods will be discussed in detail: the radioactive-radiogenic systems Rb-Sr, Sm-Nd, U-Th-Pb and K-Ar, as well as the stable isotope systems of oxygen, carbon, nitrogen, sulfur and hydrogen.

We will discuss how these methods are used in the following research fields: geochemistry of the earth, age dating, paleotemperature reconstructions, evolution of the crust and mantle reservoirs, sediment diagenesis, fluid rock interactions, hydrothermal activity, paleoceanography, biogeochemical cycles.

Lecture notes
Available

Literature
- Dickin A. P., Radiogenic Isotope Geology, (2005), Cambridge University Press

Prerequisites / notice
Geochemie I: (Bachelor course)

651-3503-00L Metamorphism  W+  3 credits  3G  M. W. Schmidt

Abstract
Understanding of the principles governing (chemical) reactions in metamorphic processes and resulting (physical) properties of metamorphic rocks s.l.. Recognition of metamorphic minerals and rocks (e.g. Gesteinsbestimmung)

651-3505-00L Mineral Resources  W+  3 credits  2V  C. A. Heinrich, R. Kündig, W. Leu, F. Schenker

Abstract
Overview of the geological formation processes and the global distribution of mineral resources (metals, energy resources, bulk materials and industrial minerals), their economic importance, as well as the political and environmental aspects of responsible resource extraction and site rehabilitation.

Objective

Content
- Vorstellung der Dozierenden aus der persönlichen Berufspraxis (CH, RK, WL, FS)
- Ressourcen der Welt und Bedeutung für die Schweiz (RK)
- Metallische Erzlagerstätten - Einführung (CH)
- Metallische Erzlagerstätten - Magmatische Prozesse (CH)
- Ozeanische Hydrothermalsysteme, Oberflächenenergie und Atmosphärenentwicklung (CH)
- Metallische Erzlagerstätten - Magmatisch-hydrothermale Systeme (CH)
- Energiereichstoffe - Einführung: Bildungsprozesse Petroleum und Erdgas (WL)
- Energiereichstoffe - Kohle und CO2-Entsorgung (WL/ RK)
- Nichtmetallische Rohstoffe - Baustoffe (RK)
- Metallische und nichtmetallische Rohstoffe - Erden (RK/FS)
- Metallische und nichtmetallische Rohstoffe - Industriematerialien (FS)
- Industriematerialien und nachhaltige Nutzung von Rohstoffen der Erde (FS)

Lecture notes
Kursnotizen werden in den Stunden verteilt

Literature

Prerequisites / notice

651-3521-00L Tectonics  W+  3 credits  2V  J.P. Burg, E. Kissling

Abstract
Comprehensive understanding of evolution, mechanics, and rheology of divergent, convergent and wrenching tectonic systems from the lithospheric scale to local shallow crustal and outcrop-scales. Evaluation of plate tectonic and other orogenic processes through the study of reference examples of taken in Alp-Himalaya orogenic system.

Objective
Comprehensive understanding of evolution, mechanics, and rheology of divergent, convergent and wrenching tectonic systems from the lithospheric scale to local shallow crustal and outcrop-scales. Assessment of mechanisms responsible for plate movements (the Earth as a heat transfer machine, dynamics of earth mantle, plate driving forces) and subsequent large-scale structures (oceanic basins and cycle of the oceanic lithosphere, convergence and mountain systems and continental growth, etc) through theoretical and experimental information.

Content
Plate tectonic frame works: earth cooling and mantle-plate interaction, three kinds of plate boundaries and their roles and characteristics, cycle of oceanic lithosphere, longlifety and growth of continents, supercontinents.
Rheology of layered lithosphere and upper mantle.
Oxidation systems
Collisions systems
Extensional systems
Basin evolution
Passive and active continental margin evolution

Lecture notes
Detailed scriptum in digital form and additional learning moduls (www.lead.ethz.ch) available on the intranet.

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 502 of 1434
Während der Vorlesung werden die wichtigsten Daten und Fakten auf Blättern abgegeben und im Internet zum Download bereitgestellt.

Hydrogeology and Quaternary Geology, P. Haldimann
This introductory course starts from a description of the behavior and phenomena of soils and rocks under near surface loading conditions. Basic geotechnical and geomechanical properties and processes of rocks and soils are introduced. Final practical aspects of ground engineering, including tunneling and landslide hazards are presented.

Lecture notes
Während der Vorlesung werden die wichtigsten Daten und Fakten auf Blättern abgegeben und im Internet zum Download bereitgestellt.

Literature

Prerequisites / notice
Voraussetzung erfolgreicher Abschluss von 701-0401-00 Hydrosphäre

Introduction to Engineering Geology, W+ 3 credits
This introductory course starts from a description of the behavior and phenomena of soils and rocks under near surface loading conditions and their geotechnical properties. Lab and field methods for the characterization of soils, rocks and rock masses are introduced. Final practical aspects of ground engineering, including tunneling and landslide hazards are presented.

Objective
Understanding the basic geotechnical and geomechanical properties and processes of rocks and soils. Understanding the interaction of rock and soil masses with technical systems. Understanding the fundamentals of geological hazards.

Content

Lecture notes
Written course documentation available under "Kursunterlagen".

Literature

Earth Science Mapping Exercises II, W+ 2 credits
Reading and interpretation of geological and climatological maps. Reading and interpretation of geological and climatological maps.

Objective

Lecture notes
Exercises and instructions are handed out.

Prerequisites / notice
Requirement: Earth science mapping exercises I
Objective Overview and understanding of the most important geophysical methods. Proposed solutions to assess and observe problems relevant to exploration and environmental geophysics in soil, ice and lithosphere at different scales. Getting familiar with measuring- and interpretation procedures. Pointing out the possibilities and limitations of geophysical methods.


Lecture notes Available through eDoz/ILIAS.

Additional material will be provided by the lecturers.


### Content

- Erprobungsgeschichte und Gliederung des Quartärts, Klimaentwicklung.
- Prozesse während Kaltzeiten (Eisvorstösse, glaziale Erosion) und während Warmzeiten (Sedimentation, fluviatile Erosion) (mit Übungen).
- Quartäre Geomorphologie, quartäre Ablagerungen (mit Übungen).
- Entwicklungsgeschichte der Täler in den Alpen und im Alpenvorland (mit Übungen).
- Altersbestimmungen, Quartärstratigraphische Methoden, Stratigraphie der Talfüllungen.
- Wiederholung Hydrogeologischer Grundlagen.
- Grundwasservorkommen der Schweiz (mit Übungen).
- Hydrogeologie quartärer Ablagerungen (namentlich fluvio-glaziale Schotter).
- Nutzung und Bewirtschaftung der Grundwasservorkommen in quartären Ablagerungen (mit Übungen).
- Grundwassernutzung im Hauptsiedlungsraum der Schweiz.
- Gefährdung und Schutz der Grundwasservorkommen in quartären Lockergesteinen (mit Übungen).
- Einführung in die Hydrogeologie von Kluft- und Karstgrundwasserleitern (mit Übung).

### Lecture notes

- Während der Vorlesung werden die wichtigsten Daten und Fakten auf Blättern abgegeben und im Internet zum Download bereitgestellt.

### Literature

- Scandinavian University Press, Oslo.
- Zahlreiche Publikationen des BAFU zur Hydrologie und Hydrogeologie der Schweiz

### Prerequisites / notice

- Voraussetzung erfolgreicher Abschluss von 701-0401-00 Hydrorepräre

### 651-3561-00L

<table>
<thead>
<tr>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading and interpretation of geological and climatological maps.</td>
<td>W</td>
<td>2 credits</td>
<td>2P</td>
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### 651-3525-00L

<table>
<thead>
<tr>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understanding the basic geotechnical and geomechanical properties and processes of rocks and soils. Understanding the interaction of rock and soil masses with technical systems. Understanding the fundamentals of geological hazards.</td>
<td>W</td>
<td>3 credits</td>
<td>3G</td>
</tr>
</tbody>
</table>

### 651-3541-00L

<table>
<thead>
<tr>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploration and Environmental Geophysics</td>
<td>W</td>
<td>4 credits</td>
<td>3V</td>
</tr>
</tbody>
</table>

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### Major in Geophysics

[Advisor of the major geophysics is Prof. Taras Gerya.]

#### Major in Geophysics: Core Courses

From the offered core courses in autumn and spring semester, 27 credits have to be acquired.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>651-3541-00L</td>
<td>Exploration and Environmental Geophysics</td>
<td>W</td>
<td>4 credits</td>
<td>3V</td>
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**Data:** 06.02.2019 13:00  
**Autumn Semester 2015**  
**Page 505 of 1434**
Abstract
Overview and understanding of the most important geophysical methods: Potential field methods (Gravimetrics and Magnetics), Electrical and electromagnetic methods, Refraction and reflection seismsics, Georadar. Discussion of survey design, sources and receivers and data processing.

Objective
Overview and understanding of the most important geophysical methods. Proposed solutions to assess and observe problems relevant to exploration and environmental geophysics in soil, ice and lithosphere at different scales. Getting familiar with measuring- and interpretation procedures. Pointing out the possibilities and limitations of geophysical methods.

Content

Lecture notes
Available through eDoz/ILIAS.

Additional material will be provided by the lecturers.

Literature

651-3543-00L
Seismology
W+ 3 credits 2G D. Giardini, D. Fäh

651-3527-00L
Earth Science Mapping Exercises II
W+ 2 credits 2P J.P. Burg

651-3525-00L
Introduction to Engineering Geology
W+ 3 credits 3G S. Löw

651-3523-00L
Hydrogeology and Quaternary Geology
W+ 3 credits 2G M. Kleipokova, P. Haldimann
Plate tectonic framework: earth cooling and mantle-plate interaction, three kinds of plate boundaries and their roles and characteristics, comprehensive understanding of evolution, mechanics, and rheology of divergent, convergent and wrenching tectonic systems from the lithospheric scale to local shallow crustal and outcrop-scales. Evaluation of plate tectonic and other orogenic processes through the study of reference examples of taken in Alps-Himalaya orogenic system.

Overview of the geological formation processes and the global distribution of mineral resources (metals, energy resources, bulk materials and industrial minerals), their economic importance, as well as the political and environmental aspects of responsible resource extraction and site rehabilitation.

Plate tectonic frame work: earth cooling and mantle-plate interaction, three kinds of plate boundaries and their roles and characteristics, comprehensive understanding of evolution, mechanics, and rheology of divergent, convergent and wrenching tectonic systems from the lithospheric scale to local shallow crustal and outcrop-scales.

Evaluation of plate tectonic and other orogenic processes through the study of reference examples of taken in Alps-Himalaya orogenic system.

Content
- Plate tectonic frame work: earth cooling and mantle-plate interaction, three kinds of plate boundaries and their roles and characteristics, comprehensive understanding of evolution, mechanics, and rheology of divergent, convergent and wrenching tectonic systems from the lithospheric scale to local shallow crustal and outcrop-scales.
- Rheology of layered lithosphere and upper mantle.
- Obduction systems
- Collisions systems
- Extensional systems
- Basin evolution

Objective
- Understanding of the principles governing (chemical) reactions in metamorphic processes and resulting (physical) properties of metamorphic rocks s.l.
- Recognition of metamorphic minerals and rocks (e.g., Gesteinsbestimmung)
- Mineral-Reaktionen, zeitliche Entwicklung verschiedener Rohstofftypen im Verlauf der Erdgeschichte und in Bezug auf die Plattentektonik, and site rehabilitation.
- Evaluation of plate tectonic and other orogenic processes through the study of reference examples of taken in Alps-Himalaya orogenic system.

Literature
Scandinavian University Press, Oslo.

Prerequisites / notice
Voraussetzung erfolgreicher Abschluss von 701-0401-00 Hydrospäre
Content
The following methods will be discussed in detail: the radioactive-radiogenic systems Rb-Sr, Sm-Nd, U-Th-Pb and K-Ar, as well as the stable isotope systems of oxygen, carbon, nitrogen, sulfur and hydrogen.

We will discuss how these methods are used in the following research fields: geochemistry of the earth, age dating, paleotemperature reconstructions, evolution of the crust and mantle reservoirs, sediment diagenesis, fluid rock interactions, hydrothermal activity, paleoceanography, biogeochemical cycles.

Lecture notes
Available

Literature
- Dickin A. P., Radiogenic Isotope Geology, (2005), Cambridge University Press

Prerequisites / notice
Prerequisites:
- Geochemie I: (Bachelor course)

>>> Major in Geophysics: Electives
From all elective courses offered in the autumn and spring semester, 12 credits have to be acquired.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>651-3597-00L</td>
<td>Seminar I for Bachelorstudents</td>
<td>W+</td>
<td>2 credits</td>
<td>2S</td>
<td>W. Schatz, J. D. Rickli</td>
</tr>
</tbody>
</table>

Abstract
In this seminar, students learn to search effectively for scientific knowledge and how to present scientific results orally and in written form to different audiences.

Objective
- Students are able to held scientific presentations.
- Students can plan and present a scientific poster.
- Students can search scientific publications in an effective and efficient manner.

Content
- Auftreten vor Publikum (Gestik, Haltung, Sprechen und Sprache, Hemmungen abbauen)
- Medieneinsatz (Powerpoint Standard für wissenschaftliche Präsentationen, Stärken und Gefahren von Präsentationen mit Powerpoint; Einsatz von Text, Graphiken, Ton, Video, Animationen etc.)
- Beantwortung von Fragen: das Nach-dem-Vortrag, Umgang mit Fragen, Verhalten in kritischen Situationen
- Tips zum Zeitmanagement
- Kriterien für Bewertung von Vorträgen anwenden können und konstruktives Feedback geben können

>>> Major in Geophysics: Compulsory Laboratory Courses
This practical course is compulsory for the BSc-specialization "geophysics".

>>> Major in Climate and Water: Electives
Advisor of the BSc-major "Climate and Water" is Dr. Erich Fischer, Institute for climate and atmosphere (IAC).

>>> Major in Climate and Water: Core Courses
14 credits have to be acquired of the offered core courses from autumn and spring semester.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>651-3561-00L</td>
<td>Cryosphere</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>M. Funk, M. Huss, K. Steffen</td>
</tr>
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</table>

Abstract
This course introduces the different parts of the cryosphere - snow, glaciers, sea ice, permafrost - and their role in the climate system. A significant physical aspect is the focus in each part. Those completing the course are able to describe the dynamics of cryosphere components both formally and using examples.

Objective
- Students are able to qualitatively describe the main components of the cryosphere and their role in the climate system
- Students are able to qualitatively describe the relevant physical processes which determine the state of cryosphere components

Content
Introduction into the different components of the Cryosphere: Snow, glaciers, sea ice and permafrost, and their roles in the climate system. Each part is use to emphasized on one specific physical aspect: material qualities of ice, mass balance and dynamics of glaciers and energy balance of sea ice.

Lecture notes
handouts will be distributed during the teaching semester
Abstract
The lecture provides an introduction to atmospheric chemistry at bachelor level. It introduces the kinetics of gas phase and heterogeneous reactions on aerosols and in clouds and explains the chemical and physical mechanisms responsible for global (e.g. stratospheric ozone depletion) as well as regional (e.g. urban air pollution) environmental problems.

Objective
The students will understand the basics of gas phase and heterogeneous reactions and will know the most relevant atmospheric chemical processes taking place in the gas phase as well as between different phases including aerosols and clouds.

The students will also acquire a good understanding of atmospheric environmental problems including air pollution, stratospheric ozone destruction and changes in the oxidative capacity of the global atmosphere.

Content
- Origin and properties of the atmosphere: structure, large scale dynamics, UV radiation
- Thermodynamics and kinetics of gas phase reactions: enthalpy and free energy of reactions, rate laws, mechanisms of bimolecular and termolecular reactions.
- Tropospheric photochemistry: Photolysis reactions, photochemical O3 formation, role and budget of HOx, dry and wet deposition
- Aerosols and clouds: chemical properties, primary and secondary aerosol sources
- Multiphase chemistry: heterogeneous kinetics, solubility and hygroscopicity, NOx chemistry, SO2 oxidation, secondary organic aerosols
- Air quality: role of planetary boundary layer, summer- versus winter-smog, environmental problems, legislation, long-term trends
- Stratospheric chemistry: Chapman cycle, Brewer-Dobson circulation, catalytic ozone destruction cycles, polar ozone hole, Montreal protocol
- Global aspects: global budgets of ozone, methane, CO and NOx, air quality - climate interactions

Lecture notes
Vorlesungsunterlagen (Folien) werden laufend während des Semesters jeweils mind. 2 Tage vor der Vorlesung zur Verfügung gestellt.

Prerequisites / notice
Attendance of the lecture "Atmosphär"e" LV 701-0023-00L or equivalent is a pre-requisite.

701-0475-00L Atmospheric Physics W+ 3 credits 2G U. Lohmann, A. A. Mensah

Abstract
This course covers the basics of atmospheric physics, which consist of: cloud and precipitation formation, thermodynamics, aerosol physics, radiation as well as the impact of aerosols and clouds on climate and artificial weather modification.

Objective
Students are able
- to explain the mechanisms of cloud and precipitation formation using knowledge of humidity processes and thermodynamics.
- to evaluate the significance of clouds and aerosol particles for climate and artificial weather modification.

Content
Moist processes/thermodynamics; aerosol physics; cloud formation; precipitation processes, storms; importance of aerosols and clouds for climate and weather modification, clouds and precipitation

Lecture notes
Powerpoint slides and script will be made available

Literature
Rogers and Yau, A Short Course in Cloud Physics, Pergamon Press, 1989;
Wallace and Hobbs, Atmospheric Science: An Introductory Survey, Elsevier, 2006

Prerequisites / notice
50% of the time we use the concept of "flipped classroom" (en.wikipedia.org/wiki/Flipped_classroom), which we introduce at the beginning.

We offer a lab tour, in which we demonstrate with some instruments how some of the processes, that are discussed in the lectures, are measured.

There is an additional tutorial right after each lecture to give you the chance to ask further questions and discuss the exercises. The participation is recommended but voluntary.

701-0461-00L Numerical Methods in Environmental Sciences W+ 3 credits 2G C. Schär, O. Furrer

Abstract
This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

Objective
This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

Content
Classification of numerical problems, introduction to finite-difference methods, time integration schemes, non-linearity, conservative numerical techniques, an overview of spectral and finite-element methods. Examples and exercises from a diverse cross-section of Environmental Science.

Lecture notes
Is provided (CHF 10. - per copy).

Literature
List of literature is provided.

Prerequisites / notice
Die Vorlesung verlangt Vorkenntnisse in Linearer Algebra, Analysis und Physik (z.B. komplexe Zahlen, Beschreibung von ebenen Wellen, einfache gewöhnliche Differentialgleichungen)

701-0473-00L Weather Systems W+ 3 credits 2G M. A. Sprenger, C. Grams

Abstract
This lecture introduces the theoretical principles and the observational and analytical methods of atmospheric dynamics. Based on these principles, the following aspects are discussed: the energetics of the global circulation, the basic synoptic- and meso-scale flow phenomena, in particular the dynamics of extratropical cyclones, and the influence of mountains on the atmospheric flow.

Objective
The students are able to
- explain up-to-date meteorological observation techniques and the basic methods of theoretical atmospheric dynamics
- to discuss the mathematical basis of atmospheric dynamics, based on selected atmospheric flow phenomena
- to explain the basic dynamics of the global circulation and of synoptic- and meso-scale flow features
- to explain how mountains influence the atmospheric flow on different scales

Content
Satellite observations; analysis of vertical soundings; geostrophic and thermal wind; cyclones at mid-latitude; global circulation; north-atlantic oscillation; atmospheric blocking situations; Eulerian and Lagrangian perspective; potential vorticity; Alpine dynamics (storms, orographic wind); planetary boundary layer

Lecture notes
Lecture notes and slides

Literature
Atmospheric Science, An Introductory Survey
John M. Wallace and Peter V. Hobbs, Academic Press

Major in Climate and Water: Electives
In addition to the mandatory seminar for Bachelor Students: Atmosphere and Climate (course nr. 701-0459-00 in autumn semester) another 22 credits must be acquired from the offered elective courses during the 5th and 6th semester. The choice of other courses has to be granted by the advisor (Dr. Erich Fischer).

Number Title Type ECTS Hours Lecturers
701-0459-00L Seminar for Bachelor Students: Atmosphere and Climate O 2 credits 2S R. Knutti, E. M. Fischer, O. Stebler

Abstract
In this seminar all students in the realm of atmospheric and climate science convene to train presentation techniques (talks, posters) by means of classic and modern scientific articles.

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 509 of 1434
In this seminar all students in the realm of atmospheric and climate science convene to train presentation techniques (talks, posters) by means of classic and modern scientific articles.

Content
1st week: course organisation and presentation of the institute
2nd and 3rd week: introduction to oral presentation technique
11th week: introduction to poster presentation technique
12th and 13th week: poster design
14th week: concluding poster presentation

Lecture notes
Documents are offered via the course's web page.

Literature
Documents are offered via the course's web page.

Prerequisites / notice
This course can only be offered to a limited number of students, however, in any case for everybody having to attend it compulsory. We beg you to sign in to this course early.

102-0635-00L Air Pollution Control W 6 credits 4G B. Buchmann, P. Hofer

Abstract
The lecture provides in the first part an introduction to the formation of air pollutants by technical processes, the emission of these chemicals into the atmosphere and their impact on air quality. The second part covers different strategies and techniques for emission reduction. The basic knowledge is deepened by the discussion of specific air pollution problems of today's society.

Objective
The students gain general knowledge of the factors resulting in air pollution and the techniques used for air pollution control. The students can identify major air pollution sources and understand the methods for measurement, data collection and analysis. The students can evaluate possible control methods and equipment, design a control system and estimate the efficiency and cost.

Content
Part 1 Emission, Immission, Transmission
- physical and chemical processes leading to emission of pollutants
- mass and energy of processes
- Emission measurement techniques and concepts
- quantification of emissions from individual and aggregated sources
- extent and development of the emissions (Switzerland and global)
- propagation and transport of pollutants (transmission)
- meteorological parameters influencing air pollution dispersion
- deterministic and stochastic models, describing the air pollution dispersion
- dispersion models (Gaussian model, box model, receptor model)
- measurement concepts for ambient air (immission level)
- extent and development of ambient air mixing ratios
- goal and instrument of air pollution control

Part 2 Air Pollution Control Technologies
- The reduction of the formation of pollutants is done by modifying the processes (process-integrated measures) and by different engineering operations for the cleaning of waste gas (downstream pollution control). It will be demonstrated, that the variety of these procedures can be traced back on the application of a few basic principles of physical chemistry.
- Procedures for the removal of particles (inertial separator, filtration, electrostatic pre-cipitators, scrubbers) with their different mechanisms (field forces, impaction and diffusion processes) and the modelling of these mechanisms.
- Procedures for the removal of gaseous pollutants and the description of the driving forces involved, as well as the equilibrium and the kinetics of the relevant processes (absorption, adsorption as well as thermal, catalytic and biological conversions).
- Discussion of the technical possibilities to solve the actual air pollution problems.

Lecture notes
- Brigitte Buchmann, Air pollution control, Part I
- Peter Hofer, Air pollution control, Part II
- Lecture slides and exercises

Literature
List of literature included in scrip

Prerequisites / notice
College lectures on basic physics, chemistry and mathematics

401-0649-00L Applied Statistical Regression W 5 credits 2V+1U M. Dettling

Abstract
This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning "good practice" that can be applied in every student's own projects and daily work life.

Objective
The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

Content
The course starts with the basics of linear regression modeling, and then proceeds to parameter estimation, tests and confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, categorical input variables, shrinkage and general modeling strategies.

The last third of the course is dedicated to an introduction into generalized linear regression models: this includes logistic regression for binary response variables, Poisson regression for count data, cumulative logit models for ordered, and multinomial regression for categorical response variables.

Lecture notes
A script will be available.

Literature
Faraway (2005): Linear Models with R
Faraway (2006): Extending the Linear Model with R
Draper & Smith (1998): Applied Regression Analysis
Fox (2008): Applied Regression Analysis and GLMs
Montgomery et al. (2006): Introduction to Linear Regression Analysis

Prerequisites / notice
The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-0625-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

401-0625-00L Using R for Data Analysis and Graphics (Part I) W 1 credit 1G A. J. Papritz, C. B. Schweizer

Abstract
The course provides the first part an introduction to the statistical software R for scientists. Topics covered are data generation and selection, graphical and basic statistical functions, creating simple functions, basic types of objects.

Objective
The students will be able to use the software R for simple data analysis.
The course provides the first part of an introduction to the statistical software R for scientists. R is free software that contains a huge collection of functions with focus on statistics and graphics. If one wants to use R one has to learn the programming language R - on very rudimentary level. The course aims to facilitate this by providing a basic introduction to R.

Part I of the course covers the following topics:
- What is R?
- R Basics: reading and writing data from/to files, creating vectors & matrices, selecting elements of dataframes, vectors and matrices, arithmetics;
- Types of data: numeric, character, logical and categorical data, missing values;
- Simple (statistical) functions: summary, mean, var, etc., simple statistical tests;
- Writing simple functions;
- Introduction to graphics: scatter-, boxplots and other high-level plotting functions, embellishing plots by title, axis labels, etc., adding elements (lines, points) to existing plots.

The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www rstudio.org

Note: Part I of UsingR is complemented and extended by Part II, which is offered during the second part of the semester and which can be taken independently from Part I.

Lecture notes
An Introduction to R. http://stat.ethz.ch/CRAN/doc/contrib/Lam-IntroductionToR_LHL.pdf
Prerequisites / notice
The course resources will be provided via the Moodle web learning platform
Please login (with your ETH (or other University) username+password) at https://moodle-app21.ethtz.ch/enrol/users.php?id=1145
Choose the course "Using R for Data Analysis and Graphics" and follow the instructions for registration.

701-0535-00L Environmental Soil Physics/Vadose Zone Hydrology W 3 credits 2G+2U D. Or

Abstract
The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.

Objective
Students are able to
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media;
- quantify driving forces and resulting fluxes of water, solute, and heat in soils.
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges

Content
Weeks 1 to 3: Physical Properties of Soils and Other Porous Media Units and dimensions, definitions and basic mass-volume relationships between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay behavior

- Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity

Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing

Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:

Weeks 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface evaporation.

Week 12 to 13: Solute Transport in Soils Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion eq.; solutions for pulse and step solute application; parameter estimation; salt balance.

Additional topics:

Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.

701-0479-00L Environmental Fluid Dynamics W 3 credits 2G H. Wernli, M. Croci-Maspoli

Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing

Lecture notes
Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing

Lecture notes

Lecture notes

Literature
Supplemental textbook (not mandatory) -Environmental Soil Physics, by: D. Hillel

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 511 of 1434
Abstract
This course covers the basic physical concepts and mathematical equations used to describe environmental fluid systems on the rotating Earth. Fundamental concepts (e.g. vorticity dynamics and waves) are formally introduced, applied quantitatively and illustrated using examples. Exercises help to deepen knowledge of the material.

Objective
Students are able
- to name the bases, concepts and methods of environmental fluid dynamics.
- to understand and discuss the components of the basic physical equations in fluid dynamics
- to apply basic mathematical equations to simple problems of environmental fluid dynamics

Content
Basic physical terminology and mathematical laws:
Continuum hypothesis, forces, constitutive laws, state equations and basic principles of thermodynamics, kinematics, laws of mass and momentum on rotating earth.
Concepts and illustrative flow systems: vorticity dynamics, boundary layers, instability, turbulence - with respect to environmental fluid systems.
Scale analysis: dimensionless variables and dynamical similarity, simplification of the fluid system, e.g. shallow water assumption, geostrophic flow.
Waves in environmental fluid systems.

Lecture notes
In english language

Literature
Will be presented in class.
See also: web-site.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Group</th>
<th>Instructor</th>
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<tbody>
<tr>
<td>102-0455-01L</td>
<td>Groundwater I</td>
<td>3</td>
<td>W</td>
<td>M. Willmann</td>
</tr>
</tbody>
</table>

Abstract
The course provides an introduction into quantitative analysis of groundwater flow and transport. It is focussed on formulating flow and transport problems in groundwater, which are to be solved analytically or numerically.

Objective
a) Students understand the basic concepts of flow and contaminant transport processes and boundary conditions in groundwater.
b) Students are able to formulate simple practical flow and transport problems.
c) Students are able to understand and apply simple analytical solutions to simple flow and transport problems.
d) Students are able to use simple numerical codes to adequately solve simple flow (and transport) problems.

Content
Introduction, aquifers, groundwater use, sustainability, porosity.

Properties of porous media.
Exercises: Groundwater use, porosity, grain size analysis.

Flow properties, Darcy's law, filter.
Flow equations, stream function.
Exercises: Darcy's law.

Analytical solutions, confined aquifers, steady-state flow.
Exercises: Head isolines.

Use of superposition principles, transient flow, free surface flow.
Exercises: Analytical solutions to flow problems.

Finite difference solutions to flow problems I.
Exercises: Analytical solutions to flow problems.

Finite difference solutions to flow problems II.
Exercises: Finite difference formulations to flow problems.

Transport processes.
Exercises: Computer workshop using PMWIN.

Analytical solutions to transport problems I.
Exercises: Computer workshop using PMWIN.

Analytical solutions to transport problems II.
Exercises: Analytical solutions to transport problems.

Path lines, groundwater protection.
Exercises: Analytical solutions to transport problems.

Groundwater remediation, groundwater management.
Exercises: Groundwater remediation.

Lecture notes
Folien auf Internet unter www.ihw.ethz.ch/GWH/education/index
Altes Skript auf Internet www.ihw.ethz.ch/GWH/education/index
Weitere Texte auf Internet www.ihw.ethz.ch/GWH/education/index
Didaktische Software auf Internet unter www.ihw.ethz.ch/GWH/education/index

Literature
W. Kinzelbach, R. Rausch, Grundwassermodellierung, Gebrüder Bornträger, Stuttgart, 1995
Krusemann, de Ridder, Untersuchung und Anwendung von Pumpversuchen, Verl. R. Müller, Köln, 1970
G. de Marsily, Quantitative Hydrogeology, Academic Press, 1986

Field Trips, Laboratory and Block Courses
The Practical Training in Atmosphere and Climate takes place in Spring Semester.

Electives
Courses can be chosen from the complete offerings of the ETH Zurich and University of Zurich.
Abstract
Concepts will be explained step-by-step through a set of case studies, and applied in lab by the students. The following principal steps are used when coping with natural hazard-risks. At each step, students will learn and apply the following skills:
Risk analysis - What can happen?
- Characterize the processes and environmental measures that lead to a natural hazard and integrate modeling results of these processes.
- Identify threats to human life and assets exposed to natural hazards and estimate possible drawbacks or damages.
Risk assessment - What are the acceptable levels of risk?
- Apply principles to determine acceptable risks to human life and assets in order to identify locations which should receive added protection.
- Explain causes for conflicts between risk perception and risk analysis.
Risk management - What steps should be taken to manage risks?
- Explain how various hazard mitigation approaches reduce risk.
- Describe hazard scenarios as a base for adequate dimensioning of control measures.
- Identify the best alternative from a set of thinkable measures based on an evaluation scheme.
- Explain the principles of risk-governance.

Content
Die Vorlesung besteht aus folgenden Blöcken:
1) Einführung ins Vorgehenskonzept (1W)
2) Risikoanalyse (6W + Exkursion) mit:
   - Systemabgrenzung
   - Gefahrenbeurteilung
   - Expositions- und Folgenanalyse
3) Risikobewertung (2W)
4) Risikomanagement (2W + Exkursion)
5) Abschlussbesprechung (1W)

Choice of courses from the complete offerings of ETH and UZH.

Social Sciences
Recommended GESS compulsory elective courses (Type B) for D-ERDW.
see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability
see GESS Compulsory Electives: Language Courses ETH/UZH

Bachelor Seminar
The Bachelor Seminar (651-3698-00L) takes place in spring semester.

Bachelor Thesis
The Bachelor Thesis and Bachelor-Seminar are offered once per year in the 6th semester, in the spring.

Complementary Courses
The Complementary Courses take place in Spring Semester.

Earth Sciences Bachelor - Key for Type

<table>
<thead>
<tr>
<th>W+</th>
<th>Eligible for credits and recommended</th>
<th>Z</th>
<th>Courses outside the curriculum</th>
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</thead>
<tbody>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
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<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
<td>O</td>
<td>Compulsory</td>
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Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
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<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
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<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Earth Sciences Master

➤ Major in Geology

➤➤ Compulsory Module in Analytical Methods in Earth Sciences

Students need to register for 6 credits in part A, and 6 credits in part B.

➤➤➤ Part A: Microscopy Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4045-00L</td>
<td>Microscopy of Metamorphic Rocks</td>
<td>W+</td>
<td>2 credits</td>
<td>2G</td>
<td>P. Nievergelt</td>
</tr>
</tbody>
</table>

Abstract
Repetition of methods using optic properties of crystals and the polarising microscope.
Identification of minerals and metamorphic parageneses.
Description and interpretation of microstructures.
Age relationship of crystallisation and deformation.
Estimation of metamorphic grade.

Objective
- Advanced knowledge in optical mineralogy
- Application of methods to determine minerals in thin sections
- Identification and characterisation of metamorphic minerals
- Description of rocks. Derive correct petrographic rock name, based on modal abundance and microstructure/texture
- Interpretation of rock fabric/microstructure, parageneses and mineral reactions

Content
- Repetition of principal optical properties and of microscopic methods to identify minerals. Emphasis on interpretation of interference figures.
- Study typical metamorphic rocks in thin sections
- Description and interpretation of parageneses and texture/microstructures. Study the age relationship of crystallisation and deformation.
- Estimation of metamorphic grade
- Quantification: To determine volume percentage of rock components
- Scientific documentation: Descriptions, drawings, photomicrography using different kinds of illumination and using plane- or circular-polarised light.

Literature
- Nesse, W.D.: Introduction to optical mineralogy. 3. Ed. (2004). Figures from this book will be used in lectures. Besides the theory, this book describes all optical properties of important minerals. Petrographers working on varying types of silicate rocks should have a look at this book.

Prerequisites / notice
Participants should have basic knowledge in crystallography, mineralogy and petrology, and have taken practical courses in microscopy of thin sections, as well as lectures in metamorphic petrology and structural geology!

Other microscopy courses at department D-ERDW are on:
- magmatic rocks, following this course in second half of semester (P. Ulmer, IGP; Inst. for Geochemistry and Petrology)
- sedimentary rocks (Geol. Institute)
- ore minerals (reflected light microscopy, Th. Driesner, IGP)
- microstructures, deformed rocks (Geol. Institute)

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651-4047-00L Microscopy of Magmatic Rocks W+ 2 credits 2G P. Ulmer

Abstract
This course provides basic knowledge in microscopy of igneous rocks. Apart from the identification of common igneous minerals in thin sections, mineral assemblages, textures and structures will be investigated and the results of microscopy will be combined with igneous phase equilibria to understand generation, differentiation and emplacement of igneous rocks.

Objective
The principal goal of this course is to acquire expertise in:

1. optical determination of minerals in igneous rocks using the polarizing microscope
2. Identification of igneous rocks basing on modal mineralogy, structure and texture;
3. Interpretation of textures and structures and associated igneous processes;
4. Application of igneous phase diagrams to natural rocks.

Content
This practical course bases on the course ‘Microscopy of metamorphic rocks’ (P. Nievergelt), that is taught immediately before this course, where basic knowledge in optical mineralogy and the use of the polarizing microscope is acquired.
In this course, the most important (common) igneous minerals and rocks are studied in thin sections under the polarizing microscope. Mineral assemblages, structures, textures and crystallization sequences are determined and utilized to understand the generation, differentiation and emplacement of igneous rocks. In addition, we will apply igneous phase equilibria that have been introduced in other lectures (such as magmatism and volcanism at ETH/Uni Zurich or an equivalent igneous petrology course) to natural rock samples in order to constrain qualitatively parental magma compositions and crystallization conditions.
The range of investigated rocks encompasses mantle rocks, tholeiitic, calc-alkaline and alkaline plutonic and volcanic rocks that contain the most common igneous minerals.

Lecture notes
Basis of the optical determinations of (igneous) minerals using the polarizing microscope are the tables of Tröger (‘Optische Bestimmung der gesteinsbildenden Minerale’, Optical determination of rock-forming minerals, 1982) that are available in sufficient volumes in the class room.
Some loose sheets will be distributed during the lecture providing additional information and templates for thin section descriptions.
Additionally, I recommend the lecture notes of H.-G. Stosch (University of Karlsruhe, in German) that can be provided in printed form upon request.

Literature
There are several good textbooks on the subject of ‘mineralogy in thin sections’ that I can suggest upon request.

This course does not include an introduction in optical mineralogy and the use of a polarizing microscope and, therefore, bases on the course ‘Microscopy of metamorphic rocks’ taught by P. Nievergelt immediately before this course where these basic principles are provided. Alternatively, e.g. for external students, an equivalent course is required to follow this practical course.

Other microscopy courses taught at ETH Zurich at the D-ERDW are:
- Microscopy of metamorphic rocks (P. Nievergelt, required for this course)
- Microscopy of sedimentary rocks (W. Winkler & Blaesi)
- Reflected light microscopy and ore deposits practical (T. Driesner)
- Microstructures (deformation structures, B. Cordonnier)
651-4113-00L Microscopy of carbonate and siliciclastic rocks, siliceous and phosphatic rocks, their origin and classification. Diagenesis.

- Objective: Introduction to reflected light microscopy. Use of the microscope. Identification of opaque minerals through the used of tables. Description of textures and paragenetic sequences.
- Content: Recognition of the most important ore minerals in polished section, interpretation of mineral textures in geological context
- Lecture notes: To be handed out in class
- Prerequisites / notice: To be determined upon general course on microscopy of rocks was completed.

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4055-00L</td>
<td>Analytical Methods in Petrology and Geology</td>
<td>W+</td>
<td>3 credits</td>
<td>2G</td>
<td>E. Reusser, S. Bernasconi, M. Wälle, L. Zehnder</td>
</tr>
<tr>
<td>651-4117-00L</td>
<td>Sedimentary Petrography and Microscopy</td>
<td>W+</td>
<td>2 credits</td>
<td>2G</td>
<td>V. Picotti, M. G. Fellin</td>
</tr>
</tbody>
</table>

Part B: Methods

651-4031-00L Geographic Information Systems

- Objective: Introduction to the architecture and data processing capabilities of geographic information systems (GIS). Practical application of spatial data modeling and geoprocessing functions to a selected project from the earth sciences.
- Content: Knowledge of the basic architecture and spatial data handling capabilities of geographic information systems.
- Prerequisites / notice: It is desirable but not excluding that the students bring their own material (Master or PhD project) for some of the analytical methods.
Field Course IV: Non Alpine Field Course
This course gives a tool to describe and interpret microstructures of deformed rocks. It begins with the definition of fabric elements and classification of cleavages. The second part deals with the relation between fabric, microstructure and deformation mechanisms. Finally will be examined the microstructures of high strain zones and the tools to quantify fabric and microstructure. A regional example will be studied at the end of the course.

Microstructures
Does not take place this semester.

This course gives a tool to describe and interpret microstructures of deformed rocks. It begins with the definition of fabric elements and classification of cleavages. The second part deals with the relation between fabric, microstructure and deformation mechanisms. Finally will be examined the microstructures of high strain zones and the tools to quantify fabric and microstructure. A regional example will be studied at the end of the course.

Literature


Prerequisites / notice
The course includes a high portion of practical exercises in sample preparation as well as measurement and evaluation of X-ray powder diffraction data.

Own sample will be analysed qualitatively and quantitatively. Knowledge in mineralogy of this system is essential.

The lecture course is limited to 12 participants.

Restricted Choice Modules Geology

Structural Geology

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<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4132-00L</td>
<td>Field Course IV: Non Alpine Field Course</td>
<td>O</td>
<td>3 credits</td>
<td>6P</td>
<td>J.P. Burg</td>
</tr>
</tbody>
</table>

Does not take place this semester.
Number of participants limited to 24.

Abstract
Field Course to Oman. The students will produce a geological map write and a complementing field report.

Prerequisites / notice
Successful participation in Field Courses I-III.

651-4003-00L

Numerical Modelling of Rock Deformation

Introduction to the programming software Matlab.
Learning and understanding the continuum mechanics equations describing rock deformation. Mathematical equations describing rock rheology: elasticity + viscosity.
Introduction to the finite-element method for modeling rock deformation in 2D.
A small applied project-work at the end of the semester will be tailored to the student's interest.

At the end of this course, the students should be able to:

- Use Matlab for their future needs (e.g., for their MSc Thesis)
- Understand the fundamental concept of the finite-element method
- Apply the finite-element method to successfully work on a small project tailored to the student's interests.

In addition, innovative methods will be applied to mark the performance in the course, which includes self-evaluation and peer-evaluation among the students. Therefore, some soft-skills will be required and trained as well, such as:

- honest self-evaluation and self-grading
- providing honest feedback to a colleague in a tone that is acceptable
- receiving feedback from a colleague without taking criticism personal
- learning the procedure of scientific peer-evaluation

Introduction to Matlab
Continuum mechanics equations necessary to describe rock deformation
Rheological equations: elasticity + viscous materials
Introduction to the finite-element method (in 1D)
Numerical integration + isoparametric elements
Going to 2D finite elements
Finite-element method for 2D elasticity
Stress calculation + visualization
Finite-element method for 2D viscous materials
Heterogeneous media
Final project-based work tailored to the student's interest.

Lecture notes
The script is very diverse and ranges from PowerPoint-based pdf-files, to self-study tutorials. Also, the more theoretical and mathematical aspects will be explained on the black board without a proper script.

All lecture-presentations, as well as the numerical codes, will be made available to the students online.

There is no mandatory literature. The following literature is recomended:


A good knowledge of linear algebra is expected.

Microstructures
Does not take place this semester.

This course gives a tool to describe and interpret microstructures of deformed rocks. It begins with the definition of fabric elements and classification of cleavages. The second part deals with the relation between fabric, microstructure and deformation mechanisms. Finally will be examined the microstructures of high strain zones and the tools to quantify fabric and microstructure.

Prerequisites / notice
Successful participation in Field Courses I-III.

Microstructures
Does not take place this semester.

This course gives a tool to describe and interpret microstructures of deformed rocks. It begins with the definition of fabric elements and classification of cleavages. The second part deals with the relation between fabric, microstructure and deformation mechanisms. Finally will be examined the microstructures of high strain zones and the tools to quantify fabric and microstructure. A regional example will be studied at the end of the course.

Microstructures
Does not take place this semester.

This course gives a tool to describe and interpret microstructures of deformed rocks. It begins with the definition of fabric elements and classification of cleavages. The second part deals with the relation between fabric, microstructure and deformation mechanisms. Finally will be examined the microstructures of high strain zones and the tools to quantify fabric and microstructure.

A regional example will be studied at the end of the course.
1) Terminology: grain, grain shape, grain boundaries, cracks, cleavages.

2) Recall Foliation mechanisms and their microstructures:
   a. passive rotation (examples of mica in marbles)
   b. dissolution and precipitation (+Q and M domains in schists)
   c. nucleation and growth (metamorphism, e.g. low grade schists)
   d. crystal plastic deformation (e.g. calcite, quartz)
   e. recrystallization (dynamic) (e.g. calcite)

3) Deformation mechanisms, their microstructures and CPO
   a. Cataclastic deformation (cataclastic flow, trails of fluid inclusions, interaction with fluids and melt, pseudotachylites, breccias)
   b. Intracrystalline plasticity (monomineralic calcite, olivine, quartz.microstructures and CPO, progressive deformation in simple and pure shear)
   c. Diffuse mass transfer in presence of fluids (pressure solution)
   d. Solid state
   e. Grain boundary sliding and superplastic flow (calcite)
   g. Twinning (calcite, as thermometer; plagioclase)
   h. Recovery and static recrystallization
   i. Deformation of polymineral rocks (e.g. quartzfeldspatic and schists)
   k. synkinematic mineral reactions

4) Microstructures in Fault rocks
   a. Fault gouge
   b. Mylonites (evolution of microstructures and PO with progressive strain. Natural examples and the experimental results from torsion testing; calcite and olivine).
   c. Sense of shear: Matrix, Porphyroclasts etc.

5) Advanced techniques for microstructural characterization
   a. Electron microscopy (SEM, TEM, FIB, EDX, EBSD)
   b. Texture goniometry

Lecture notes
Pratical microscopy session!

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-4041-00L</td>
<td>Sedimentology I: Physical Processes and Sedimentary Systems</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>V. Picotti</td>
</tr>
</tbody>
</table>

Abstract
Sediments preserved a record of past landscapes. This courses focuses on understanding the processes that modify sedimentary landscapes with time and how we can read this changes in the sedimentary record.
### Objective
The students learn basic concepts of modern sedimentology and stratigraphy in the context of sequence stratigraphy and sea level change. They discuss the advantages and pitfalls of the method and look beyond. In particular we pay attention to introducing the importance of considering entire sediment routing systems and understanding their functioning.

### Content
Details on the program will be handed out during the first lecture.
We will attribute the papers for presentation on the 26th, so please be here on that day!

### Literature
The sedimentary record of sea-level change
Angela Coe, the Open University.
Cambridge University Press

### Prerequisites / notice
The grading of students is based on in-class exercises and end-semester examination.

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Title</th>
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<th>3 credits</th>
<th>2G</th>
<th>I. Hajdas, S. Ivy Ochs</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4043-00L</td>
<td>Sedimentology II: Biological and Chemical Processes in Lacustrine and Marine Systems</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>The course will focus on biological and chemical aspects of sedimentation in marine environments. Marine sedimentation will be traced from coast to deep-sea. The use of stable isotopes and paleoceanography will be discussed. Neritic, hemipelagic and pelagic sediments will be used as proxies for en</td>
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<td>vironmental change during times of major perturbations of climate and oceanography.</td>
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<td><strong>Objective</strong></td>
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<td></td>
<td>- You will understand chemistry and biology of the marine carbonate system</td>
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<td>- You will be able to relate carbonate mineralogy with facies and environmental conditions</td>
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<td>- You will be familiar with cool-water and warm-water carbonates</td>
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<td>- You will see carbonate and organic-carbon rich sediments as part of the global carbon cycle</td>
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<td>- You will be able to recognize links between climate and marine carbonate systems (e.g. acidification of oceans and reef growth)</td>
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<td>- You will be able to use geological archives as source of information on global change</td>
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<td>- You will have an overview of marine sedimentation through time</td>
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<td><strong>Content</strong></td>
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<td></td>
<td>- carbonates, chemistry, mineralogy, biology</td>
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<td>- carbonate sedimentation from the shelf to the deep sea</td>
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<td>- carbonate facies</td>
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<td>- cool-water and warm-water carbonates</td>
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<td>- organic-carbon and black shales</td>
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<td>- C-cycle, carbonates, Corg : CO2 sources and sinks</td>
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<td>- Carbonates: their geochemical proxies for environmental change: stable isotopes, Mg/Ca, Sr</td>
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<td>- marine sediments through geological time</td>
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<td>- carbonates and evaporites</td>
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<td>- lacustrine carbonates</td>
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<td>- economic aspects of limestone</td>
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<td></td>
<td><strong>Lecture notes</strong></td>
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<td>no script. scientific articles will be distributed during the course</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td></td>
<td>We will read and critically discuss scientific articles relevant for &quot;biological and chemical processes in marine and lacustrine systems&quot;</td>
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<tr>
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<th>L. M. Plötze</th>
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<tbody>
<tr>
<td>651-4901-00L</td>
<td>Quaternary Dating Methods</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>Reconstruction of time scales is critical for all Quaternary studies in both Geology and Archeology. Various methods are applied depending on the time range of interest and the archive studied. In this lecture we focus on the six methods that are most frequently used for dating Quaternary sediments and landforms. Students will be made familiar with the details of the six dating methods through lectures on basic principles, analysis of case studies, solving of problem sets for age calculation and visits to dating laboratories.</td>
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<td><strong>Objective</strong></td>
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<td>At the end of the course students will:</td>
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<td></td>
<td>1. understand the fundamental principles of the most frequently used dating methods for Quaternary studies.</td>
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<td>2. be able to calculate an age based on data of the six methods studied.</td>
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<td>3. choose which dating method (or combination of methods) is suitable for a certain field problem.</td>
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<td>4. critically read and evaluate the application of dating methods in scientific publications.</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
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<tr>
<td></td>
<td>1. Introduction: Time scales for the Quaternary, Isotopes and decay</td>
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<td></td>
<td>2. Radiocarbon dating: principles and applications</td>
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<td></td>
<td>3. Cosmogenic nuclides: 3He,10Be, 14C, 21Ne, 26Cl, 36Cl</td>
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<td>4. U-series disequilibrium dating</td>
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<td>5. Luminescence dating</td>
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<td>6. Cs-137 and Pb-210 (soil, sediments, ice core)</td>
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<td>7. Summary and comparison of results from several dating methods at specific sites</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td></td>
<td>Visit to radiocarbon lab, cosmogenic nuclide lab, noble gas lab, accelerator (AMS) facility.</td>
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<td></td>
<td>Required attending the lecture, visiting laboratories, handing back solutions for problem sets (Exercises)</td>
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<tr>
<th>Code</th>
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<th>3 credits</th>
<th>2G</th>
<th>L. M. Plötze</th>
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<tbody>
<tr>
<td>651-4063-00L</td>
<td>X-ray Powder Diffraction</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>In the course the students learn to measure X-ray diffraction patterns of minerals and to evaluate these using different software for qualitative and quantitative mineral composition as well as crystallographic parameters.</td>
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<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>Upon successful completion of this course students are able to:</td>
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<tr>
<td></td>
<td>- describe the principle of X-ray diffraction analysis</td>
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<td></td>
<td>- carry out a qualitative and quantitative mineralogical analysis independently,</td>
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<td>- critically assess the data,</td>
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<td>- communicate the results in a scientific report.</td>
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<td></td>
<td><strong>Content</strong></td>
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<tr>
<td></td>
<td>Fundamental principles of X-ray diffraction</td>
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<td></td>
<td>Setup and operation of X-ray diffractometers</td>
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<td></td>
<td>Interpretation of powder diffraction data</td>
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<td></td>
<td><strong>Lecture notes</strong></td>
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<td></td>
<td>Selected handouts will be made available in the lecture</td>
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<tr>
<td></td>
<td><strong>Literature</strong></td>
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</tbody>
</table>
The course includes a high portion of practical exercises in sample preparation as well as measurement and evaluation of X-ray powder diffraction data. Own sample will be analysed qualitatively and quantitatively. Knowledge in mineralogy of this system is essential. The lecture course is limited to 12 participants.

### Palaeoclimatology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4057-00L</td>
<td>Climate History and Palaeoclimatology</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>G. Haug, A. Martinez-Garcia</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>The course &quot;Climate history and palaeoclimatology gives an overview on climate through geological time and it provides insight into methods and tools used in palaeoclimate research. The student will have an understanding of evolution of climate and its major forcing factors -orbital, atmosphere chemistry, tectonics-through geological time. He or she will understand interaction between life and climate and he or she will be familiar with the use of most common geochemical climate &quot;proxies&quot;, he or she will be able to evaluate quality of marine and terrestrial sedimentary palaeoclimatic archives. The student will be able to estimate rates of changes in climate history and to recognize feedbacks between the biosphere and climate.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Climate system and earth history - climate forcing factors and feedback mechanisms of the geosphere, biosphere, and hydrosphere.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Climate through geological time: &quot;lessons from the past&quot;</td>
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<td></td>
<td>The Late Paleocene Thermal Maximum (PETM)</td>
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<td>Cenozoic Cooling</td>
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<td>Onset and Intensification of Southern Hemisphere Glaciation</td>
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<td>Cenozoic Cooling</td>
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<td>Glacial and Interglacials</td>
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<td>Millennial-scale climate variability during glaciations</td>
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<td>The last deglaciation(s)</td>
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<td>The Younger Dryas</td>
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<td></td>
<td>Holocene climate - climate and societies</td>
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</table>

**651-4043-00L** Sedimentology II: Biological and Chemical Processes in Lacustrine and Marine Systems

For this course the successful completion of the MSc-course "Sedimentology I" (651-4041-00L) is a condition.

| **Abstract** | The course will focus on biological and chemical aspects of sedimentation in marine environments. Marine sedimentation will be traced from coast to deep-sea. The use of stable isotopes palaeoceanography will be discussed. Neritic, hemipelagic and pelagic sediments will be used as proxies for environmental change during times of major perturbations of climate and oceanography. -You will understand chemistry and biology of the marine carbonate system -You will be able to relate carbonate mineralogy with facies and environmental conditions -You will be familiar with cool-water and warm-water carbonates -You will see carbonate and organic-carbon-rich sediments as part of the global carbon cycle -You will be able to recognize links between climate and marine carbonate systems (e.g. acidification of oceans and reef growth) -You will be able to use geological archives as source of information on global change -You will have an overview of marine sedimentation through time |      |      |       | V. Picotti, A. Gilli      |
| **Objective** | -carbonates; chemistry, mineralogy, biology -carbonate sedimentation from the shelf to the deep sea -carbonate facies -cool-water and warm-water carbonates -organic-carbon and black shales -C-cycle, carbonates, Corg : CO2 sources and sink -Carbonates: their geochemical proxies for environmental change: stable isotopes, Mg/Ca, Sr -marine sediments through geological time -carbonates and evaporites -lacustrine carbonates -economic aspects of limestone |      |      |       |                            |
| **Content**   | no script. scientific articles will be distributed during the course |      |      |       |                            |
| **Lecture notes** | We will read and critically discuss scientific articles relevant for "biological and chemical processes in marine and lacustrine systems" |      |      |       |                            |
| **Prerequisites / notice** | The grading of students is based on in-class exercises and end-semester examination. |      |      |       |                            |

**651-4058-00L** Basics of Palaeobotany (University of Zurich)

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: BIO280

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

| **Abstract** | The course "Basics in Palaeobotany" gives an overview on the evolution and palaeobiology of plants and their relevance for the reconstruction of past environments. |      |      |       | University lecturers      |
| **Objective** | On successful completion of the module, the students should be able to explain how plants are preserved in the fossil record, to describe the morphology of plant mega fossils, and of spores and pollen. They can describe how plant fossils can be used for reconstructing palaeoenvironments. Students should be able to explain the interactions between evolution of plants, climate and physical environment and they will be able to integrate the dimension of geological time into their understanding of biological events. |      |      |       |                            |
Content
- Preservation of plants in the fossil record.
- First evidence for plants on Earth
- The conquest of the continents by plants
- Major adaptation and innovations leading to the present plant diversity
- The evolution and morphology of the major plant groups
- Plant associations through geological time and their palaeogeographic and stratigraphic relevance
- Mass extinctions and the fossil plant record
- Interaction between past vegetation and climate
- The relevance of plant microfossils for reconstruction of palaeoclimate and palaeoecology

Biogeochemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-4043-00L</td>
<td>Sedimentology II: Biological and Chemical Processes in Lacustrine and Marine Systems</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>V. Picotti, A. Gilli</td>
</tr>
</tbody>
</table>

Abstract
The course will focus on biological and chemical aspects of sedimentation in marine environments. Marine sedimentation will be traced from coast to deep-sea. The use of stable isotopes palaeoceanography will be discussed. Neritic, hemipelagic and pelagic sediments will be used as proxies for environmental change during times of major perturbations of climate and oceanography.

Objective
- You will understand chemistry and biology of the marine carbonate system
- You will be able to relate carbonate mineralogy with facies and environmental conditions
- You will be familiar with cool-water and warm-water carbonates
- You will see carbonate and organic-carbon rich sediments as part of the global carbon cycle
- You will be able to recognize links between climate and marine carbonates systems (e.g. acidification of oceans and reef growth)
- You will be able to use geological archives as source of information on global change
- You will have an overview of marine sedimentation through time

Content
- carbonates, chemistry, mineralogy, biology
- carbonate sedimentation from the shelf to the deep sea
- carbonate facies
- cool-water and warm-water carbonates
- organic-carbon and black shales
- C-cycle, carbonates, Corg : CO2 sources and sink
- Carbonates: their geochemical proxies for environmental change: stable isotopes, Mg/Ca, Sr
- marine carbonates: the course "Sedimentology II" (651-4041-00L) is a condition.

Lecture notes
No script. Scientific articles will be distributed during the course.

Literature
We will read and critically discuss scientific articles relevant for "biological and chemical processes in marine and lacustrine systems".

The grading of students is based on in-class exercises and end-semester examination.

Climate History and Palaeoclimatology

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<tr>
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<tr>
<td>651-4057-00L</td>
<td>Climate History and Palaeoclimatology</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>G. Haug, A. Martinez-Garcia</td>
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</table>

Abstract
The course "Climate history and palaeoclimatology gives an overview on climate through geological time and it provides insight into methods and tools used in palaeoclimatic research.

Objective
The student will have an understanding of evolution of climate and its major forcing factors -orbital, atmosphere chemistry, tectonics- through geological time. He or she will understand interaction between life and climate and he or she will be familiar with the use of most common geochemical climate "proxies". He or she will be able evaluate quality of marine and terrestrial sedimentary palaeoclimate archives. The student will be able to estimate rates of changes in climate history and to recognize feedbacks between the biosphere and climate.

Content
Climate system and earth history - climate forcing factors and feedback mechanisms of the geosphere, biosphere, and hydrosphere.

- Geological time, stratigraphy, geological archives, climate archives, palaeoclimate proxies
- Climate through geological time: "lessons from the past"
- Cretaceous greenhouse climate
- The Late Paleocene Thermal Maximum (PETM)
- Cenozoic Cooling
- Onset and Intensification of Southern Hemisphere Glaciation
- Onset and Intensification of Northern Hemisphere Glaciation
- Pliocene warmth
- Glacial and Interglacials
- Millennial-scale climate variability during glaciations
- The last deglaciation(s)
- The Younger Dryas
- Holocene climate - climate and societies

Basics of Palaeobotany (University of Zurich)

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4058-00L</td>
<td>Basics of Palaeobotany (University of Zurich)</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>University lecturers</td>
</tr>
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</table>

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

UZH Module Code: BIO280

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html
The course "Basics in Palaeobotany" gives an overview on the evolution and palaeobiology of plants and their relevance for the reconstruction of past environments.

On successful completion of the module, the students should be able to explain how plants are preserved in the fossil record, to describe the morphology of plant mega fossils, and of spores and pollen. They can describe how plant fossils can be used for reconstructing palaeoenvironments. Students should be able to explain the interactions between evolution of plants, climate and physical environment and they will be able to integrate the dimension of geological time into their understanding of biological events.

- Preservation of plants in the fossil record.
- First evidence for plants on Earth
- The conquest of the continents by plants
- Major adaptation and innovations leading to the present plant diversity
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- Plant associations through geological time and their palaeogeographic and stratigraphic relevance
- Mass extinctions and the fossil plant record
- Interaction between past vegetation and climate
- The relevance of plant microfossils for reconstruction of palaeoclimates and palaeoecology

### Open Choice Modules

### Quaternary Geology and Geomorphology

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4901-00L</td>
<td>Quaternary Dating Methods</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>I. Hajdas, S. Ivy Ochs</td>
</tr>
</tbody>
</table>

**Abstract**

Reconstruction of time scales is critical for all Quaternary studies in both Geology and Archeology. Various methods are applied depending on the time range of interest and the archive studied. In this lecture we focus on the six methods that are most frequently used for dating Quaternary sediments and landforms.

**Objective**

Students will be made familiar with the details of the six dating methods through lectures on basic principles, analysis of case studies, solving of problem sets for age calculation and visits to dating laboratories.

1. Understand the fundamental principles of the most frequently used dating methods for Quaternary studies.
2. Be able to calculate an age based on data of the six methods studied.
3. Choose which dating method (or combination of methods) is suitable for a certain field problem.
4. Critically read and evaluate the application of dating methods in scientific publications.

**Content**

1. Introduction: Time scales for the Quaternary, Isotopes and decay
2. Radiocarbon dating: principles and applications
3. Cosmogenic nuclides: 3He, 10Be, 14C, 21Ne, 26Cl, 36Cl
4. U-series disequilibrium dating
5. Luminescence dating
6. K/Ar and Ar/Ar dating of lava flows and ash layers
7. Cs-137 and Pb-210 (soil, sediments, ice core)
8. Summary and comparison of results from several dating methods at specific sites

**Prerequisites / notice**

Visit to radiocarbon lab, cosmonic nuclide lab, noble gas lab, accelerator (AMS) facility.

Required attending the lecture, visiting laboratories, handing back solutions for problem sets (Exercises)

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<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4077-00L</td>
<td>Quantification and Modeling of the Cryosphere: Dynamic Processes (University of Zurich)</td>
<td>W</td>
<td>3</td>
<td>1V</td>
<td>University lecturers</td>
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</tbody>
</table>

**Abstract**

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

UZH Module Code: GEO815

**Mind the enrolment deadlines at UZH:**

http://www.uzh.ch/studies/application/mobilitaet_en.html

**Objective**

Overview of the most important earth surface processes and landforms in cold regions (regions with glaciers and intense frost) with emphasis on high-mountain aspects. Discussion of present research challenges.

**Content**

Knowledge of the most prominent climate-related geomorphological processes and phenomena in high-mountain regions, understanding of primary research challenges.

Erosion and sedimentation by glaciers as a function of topography, englacial temperature, sediment balance, sliding and melt water runoff. Processes and landforms in regions of seasonal and perennial frost (frost weathering, rock falls, debris cones/talus, solifluction, permafrost creep/rock glaciers, debris flows).

**Lecture notes**

Glacial and periglacial geomorphodynamics in high-mountain regions. Ca. 100 pages.

**Literature**

References in script

**Prerequisites / notice**

Basic knowledge about geomorphology and glaciers/permafrost from corresponding courses at ETH/UZH or from the related lecture notes

### Basin Analysis

<table>
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<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4231-00L</td>
<td>Basin Analysis</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>K. Ueda, T. I. Eglinton</td>
</tr>
</tbody>
</table>

**Abstract**

The course discusses the formation and development of different basin types as part of lithosphere geodynamics. It introduces conceptual models and governing physics, with practical application to the study of basin evolution. Techniques for the analysis of subsidence and thermal history are demonstrated. Organic matter, petroleum play, and their biogeochemical investigation are examined.

**Objective**

Based on the introductory education and practical training during this course, each participant should be able to choose and apply approaches and techniques to own problems of basin analysis, and should be versed to expand their knowledge independently.

1. Develop an intuitive understanding for origin, dynamics, and temporal evolution of basins in a geological / geodynamic context;
2. Acquire the necessary theoretical foundation to describe basin evolution quantitatively;
3. Be familiar with geological and geophysical methods that are applied to obtain information about rock properties, structural geometry, and thermal and subsidence history of basins;
4. Understand the burial and maturation of organic matter in basins, the development of petroleum play, and be acquainted with geochemical methods to study the evolution of biogenic carbon.
The following topics are covered:

- Introduction; classification schemes and types of basins; heat conduction; geotherms;
- The lithosphere; isostasy; rifts and basins due to lithospheric stretching; uniform extension model; modifications to the uniform stretching model; dynamics of rifting.
- Elasticity of the lithosphere; flexural compensation; geometry and analytical description of loads and the resulting deflection; foreland basins; their anatomy;
- Reconstruction of basin evolution; borehole data; porosity loss and decompaction; backstripping; subsidence curves; thermal history and its reconstruction;
- Petroleum play concept; organic production; source rock prediction and depositional environment; petroleum generation, expulsion, migration, alteration; reservoir and traps;
- Carbon cycle; maturation of organic matter; geochemistry of biogenic carbon; biomarkers; analytical techniques
- Overview of other basin types: effects of mantle dynamics, strike-slip basins.

Each week of the course is split in lectures and corresponding practicals, in which the concepts are applied to simplified problems.

Grading of the semester performance is based on submitted practicals (50%) and a final exam (50%). The exam will take place in the time slot of the last practical (18.12.).

Lecture notes are provided online during the course. They summarize the current subjects week by week, and provide the essential theoretical background.

Main reference:

Recommended, but not required (available in library).

Supplementary:


Familiarity with MATLAB is advantageous, but not required.

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Name</th>
<th>Credits</th>
<th>Group</th>
<th>Instructor</th>
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</thead>
<tbody>
<tr>
<td>651-4243-00L</td>
<td>Seismic Stratigraphy and Facies</td>
<td>2</td>
<td>3G</td>
<td>G. Eberli</td>
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</tbody>
</table>

**Abstract**
Introduction into seismic interpretation for solving geological and environmental problems. A special focus is given to the seismic facies analysis and seismic sequence stratigraphy. In addition, the seismic attributes are explained, which are important for the analysis of paleo-geomorphology and structural deformation.

**Objective**
1. Acquire techniques for a comprehensive interpretation of seismic sections for solving geologic, tectonic, stratigraphic and environmental problems
2. Correlation of seismic facies to lithologic facies in different sedimentary systems
3. Recognition of structural elements and faults on seismic sections.
4. Learning the techniques of 3D seismic data interpretation
5. Reconstruction of sedimentary history using seismic stratigraphy and facies analysis and core information.

**Content**
The four day course consists of lectures that are accompanied by a variety of exercises.

**Day 1:**
Introduction seismic facies analysis with exercise
Seismic resolution
Factors controlling sedimentation
Exercise: Seismic section in Straits of Florida

**Day 2:**
Seismic attributes and seismic geomorphology
Siliciclastic deltas, shelves and turbidite systems, 2D-3D
Exercise: Seismic section Tarragon Basin
Seismic facies carbonates
Exercise: Seismic section platform margin Great Bahama Bank
Deepwater environments, including cold-water coral habitats

**Day 3:**
Seismic facies of mixed systems with exercises
Faults and structures on seismic sections
Exercise: Seismic section Golf von Mexiko

**Day 4:**
Telling ages on seismic section
Seismic stratigraphy and sequence stratigraphy
Exercise: Sequence analysis Straits of Andros
Final discussion
Lecture notes
An original script (110 pages) designed for the class will be distributed at the beginning of the course.

Books Seismic Facies:


Books Seismic Stratigraphy:


Harris, P.M., Saller, A.H., and Simo, J.A. (eds.), 1999, Advances in carbonate sequence stratigraphy; application to reservoirs, outcrops, and models. SEPM Special Publication v. 83.


Schlager, W., 1992, Sedimentology and sequence stratigraphy of reefs and carbonate platforms: AAPG Cont. Education course notes #34, pp71.


Prerequisites / notice
Basic knowledge in sedimentology and stratigraphy

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4107-00L</td>
<td>Rock and Environmental Magnetism</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>A. M. Hirt</td>
</tr>
</tbody>
</table>

Abstract
The course will cover basic physical theory related to mineral and rock magnetism, measurement techniques, and applications in earth and soil sciences, climatology and biophysics

Objective
There are two objectives in this course: (1) to acquire an understanding of the physical theory behind the origin of magnetism in a mineral or rock; and (2) to learn how material magnetic properties can be used to study environmental and geologic systems and processes

Content
1. Fundamentals of magnetism
2. Magnetic mineralogy
3. Measurement techniques
4. Time
5. Special Topics: Magnetoclimatology, mass transport, pollution monitoring, biophysics, magnetic properties of nanoscale materials

Lecture notes
Available on-line

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<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-4109-00L</td>
<td>Geothermal Energy</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>K. F. Evans, P. Bayer, M. O. Saar</td>
</tr>
</tbody>
</table>

Abstract
The course will introduce students to the general principles of Geothermics and is suitable for students who have a basic knowledge of Geoscience or Environmental Science (equivalent of a Bachelor degree).

Objective
To provide students with a broad understanding of the systems used to exploit geothermal energy in diverse settings.

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 523 of 1434
The course will begin with an overview of heat generation and the thermal structure of the Earth. The basic theory describing the flow of heat in the shallow crust will be covered, as will be the methods used to measure it. Petrophysical parameters of relevance to Geothermics, such as thermal conductivity, heat capacity and radiogenic heat productivity, are described with the laboratory and borehole measurement techniques used to estimate their values. The focus will then shift towards the exploitation of geothermal heat at various depths and temperatures, ranging from electricity and heat production in various types of deep geothermal systems (including high and medium temperature hydrothermal systems, and Engineered Geothermal Systems at depths of 5 km or more), to ground-source heat pumps installed in boreholes at depths of a few tens to hundreds of meters for heating domestic houses.

The subjects covered are as follows:

Week 1: Introduction. Earth's thermal structure. Conductive heat flow


Week 3: Temperature measurement. Hydrothermal reservoirs & well productivity

Week 4: Hydrological characterisation of reservoirs. Drilling. Optimised systems

Week 5: Petrothermal or Engineered Geothermal Systems

Week 6: Low-enthalpy systems 1

Week 7: Low-enthalpy systems 2.

Lecture notes

The script for each class will be available for download from the ilias website no later than 1 day before the class.

### Lithosphere Structure and Tectonics

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<tr>
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<th>Hours</th>
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<tbody>
<tr>
<td>651-4014-00L</td>
<td>Seismic Tomography</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>E. Kissling, T. Diehl, G. Hetényi</td>
</tr>
</tbody>
</table>

**Abstract**

Seismic tomography is the science of interpreting seismic measurements (seismograms) to derive information about the structure of the Earth. The subject of this course is the formal relationship existing between a seismic measurement and the nature of the Earth, or of certain regions of the Earth, and the ways to use it, to gain information about the Earth.

**Literature**


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<th>Number</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-3521-00L</td>
<td>Tectonics</td>
<td>O</td>
<td>3 credits</td>
<td>2V</td>
<td>J.P. Burg, E. Kissling</td>
</tr>
</tbody>
</table>

**Abstract**

Comprehensive understanding of evolution, mechanics, and rheology of divergent, convergent and wrenching tectonic systems from the lithospheric scale to local shallow crustal and outcrop-scales. Evaluation of plate tectonic and other orogenic processes through the study of reference examples of taken in Alp-Himalaya orogenic system.

**Objective**

Comprehensive understanding of evolution, mechanics, and rheology of divergent, convergent and wrenching tectonic systems from the lithospheric scale to local shallow crustal and outcrop-scales. Assessment of mechanisms responsible for plate movements (the Earth as a heat transfer machine, dynamics of earth mantle, plate driving forces) and subsequent large-scale structures (oceanic basins and cycle of the oceanic lithosphere, convergence and mountain systems and continental growth, etc) through theoretical and experimental information. Evaluation of plate tectonic and other orogenic processes through the study of reference examples of taken in Alp-Himalaya orogenic system.

**Content**


**Lecture notes**

Detailed scriptum in digital form and additional learning moduls (www.lead.ethz.ch) available on the intranet.

**Literature**


### Earthquake Seismology

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-4021-00L</td>
<td>Engineering Seismology</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>D. Fäh, J. Burjanek</td>
</tr>
</tbody>
</table>

**Abstract**

This course is a general introduction to the methods of seismic hazard analysis. It provides an overview of the input data and the tools in deterministic and probabilistic seismic hazard assessment, and discusses the related uncertainties.

**Objective**

This course is a general introduction to the methods of seismic hazard analysis.

**Content**

In the course it is explained how the disciplines of seismology, geology, strong-motion geophysics, and earthquake engineering contribute to the evaluation of seismic hazard. It provides an overview of the input data and the tools in deterministic and probabilistic seismic hazard assessment, and discusses the related uncertainties. The course includes the discussion related to Intensity and macroseismic scales, historical seismicity and earthquake catalogues, ground motion parameters used in earthquake engineering, definitions of the seismic source, ground motion attenuation, site effects and microzonation, and the use of numerical tools to estimate ground motion parameters, both in a deterministic and probabilistic sense.

During the course recent earthquakes and their impacts are discussed and related to existing hazard assessments for the areas of interest.

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>651-4103-00L</td>
<td>Earthquakes Source Physics</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>S. Wiemer</td>
</tr>
</tbody>
</table>

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 524 of 1434
This course teaches earthquake source theory, covering the moment-tensor representation of earthquakes treated as point-sources, the kinematic characterization of extended-fault ruptures, and the dynamics of earthquake rupture. Fault mechanics and fault-zone structure as well as implication of rupture dynamics for near-source ground-motion prediction will complement the material.

The aim of the course is to gain a thorough understanding of the physical processes (and their mathematical description) leading to and governing earthquake source ruptures. Simplified earthquake-source representations will be used to motivate the study of the complexity of the dynamic rupture process, its fundamental aspects in terms of fracture mechanics and friction, and its implications for ground-motions (and hence seismic hazard).

The course is sub-divided in two parts:

**FIRST PART**
- Introduction: Definition of earthquake, faults, elastic rebound theory, source parameters definition.
- Introduction to elastodynamic: strain, stress, equation of motion.
- Mathematical description of the source: Representation theorem, earthquakes as point sources, moment-tensor derivation, source spectra.
- Earthquakes on extended faults: Kinematic earthquake characterization, kinematic source inversion

**SECOND PART**
- Earthquake source dynamics: Introduction to Linear Elastic Fractures mechanics, the state of stress and friction models,
- Energy partition during Earthquake
- Numerical simulation of shear rupture: Fault representation methods, elastodynamic coupled to frictional sliding.
- Identifying source-dominant ground motion phenomena
- Numerical exercise to model earthquake rupture dynamic

Course notes will be made available on a designated course web site several days in advance of each lecture. No single script or book will be distributed or recommended as the material is compiled from several text books and the recent literature.

By the end of the course, students will be able to independently conceptualize:
- The inter-seismic strain accumulation for an earthquake and the inflation of a spherical reservoir (i.e. magma chamber of a volcano) or water level change within an aquifer.
- The inter-seismic strain accumulation for an earthquake and the seismic source characterization.

Students are then introduced to:
- The Seismic Cycle monitoring (Moment release, seismology, Stress transfer)
- Earthquakes on extended faults: Kinematic earthquake characterization, kinematic source inversion

**Prerequisites / notice**
- The course will be evaluated in four parts, from a two hours final exam at the end of the course, a final presentation which will be based on a paper-study from the relevant recent literature, a writing report of a computer exercise and homework delivered during the course. The course will be worth 3 credit points, and a satisfactory total grade (4 or better averaged from the four evaluation parts) is needed to obtain 3 CPs. The final writing exam has a weight of 40% and the other three have a weight of 60% (each contributing 20% of the total grade).

The course will be given entirely in English.

Course pre-requisites: standard "higher maths for physicists" (i.e. linear algebra, calculus, ODE's, PDE's, Fourier-Transforms, some probability theory); useful but not mandatory courses would be "Inverse Theory in Geophysics" and general geophysics courses (i.e. seismost-tectonics, seismic waves, introduction to geophysics).

**CPs** The final writing exam has a weight of 40% and the other three has a weight of 60% (each contributing 20% of the total grade).

**Lecture notes** Slides. Script in English is planned. PDF of articles cited.

**Literature**
- Principles of Seismology by A. Udias, Cambridge University Press (January 13, 2000) ($140): easier to understand than Aki & Richards, less comprehensive
- An Introduction to Seismology, Earthquakes and Earth Structure by S. Stein and M. Wyssession, Blackwell Science; 1st edition (September 2002) ($96), very nice and comprehensive, not very theoretical
We will explain the fundamentals of physics of glaciers which are necessary for treating applied problems. We will go into climate-glacier interactions, flow of glaciers, lake ice and hydrology of glaciers.

**Physics of Glaciers**

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<th>Lecturers</th>
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<tbody>
<tr>
<td>651-3561-00L</td>
<td>Cryosphere</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>M. Funk, M. Huss, K. Steffen</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course introduces the different parts of the cryosphere - snow, glaciers, sea ice, permafrost - and their role in the climate system. A significant physical aspect is the focus in each part. Those completing the course are able to describe the dynamics of cryosphere components both formally and using examples.</td>
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<tr>
<td>Objective</td>
<td>Students are able - to qualitatively describe the main components of the cryosphere and their role in the climate system - to formally describe the relevant physical processes which determine the state of cryosphere components</td>
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<tr>
<td>Content</td>
<td>Introduction into the different components of the Cryosphere: Snow, glaciers, sea ice and permafrost, and their roles in the climate system. Each part is use to emphasized on one specific physical aspect: material qualities of ice, mass balance and dynamics of glaciers and energy balance of sea ice.</td>
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<tr>
<td>Lecture notes</td>
<td>Handouts will be distributed during the teaching semester</td>
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**Applied Glaciology**

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<tbody>
<tr>
<td>101-0289-00L</td>
<td>Applied Glaciology</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>M. Funk, A. Bauder</td>
</tr>
<tr>
<td>Abstract</td>
<td>We will explain the fundamentals of physics of glaciers which are necessary for treating applied problems. We will go into climate-glacier interactions, flow of glaciers, lake ice and hydrology of glaciers.</td>
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<tr>
<td>Objective</td>
<td>To understand the fundamental physical processes in glaciology. To learn some basic numerical modelling techniques for glacier flow. To identify glaciological hazards and to learn some assessment and mitigation possibilities.</td>
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<tr>
<td>Content</td>
<td>Basics in physical glaciology Dynamics of glaciers: deformation of glacier ice, role of water in glacier motion, reaction of glaciers to climate changes, glacier calving, surges Ice falls, ice avalanches Glacier floods Lake ice and bearing capacity</td>
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<tr>
<td>Lecture notes</td>
<td>Handouts are available</td>
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<tr>
<td>Literature</td>
<td>Relevante Literatur wird während der Vorlesung angegeben.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Für aktuelle Fallbeispiele werden risikobasierte Massnahmen bei glaziologischen Naturgefahren diskutiert.</td>
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**Quantification and Modeling of the Cryosphere**

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<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-4101-00L</td>
<td>Physics of Glaciers</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>M. Lüthi, G. Jouvet, F. T. Walter</td>
</tr>
<tr>
<td>Abstract</td>
<td>Application of basic physical concepts to glaciers and ice caps. Understanding glaciers and ice sheets with simple physical concepts. Topics include the reaction of glaciers to the climate, ice rheology, temperature in glaciers and ice sheets, glacier hydrology, basal motion and calving glaciers. A special focus is the current development of Greenland and Antarctica.</td>
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<tr>
<td>Objective</td>
<td>The course outlines the physical principles governing the gravity-driven motion of glacier ice. This is applied to understand the response of glaciers and ice sheets to changes in their environment. Polar ice caps, ice streams and mountain glaciers and their recent rapid changes are discussed.</td>
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<tr>
<td>Content</td>
<td>The dynamics of glaciers and polar ice sheets is the key requisite to understand their history and their future evolution. We will take a closer look at ice deformation, basal motion, heat flow and glacier hydraulics. The specific dynamics of tide water and calving glaciers is investigated, as is the reaction of glaciers to changes in mass balance (and therefore climate).</td>
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<tr>
<td>Lecture notes</td>
<td>Good high school mathematics and physics knowledge required.</td>
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</tr>
<tr>
<td>Literature</td>
<td><a href="http://people.ee.ethz.ch/~luethim/teaching.html">http://people.ee.ethz.ch/~luethim/teaching.html</a></td>
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**Seminar in Glaciology**

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<tbody>
<tr>
<td>651-1581-00L</td>
<td>Seminar in Glaciology</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>A. Bauder</td>
</tr>
<tr>
<td>Content</td>
<td>Studium aktueller und klassischer Arbeiten der glaziologischen Forschung benötigte Unterrichten werden im Verlauf der Veranstaltung abgegeben</td>
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<tr>
<td>Lecture notes</td>
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#### Palaeontology

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<th>Lecturers</th>
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<tbody>
<tr>
<td>651-1380-00L</td>
<td>Paleontological Excursions (University of Zürich)</td>
<td>W</td>
<td>1</td>
<td>1P</td>
<td>University lecturers</td>
</tr>
<tr>
<td>Abstract</td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.</td>
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</tr>
<tr>
<td>UZH Module Code: BIO279</td>
<td>Mind the enrolment deadlines at UZH: <a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
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</table>

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

**Overview of the most important earth surface processes and landforms in cold regions (regions with glaciers and intense frost) with emphasis on high-mountain aspects. Discussion of present research challenges.**

**Knowledge of the most prominent climate-related geomorphological processes and phenomena in high-mountain regions, understanding of primary research challenges.**

**Erosion and sedimentation by glaciers as a function of topography, englacial temperature, sediment balance, sliding and melt water runoff. Processes and landforms in regions of seasonal and perennial frost (frost weathering, rock falls, debris cones/talus, solifluction, permafrost creep/rock glaciers, debris flows).**

**Glacial and periglacial geomorphodynamics in high-mountain regions. Ca. 100 pages.**

**Good high school mathematics and physics knowledge required.**

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

**Basic knowledge about geomorphology and glaciers/permafrost from corresponding courses at ETH/UZH or from the related lecture notes**

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

**Studium aktueller und klassischer Arbeiten der glaziologischen Forschung**

- to formally describe the relevant physical processes which determine the state of cryosphere components
- to qualitatively describe the main components of the cryosphere and their role in the climate system

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 526 of 1434
**Objective**
Besuch von Fossilvorkommen im In- und Ausland, um die Erhaltung der Fossilien, die fazielle Ausbildung und die Stratigraphie der fossilführenden Schichten kennenzulernen und zu diskutieren sowie gegebenenfalls Fossilien zu sammeln.

**Content**

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**Basics of Palaeobotany (University of Zurich)**
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

**UZH Module Code:** BIO280

**Abstract**
The course "Basics in Palaeobotany" gives an overview on the evolution and palaeobiology of plants and their relevance for the reconstruction of past environments.

**Objective**
On successful completion of the module, the students should be able to explain how plants are preserved in the fossil record, to describe the morphology of plant mega fossils, and of spores and pollen. They can describe how plant fossils can be used for reconstructing palaeoenvironments. Students should be able to explain the interactions between evolution of plants, climate and physical environment and they will be able to integrate the dimension of geological time into their understanding of biological events.

**Content**
- Preservation of plants in the fossil record.
- First evidence for plants on Earth
- The conquest of the continents by plants
- Major adaptation and innovations leading to the present plant diversity
- The evolution and morphology of the major plant groups
- Plant associations through geological time and their palaeogeographic and stratigraphic relevance
- Mass extinctions and the fossil plant record
- Interaction between past vegetation and climate
- The relevance of plant microfossils for reconstruction of palaeoclimate and palaeoecology

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**Geographic Information Systems**

**Remote Sensing**

**Modules from the Geology Major**
Choice from Geology Restricted Choice Modules

**Modules from the Engineering Geology Major**
Choice from Engineering Geology Required Modules

**Modules from the Geophysics Major**
Choice from Geophysics Compulsory Modules

Choice from Geophysics Restricted Choice Modules

Choice from the Mineralogy & Geochemistry Major

Choice from the Mineralogy & Geochemistry Restricted Choice Modules

Major in Engineering Geology

Compulsory Modules Engineering Geology

Engineering Geology Fundamentals

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>651-4025-00L</td>
<td>Rock Mechanics and Rock Engineering</td>
<td>O</td>
<td>4 credits</td>
<td>4V+2U</td>
<td>F. Amann, V. Gischig, M. Perras</td>
</tr>
</tbody>
</table>

Abstract
This course focuses on the principles (fundamentals) and basic concepts of rock mechanics and rock engineering (e.g. tunnelling, rock slope stability).

Objective
The course aims to introduce the fundamentals and basic concepts of rock mechanics and generic rock engineering. The student shall understand how rocks behave at different scales, under various artificial loads and in the shallow subsurface (a few km below ground). The link between rock mechanics, geology, hydrogeology and tectonics (i.e. the conditions under which the rock formed) will be clearly established.

The student shall understand basic principles of rock mechanics and rock engineering. In addition, the student shall learn how to carry out laboratory tests, to interpret these tests and to apply the results from lab and field investigations to simple engineering problems. This knowledge is required for subsequent integration courses (Landslide Analysis and Hazard Mitigation; Engineering Geology of Underground Excavations).

Content
This course focuses on the principles (fundamentals) and basic concepts of rock mechanics and generic rock engineering. The behavior of different rock types is studied with laboratory investigations, which are linked to the theoretical aspects discussed in lectures and applied in exercises. The course is compulsory for the MSc Eng Geol. The applications of rock mechanical principles and rock engineering methods are extensively covered in subsequent courses.

Lecture notes
Written course documentation available on our homepage: www.engineeringgeology.ethz.ch

651-4033-00L | Soil Mechanics and Foundation Engineering | O    | 4 credits | 3V+2U | M. Perras, A. Wolter, M. Stolz |

Abstract
The course presents the principles of soil mechanics and soil behaviour characteristics and its applications in geotechnical structures and systems. It is based on more descriptive courses on Engineering Geology within the BSc Geol. Program and is a compulsory prerequisite for other courses within the MSc Eng. Geol. program.

Objective
Understanding the principles of soil behaviour and the fundamentals of geotechnical practices in soils.

Content
Soil Mechanics:
Fundamental concepts of strength and deformation of different soils. Introduction to geotechnical calculations
Significance of (ground)water
Geotechnical Engineering in Soils:
Evaluation of geotechnical scenarios, handling of forecast uncertainties, relation of soil properties and soil composition, interactions between soil and building,
standard construction methods in soils (foundations, slopes, dams and levees),
requirements for the geotechnical prognosis

Lecture notes
This lecture is supported by the textbook: “Geotechnical Engineering” by Donald P. Coduto, 2nd edition, 2011; ISBN-13: 978-0-13-135425-8

Prerequisites / notice
Courses must be completed:
Introduction to Engineering Geology (BSc level)
Introduction to Groundwater
Sedimentology and Quaternary deposits
Principles of Physics

Courses recommended:
Eng Geol Site Investigations
Eng Geol Field Course I (soils)
Clay Mineralogy

651-4023-00L | Groundwater | O    | 4 credits | 3G    | M. O. Saar, X.Z. Kong |

Abstract
The course provides an introduction into quantitative analysis of groundwater flow and transport. It is focussed on formulating flow and transport problems in groundwater, which are to be solved analytically or numerically.

Objective
a) Students understand the basic concepts of flow and contaminant transport processes and boundary conditions in groundwater.

b) Students are able to formulate simple practical flow and transport problems.

c) Students are able to understand and apply simple analytical solutions to simple flow and transport problems.

d) Students are able to use simple numerical codes to adequately solve simple flow (and transport) problems.
1. Introduction to groundwater problems. Concepts to quantify properties of aquifers.
2. Flow equation. The generalized Darcy law.
3. The water balance equation.
5. Analytical solutions to flow problems I
6. Analytical solutions to flow problems II
7. Finite difference solution to flow problems.
12. Analytical solutions to transport problems I.
13. Analytical solutions to transport problems II

Lecture notes
Handouts of slides.

Literature
de Marsily G., Quantitative Hydrogeology, Academic Press, 1986

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4065-00L</td>
<td>Geological Site Investigations</td>
<td>O</td>
<td>3</td>
<td>3G</td>
<td>M. Ziegler, A. Manconi</td>
</tr>
</tbody>
</table>

Abstract
This course introduces students to the methods used in characterising, developing or monitoring geotechnical engineering project sites. Measurements, tools and analyses are described that are relevant to determining the geologic conditions at a site as well as deformations that occur under natural or construction conditions.

Objective
This course aims to introduce the general procedures taken during a engineering geological site investigation. Students who complete the course should be able to design a site investigation program of measurements based on information from initial desk studies, and to analyse, integrate and interpret data from the measurement program.

Content
The methods that are routinely employed in site investigations will be described focusing on their applicability in different geologic environments. The limitations of the data in constraining the parameters of interest will be addressed together with problems of interpretation and cost-versus-information value. Specific topics addressed include drilling, coring, sampling, borehole testing, geophysical methods used in engineering geology, satellite, air- and ground-based surface and displacement monitoring (photogrammetry, LIDAR and Radar), and in-situ deformation measurement methods.

Lecture notes
Lecture notes will be available for download 1-2 days before each class.

Literature

Supplemental literature will be suggested and made available during the course.

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4071-00L</td>
<td>Industrial Internship</td>
<td>O</td>
<td>12</td>
<td>32P</td>
<td>B. Oddsson</td>
</tr>
</tbody>
</table>

Notes: Prerequisites: successful participation in all 3 compulsory modules of the Major in Engineering Geology (Fundamentals, Methods and Integration).

The Industrial Internship of the Eng Geol Major should take place in the second MSc year after consultation with Dr. Björn Oddsson. Detailed regulations of this practical are published on the Eng Geol Website.
The industry practical is supervised both from the industry partner and ETH and consists of technically and/or scientifically challenging work in the engineering geology domain. The regular duration of the practical is 2.5 months. The practical is pre-defined in a work plan and concluded with a report written by the student.

The goals of the industry practical are to become familiar with technical, economic, legal and communication issues of real-life work in private industry or technical administration.

### Major in Geophysics

#### Compulsory Modules Geophysics

#### Geophysical Methods I

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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4001-00L</td>
<td>Geophysical Data Processing</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>C. V. Cauzzi</td>
</tr>
</tbody>
</table>

#### Geophysical Methods II

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4001-00L</td>
<td>Geophysical Fluid Dynamics</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>J. A. R. Noir</td>
</tr>
</tbody>
</table>

Taras Gerya, Introduction to Numerical Geodynamic Modelling, Cambridge University Press 2010

GRADING will be based on weekly programming homeworks (50%) and a term project (50%) to develop an application of their choice to a more advanced level.

Literature

Taras Gerya, Introduction to Numerical Geodynamic Modelling, Cambridge University Press 2010
The course is a general introduction to the theory of seismic wave propagation. The course will guide students in learning about solutions of partial differential equations arising in connection with various physical processes. The goal of this course is to learn and understand few principal partial differential equations (conservation laws) that are applicable for analysing and modelling of any continuum including the Earth’s mantle, core, atmosphere and ocean. By the end of the course, students should be able to write, explain and analyse the equations and apply them for simple analytical cases. Numerical solving of these equations will be discussed in the Numerical Modelling I and II course running in parallel.

A provisional week-by-week schedule (subject to change) is as follows:

Week 1: The continuity equation
Theory: Definition of a geological media as a continuum. Field variables used for the representation of a continuum. Methods for definition of the field variables. Eulerian and Lagrangian points of view. Continuity equation in Eulerian and Lagrangian forms and their derivation.
Exercise: Computing the divergence of velocity field.

Week 2: Density and gravity
Exercise: Computing density, thermal expansion and compressibility from an equation of state.

Week 3: Stress and strain
Exercise: Analysing strain rate tensor for solid body rotation.

Week 4: The momentum equation
Exercise: Computing velocity for magma flow in a channel.

Week 5: Viscous rheology of rocks
Theory: Solid-state creep of minerals and rocks as themajor mechanism of deformation of the Earths interior. Dislocation and diffusion creep mechanisms. Rheological equations for minerals and rocks. Effective viscosity and its dependence on temperature, pressure and strain rate. Formulation of the effective viscosity from empirical flow laws.
Exercise: Deriving viscous rheological equations for computing effective viscosities from empirical flow laws.

Week 6: The heat conservation equation
Exercise: steady temperature profile in case of channel flow.

Week 7: Elasticity and plasticity

Restrictive Choice Modules Geophysics

Seismology

The course is a general introduction to the theory of seismic wave propagation. It explains the principles and assumptions used in seismology. It provides the tools to solve basic seismological problems.
The course explains the principles and assumptions used in seismology. It provides the tools to solve basic seismological problems. The course includes the theorems in dynamic elasticity, the formulation with potentials, Greens function, elastic waves from point dislocations sources, moment tensors, 1D, 2D, and 3D wave propagation problems, reflection and transmission at plane boundaries, and surface waves in a vertically heterogeneous medium.

### 651-4015-00L Seismotectonics

**W 3 credits 2G**  
J. D. Zechar, A. P. Rinaldi

**Abstract**  
If you're interested in knowing more about the relationship between seismicity and plate tectonics, this is the course for you. (If you're not that interested, but yr program of study requires that you complete this course, this is also the course for you.)

**Objective**  
By the conclusion of this course, we hope that you:

- have a solid understanding of stress and strain and tensor representations;
- have a feeling for what rheology is and why it is important;
- have a more sophisticated understanding of the relationship b/w plate tectonics and eqks;
- understand eqk source representations of varying complexity;
- understand eqks in the context of different tectonic settings;
- understand why we can't predict eqks; and
- understand that "modern science is... a set of research directions rather than a collection of nuggets of established truth."

**Content**  
To begin our series of 14 meetings, we will review fundamentals of continuum mechanics and tensor analysis; our goal is to help you understand deformation from the scale of conchastar in the classroom to the scale of plate tectonics. We will tell you about several ways to approximately represent an earthquake source; we'll present these in order of increasing sophistication. We'll discuss a currently-popular theory to explain earthquake triggering. We'll talk about the conceptual connections between earthquakes and tectonic deformation. You will enjoy (at least) two computer exercises.

Discussed:  
- stress and deformation in the Earth; stress and strain tensors; rheology and failure criteria; fault stresses, friction and effects of fluids; stable and unstable sliding; earthquake focal mechanisms; relationship between stress fields and focal mechanisms; seismic moment and moment tensors; relationship between moment- and deformation tensors; crustal deformation from seismic, geologic, and geodetic observations; earthquake stress drop, scaling, and source parameters; earthquake induced stress changes; global earthquake distribution; current global earthquake activity; different seismotectonic regions; examples of earthquake activity in different tectonic settings, such as in subduction zones, California, the Mediterranean, and in Switzerland.

**Lecture notes**  
TBA

**Literature**  

**Prerequisites / notice**  
You should have at least a foggy recollection of calculus.

### 651-4021-00L Engineering Seismology

**W 3 credits 2G**  
D. Fäh, J. Burjánek

**Abstract**  
This course is a general introduction to the methods of seismic hazard analysis. It provides an overview of the input data and the tools in deterministic and probabilistic seismic hazard assessment; and discusses the related uncertainties.

**Objective**  
This course is a general introduction to the methods of seismic hazard analysis.

**Content**  
In the course it is explained how the disciplines of seismology, geology, strong-motion geophysics, and earthquake engineering contribute to the evaluation of seismic hazard. It provides an overview of the input data and the tools in deterministic and probabilistic seismic hazard assessment, and discusses the related uncertainties. The course includes the discussion related to Intensity and macroseismic scales, historical seismicity and earthquake catalogue, ground motion parameters used in earthquake engineering, definitions of the seismic source, ground motion attenuation, site effects and microzonation, and the use of numerical tools to estimate ground motion parameters, both in a deterministic and probabilistic sense.

During the course recent earthquakes and their impacts are discussed and related to existing hazard assessments for the areas of interest.

### Physics of the Earth's Interior

**Courses for the Module Physics of the Earth's Interior take place in Spring Semester.**

**Number**  
651-4010-00L

**Title**  
Planetary Physics and Chemistry

**Type ECTS Hours Lecturers**  
O 3 credits 2G  
P. Tackley

**Abstract**  
This course aims to give a physical understanding of the formation, structure, dynamics and evolution of planetary bodies in our solar system and also apply it to ongoing discoveries regarding planets around other stars.  

**Objective**  
The goal of this course is to enable students to understand current knowledge and uncertainties regarding the formation, structure, dynamics and evolution of planets and moons in our solar system, as well as ongoing discoveries regarding planets around other stars.  

Students will practice making quantitative calculations relevant to various aspects of these topics through weekly homeworks.

The following gives an overview of the course content and approximate schedule (subject to change).

**Hours Topics**  
1-2 Introduction  
3-4 Orbital dynamics and Tides  
5-6 Solar heating and Energy transport  
7-8 Planetary atmospheres  
9-10 Planetary surfaces  
11-12 Planetary interiors  
13-14 Asteroids and Meteorites  
15-16 Comets  
17-18 Planetary rings  
19-20 Magnetic fields and Magnetospheres  
21-22 The Sun and Stars  
23-24 Planetary formation  
25-26 Exoplanets and Exobiology  
27-28 Review

**Lecture notes**  
Slides and scripts will be posted at the moodle site:https://moodle-app2.let.ethz.ch/course/view.php?id=1658

**Literature**  
It is recommended but not mandatory to buy one of these books:

  (books.ch Fr64.90, amazon.co.uk £35.00, amazon.de €38.61, amazon.com $49.26).

  (books.ch Fr98.90, amazon.co.uk £54.99, amazon.de €80.04, amazon.com $82.76).

### Applied Geophysics

The compulsory Courses for the Module Applied Geophysics take place in Spring Semester. One additional elective course of at least 3KP has to be
In the course the students learn to measure X-ray diffraction patterns of minerals and to evaluate these using different software for:

- Elementary concepts (1st and 2nd Laws; composition, state and extent); stability criteria; Legendre transforms; Maxwell relations and other manipulations of thermodynamic functions; calculation of Gibbs energy for a pure solid; simple solution models; order-disorder solution models; reciprocal solution models; equations of state for molecular fluids; free energy minimization.

This course is neither an introduction to computer methods for calculating petrological phase equilibria nor an introduction to phase diagram methods.

Some familiarity with elementary thermodynamics (phase rule, reactions) and mathematics (differentiation, integration) is assumed. Experience with Maple or comparable programs such as Mathematica is helpful.

Lecturer: J. Connolly

Number of participants limited to 12.

Lecture notes

Selected handouts will be made available in the lecture.

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**651-4039-00L** Thermodynamics Applied to Earth Materials

**Objective**

To provide students with the conceptual and practical skills necessary to implement thermodynamic models and data as provided in the earth science literature. The computer software package Maple is relied upon to allow students to solve realistic problems without the distraction of mathematical details.

**Content**

This course is neither an introduction to computer methods for calculating petrological phase equilibria nor an introduction to phase diagram methods.

**Prerequisites / notice**

The grade for the course is based on exercises assigned as homework.

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**651-4097-00L** Applied Mineralogy and Non-Metallic Resources I

**Objective**

Students will learn to understand the use of non-metallic mineral resources from a geological and mineralogical point of view as well as from industrial, technical and strategic (political) point of view. Environmental aspects on the worldwide use of non-metallic mineral resources are discussed. A special focus will be given on the situation in Switzerland.

**Content**

Teaching, case-studies and excursions (e.g. raw-material industry).

Course "Applied mineralogy and non-metallic resources I" (autumn/winter semester):

- Non-metallic resources.
- Occurrences, geology, extraction, properties, fabrication and use.
- Industrial aspects, (new) technologies, market, stock, situation, reserves & resources, trends and development, environmental aspects, law.
- Chapters: e.g. coal/carbon (coal, graphite, diamond, fullerene); oil/gas (oil- and tarsands, oil-shists); phosphates/nitrates; aluminum (bauxite, corundum); salt; carbonates; titanium; clay and clay minerals; sulphur; gypsum/anhdydrite; fluoride; asbestos; talc; micas; rare earth elements.
- Course "Applied mineralogy and non-metallic resources II" (fall/summer semester):
- Stone and earth industry (gravel, sand, crushed stones, stones), natural stone, building stone, cement, cement-industry.
- New perception on raw materials.
- Case studies in applied mineralogy.

**Lecture notes**

Will be given according to the lessons. Partially integration of e-learning tools.


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**651-4233-00L** Geotectonic Environments and Deep Global Cycles

**Objective**

This course addresses master students interested in in integral view of processes operating in various tectonic environments, most specifically divergent and convergent plate margins.

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**651-4063-00L** X-ray Powder Diffraction

**Abstract**

In the course the students learn to measure X-ray diffraction patterns of minerals and to evaluate these using different software for qualitative and quantitative mineral composition.

**Objective**

Upon successful completion of this course students are able to:
- describe the principle of X-ray diffraction analysis
- carry out a qualitative and quantitative mineralogical analysis independently
- critically assess the data
- communicate the results in a scientific report.

**Content**

Fundamental principles of X-ray diffraction
- Setup and operation of X-ray diffractometers
- Interpretation of powder diffraction data
- Qualitative and quantitative phase analysis of crystalline powders (e.g. with Rietveld analysis)

Lecture notes

Selected handouts will be made available in the lecture.
Principles of hydrothermal ore formation, using base metal deposits (Cu, Pb, Zn) in sedimentary basins to explain the interplay of

1) the blue book by F Spear 1993 Metamorphic phase equilibria and pressure-temperature-time paths. MSA Mongraph

Understanding the fundamental processes of hydrothermal and magmatic ore formation, recognising and interpreting mineralised rocks in Geotectonic Environments and Deep Global Cycles


The course includes a high portion of practical exercises in sample preparation as well as measurement and evaluation of X-ray powder diffraction data.

Own sample will be analysed qualitatively and quantitatively. Knowledge in mineralogy of this system is essential.

The lecture course is limited to 12 participants.

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<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>651-4028-00L</td>
<td>Physical Properties of Minerals</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>E. Reusser</td>
</tr>
<tr>
<td>Abstract</td>
<td>Physical properties of minerals, e.g. electrical properties, elasticistical properties are discussed. The effect of the crystal symmetry on the symmetry of physical properties as well as the mathematical formulation of the physical properties are major topics.</td>
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</thead>
<tbody>
<tr>
<td>651-4223-00L</td>
<td>Phase Petrology</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>L. Tajmanová</td>
</tr>
<tr>
<td>Abstract</td>
<td>A comprehensive introduction to heterogeneous phase equilibria in the geosciences. The course will give an introduction to phase petrology and its application to magmatic and metamorphic systems. Further, the course will give an introduction to thermobarochemistry of mineral assemblages. The origin and interpretation of microstructures and chemical zoning in rocks will be discussed. We will also touch kinetics of rock forming processes and the role of fluids during the lectures.</td>
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The specific topics will involve:

Mineral reactions and chemical equilibrium in metamorphic and magmatic rocks, recalculation of rock and mineral analyses, mineral modes, P-T-X relations.

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<tbody>
<tr>
<td>651-4063-00L</td>
<td>X-ray Powder Diffraction</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>L. M. Plötze</td>
</tr>
<tr>
<td>Abstract</td>
<td>In the course the students learn to measure X-ray diffraction patterns of minerals and to evaluate these using different software for qualitative and quantitative mineral composition as well as crystallographic parameters. Upon successful completion of this course students are able to: - describe the principle of X-ray diffraction analysis, - carry out a qualitative and quantitative mineralogical analysis independently, - critically assess the data, - communicate the results in a scientific report.</td>
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</table>

The course will give an introduction to thermobarochemistry of mineral assemblages. The origin and interpretation of microstructures and chemical zoning in rocks will be discussed. We will also touch kinetics of rock forming processes and the role of fluids during the lectures.

The specific topics will involve:

Mineral reactions and chemical equilibrium in metamorphic and magmatic rocks, recalculation of rock and mineral analyses, mineral modes, P-T-X relations.

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<tbody>
<tr>
<td>651-4037-00L</td>
<td>Ore Deposits I</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>C. A. Heinrich, P. Lecumberri Sanchez</td>
</tr>
<tr>
<td>Abstract</td>
<td>Can be chosen as an elective course within the Bachelor. Prospective MSc-Students attending the module &quot;Mineral Resources&quot; should attend Ore Deposits I and II in the first year of their MSc studies. Principles of hydrothermal ore formation, using base metal deposits (Cu, Pb, Zn) in sedimentary basins to explain the interplay of geological, chemical and physical factors from global scale to sample scale. Introduction to orthomagmatic ore formation (mostly Cr, Ni, PGE). Understanding the fundamental processes of hydrothermal and magmatic ore formation, recognising and interpreting mineralised rocks in geological context. (a) Principles of hydrothermal ore formation: base metal deposits in sedimentary basins. Practical classification of sample suites by genetic ore deposit types. Mineral solubility and ore deposition, principles &amp; thermodynamic prediction using activity diagrams. Stable isotopes in ore-forming hydrothermal systems (O, H, C, S) Driving forces and structural focussing of hydrothermal fluid flow (b) Introduction to orthomagmatic ore formation. Chromite, Ni-Cu sulphides and PGE in layered mafic intrusions. Distribution coefficients between silicate and sulphide melts. Carbonatites and pegmatite deposits.</td>
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Notes handed out during lectures

Extensive literature list distributed in course

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Data: 06.02.2019 13:00  Autumn Semester 2015  Page 534 of 1434
2 contact hours per lecture/week including lectures, exercises and practical study of samples, and small literature-based student presentations. Supplementary contact for sample practicals and exercises as required. Credits and mark based on participation in course (exercises, 50%) and 1h written exam in the last lecture of the semester (50%).

651-4097-00L Applied Mineralogy and Non-Metallic Resources I O 3 credits 2G R. Kündig, C. Bühler
Objective
Geological and mineralogical aspects to important non-metallic mineral resources. Industrial use of specific mineral resources as well as economic, strategic and environmental aspects are discussed. Examples from all over the world with a specific focus on the non-mineral mineral resources potential in Switzerland.
Content
Teaching, case-studies and excursions (e.g. raw-material industry).
Course “Applied mineralogy and non-metallic resources I” (autumn/winter semester):
Non-metallic resources. Occurrences, geology, extraction, properties, fabrication and use. Industrial aspects, (new) technologies, market, stock, situation, reserves & resources, trends and development, environmental aspects, law.
Chapters: e.g. coal/ carbon (coal, graphite, diamond, fullerene); oil/gas (oil- and tarsands, oil-shists); phosphates/nitrates; aluminum (bauxite, corundum); salt; carbonates; titanium; clay and clay minerals; sulphur; gypsum/anhydrite; fluorspar; asbestos; talc; micas; rare earth elements.
Course “Applied mineralogy and non-metallic resources II” (fall/summer semester):
Chapters: e.g. Stone industry - technical aspects of building stones, properties, weathering, treatment, quarries, products, Crushed stones - quarries, products, planning, environment. Gravel an sand - resources/reserves, environment (protection/law), alternative products (substitution). Cement and concrete (geological resources, prospection, fabrication, environment).

Abstract
Global mineral economics and the strategies of mineral exploration -- including geological, geochemical and geophysical methods, but also non-geological factors such as organisational, political and environmental aspects. Changing external examiners.
Objective
Practical understanding of the procedure of exploring a mineral prospect, based on geological analysis, exploration by drilling, resource calculation of tonnage and grade as a basis for economic evaluation for reporting to investors.
Content
This block course in will comprise 4 half-day lectures and a series of practical exercises from selection of a mineral property to discovery of mineral resources and their valuation. Teams are formed as Limited Partnership companies that have to select and bid for a mineral property offered during an auction. Each company has the same nominal budget. The highest bidder purchases the selected property. Others need to purchase the remaining properties during an auction. Justification for selecting the property is justified in a report. The companies must interpret the geological of their mineral property to prepare a diamond drill program to discover and, eventually, delineate the mineral resources. This drill program is presented in a report prior to drilling. Drilling in the tri-dimensional matrix of the property is simulated using the software FOREUR, until budget lapse. The companies must select drill intervals for chemical analysis to document the extent and composition of the discovered mineralization. Portions of the mineral rights can be traded for capital between the companies. An estimate of the tonnage and grade of the discovered resource is prepared using geometric methods and GIS software (ex. Arc GIS). The ground value of the resource is estimated by a computation of the Net Smelter Return at current metal prices. The results of the exploration program are presented in a comprehensive report.

651-4221-00L Numerical Modelling of Ore Forming Hydrothermal Processes W 3 credits 2G T. Driesner, D. Zezin
Abstract
Introduction to computer tools for the simulation of hydrothermal processes. This includes fluid flow modelling and thermodynamic modelling of hydrothermal reactions. The computer programs are handed out to the students and can be run on normal PCs. No programming knowledge is necessary.
Objective
Learn how to use the simulation programs HYDROTHERM and HCh to explore how hydrothermal systems work.
Content
Introduction to computer tools for the simulation of hydrothermal processes: HYDROTHERM for fluid flow simulations, HCh for thermodynamic modeling. While learning the respective computer programs is an essential part of the course, the emphasis will be on using these tools to learn how the physics and chemistry of hydrothermal system actually work.
Literature
Objective
Practical ability to carry out a meaningful fluid or melt inclusion study in the fields of geochemistry, petrology or resource geology, involving problem definition, research planning, quantitative measurements using a combination of techniques, critical interpretation and correct documentation of results.

Lecture notes
Handouts with extensive list of primary literature available

Literature
Goldstein and Reynolds (1994): CD available for in-house use

Geochemistry

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4227-00L</td>
<td>Planetary Geochemistry</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>M. Schönböchler, H. Busemann, D. L. Cook</td>
</tr>
<tr>
<td>Abstract</td>
<td>Formation and evolution of the solar system with a geochemical perspective</td>
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<tr>
<td>Objective</td>
<td>To understand the formation and evolution of the solar system from a geochemical perspective</td>
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<tr>
<td>Content</td>
<td>The sun and solid objects in the solar system (planets, comets, asteroids, meteorites, interplanetary dust) are discussed with a geochemical perspective. What does their present-day composition tell us about the origin and evolution of the solar system? The lecture first introduces the basic facts of the terrestrial and giant planets, as well as comets and asteroids, as mainly gained from modern planetary missions. The chemical and isotopic composition of meteorites, being the most primitive material available for study, is a further major topic.</td>
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<tr>
<td>Lecture notes</td>
<td>available electronically</td>
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<tr>
<td>651-4049-00L</td>
<td>Conceptual and Quantitative Methods in Geochemistry</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>O. Bachmann, M. Schönböchler, D. Vance, M. Ellwood</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course will introduce some of the main quantitative methods available for the quantitative treatment of geochemical data, as well as the main modelling tools. Emphasis will both be on conceptual understanding of these methods as well as on their practical application, using key software packages to analyse real geochemical datasets.</td>
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<tr>
<td>Objective</td>
<td>Development of a basic knowledge and understanding of the main tools available for the quantitative analysis of geochemical data.</td>
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<tr>
<td>Content</td>
<td>The following approaches will be discussed in detail: major and trace element modelling of magmas, with application to igneous systems; methods and statistics for calculation of isochrons and model ages; reservoir dynamics and one-dimensional modelling of ocean chemistry; modelling speciation in aqueous (hydrothermal, fresh water sea water) fluids. We will discuss how these methods are applied in a range of Earth Science fields, from cosmochemistry, through mantle and crustal geochemistry, volcanology and igneous petrology, to chemical oceanography. A special emphasis will be put on dealing with geochemical problems through modeling. Where relevant, software packages will be introduced and applied to real geochemical data.</td>
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<tr>
<td>Lecture notes</td>
<td>Slides of lectures will be available.</td>
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<tr>
<td>Prerequisite / notice</td>
<td>Pre-requisite: Geochemistry (651-3400-00L), Isotope Geochemistry and Geochronology (651-3501-00L).</td>
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<tr>
<td>651-4225-00L</td>
<td>Topics in Geochemistry</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>S. Bernasconi, G. Bernasconi-Green</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course aims to present and discuss advanced topics in geochemistry based on the critical reading of research papers. Themes will vary from year to year and suggestions from students are welcome. The format of the course will be: one or more lectures introducing a theme, followed by a presentation of one or more papers by a student or group of students.</td>
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<tr>
<td>Objective</td>
<td>The goal of the course is discuss topics in advanced geochemistry which were not covered in other general and specialized geochemistry courses. In addition, we aim at training the student's ability to critically evaluate research papers and to summarize the findings concisely in an oral presentation.</td>
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<tr>
<td>Content</td>
<td>Themes will vary from year to year and suggestions from students are welcome. Some possible topics are: Organic geochemistry. Isotope geochemistry of organic matter: carbon, hydrogen and nitrogen. Multiply-substituted isotopologues. Mass-independent fractionations. Mass transfer and isotopes in modern and ancient ocean-floor hydrothermal systems and subduction zone environments. Noble gas geochemistry: terrestrial and extraterrestrial applications</td>
<td></td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>None</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literature</td>
<td>None</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>Will be identified based on the chosen topic.</td>
<td></td>
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<tr>
<td>651-4229-00L</td>
<td>Advanced Geochronology</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>A. Quadt Wykradt-Hüchtenbruck, H. Busemann, B. Ellis, M. Guillong, A. Liati</td>
</tr>
<tr>
<td>Objective</td>
<td>The purpose of this lecture is to provide a comprehensive overview of: a) the different radiometric methods in Geology, the different dating tasks and the constraints put by the complexity of natural systems, including dating by cosmogenic nuclides, b) the various analytical tools available today for radiometric dating, their advantages and disadvantages, c) the use of noble gases in Geochemistry and d) detailed description of case studies, as examples of approach of a number of geological problems and interpretation of the data.</td>
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</tbody>
</table>
The content of this lecture is summarised as follows:

**Anthi Liati:**
- Ion microprobes - U-Pb SHRIMP dating (zircon, sphene, rutile, monazite)
- Dating metamorphic rocks
- Combined geochronology and petrology subduction and exhumation rates
- Tracing the timing of mantle and crustal events via zircon-dating in mantle xenoliths: Two case studies: South Namibia, Kilbourne Hole (New Mexico)

**Giuditta Fellin:**
- Fission track dating (two hours lecture)
- U-Th/He dating
- Visit of the laboratories

**Henner Busemann:**
- Noble gas geo- and cosmochemistry
- Surface exposure dating with cosogenic nuclides
- Carbon-14 dating and U-Th-He thermochronology
- Visit of the radiogenic and noble gas isotope laboratories of IGMR

**Albrecht von Quad:**
- Analytical tools and applications to radiogenic isotopes (basics about TIMS, LA-ICP-MS-MC)
- Dating magmatic rocks and ore deposits (porphyry, epithermal Cu-Au-(Mo) deposits)
- U-Pb, Re-Os, Pb-Pb methods - HI tracing of zircons
- Geochemistry and geochemistry of magmatic systems

**Marcel Guillong:**
- LA-ICP-MS as the method of choice for dating, in comparison to other methods (Ion-probe, TIMS, ...)
- Data reduction in LA-ICP-MS: from measured counts per seconds to the final age of a sample, with hands on example.
- The challenge to date very young Zircons, with an example from Kos.

**Ben Ellis:**
- Ar-Ar dating techniques
- Ar-Ar dating of volcanic rocks

**Lecture notes**
Script (for part of the lecture), partly power point presentations (in the web) and partly copies of power point transparencies.

**Literature**

---

**651-4235-00L**  **Marine Geology and Geochemistry**  **W**  **3 credits**  **2G**  **G. Bernasconi-Green**

**Abstract**
Does not take place this semester.

**Objective**
Introduction to oceanographic methods and international research programs in marine geology and an overview of physical, chemical and biological processes in modern marine environments.

**Content**
This course aims at giving an overview of oceanographic methods and an understanding of physical, chemical and biological processes in modern marine environments. This course will combine lectures and student participation. Student presentations are based on critical reading of research papers and integration of data and results from international oceanographic programs and ocean drilling.

Specific topics will be chosen to examine processes of crustal formation, alteration, mass transfer and biological activity in mid-ocean ridge, continental margin and subduction zone settings, with consideration of data and new results obtained from international oceanographic programs and from DSDP, ODP and IODP drilling.

Student participation and discussions are based on critical reading of research papers, use of internet-based data, and web-based cruise results. Requirements to obtain credit points are oral or poster presentations and a short written summary of selected themes.

**Lecture notes**
No formal script will be distributed. Handouts will be given, where necessary. These will consist of the most important diagrams presented in the lectures. The students are expected to take their own notes and consult the literature for more details.

**Literature**
Lists of literature relevant to the selected topics will be handed out in the course.

**Prerequisites / notice**
This course is offered every 2 years.

---

**651-4057-00L**  **Climate History and Palaeoclimatology**  **W**  **3 credits**  **2G**  **G. Haug, A. Martinez-Garcia**

**Abstract**
The course "Climate history and paleoclimatology gives an overview on climate through geological time and it provides insight into methods and tools used in paleoclimate research.

The student will have an understanding of evolution of climate and its major forcing factors -orbital, atmosphere chemistry, tectonics-through geological time. He or she will understand interaction between life and climate and he or she will be familiar with the use of most common geochemical climate "proxies", he or she will be able to evaluate quality of marine and terrestrial sedimentary paleoclimate archives. The student will be able to estimate rates of changes in climate history and to recognize feedbacks between the biosphere and climate.
Content
Climate system and earth history - climate forcing factors and feedback mechanisms of the geosphere, biosphere, and hydrosphere.
Geological time, stratigraphy, geological archives, climate archives, paleoclimate proxies
Climate through geological time: "lessons from the past"
Cretaceous greenhouse climate
The Late Paleocene Thermal Maximum (PETM)
Cenozoic Cooling
Onset and Intensification of Southern Hemisphere Glaciation
Onset and Intensification of Northern Hemisphere Glaciation
Pliocene warmth
Glacial and Interglacials
Millennial-scale climate variability during glaciations
The last deglaciation(s)
The Younger Dryas
Holocene climate - climate and societies

Planetary Physics and Chemistry

<table>
<thead>
<tr>
<th>Hours</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>Introduction</td>
</tr>
<tr>
<td>3-4</td>
<td>Orbital dynamics and Tides</td>
</tr>
<tr>
<td>5-6</td>
<td>Solar heating and Energy transport</td>
</tr>
<tr>
<td>7-8</td>
<td>Planetary atmospheres</td>
</tr>
<tr>
<td>9-10</td>
<td>Planetary surfaces</td>
</tr>
<tr>
<td>11-12</td>
<td>Planetary interiors</td>
</tr>
<tr>
<td>13-14</td>
<td>Asteroids and Meteorites</td>
</tr>
<tr>
<td>15-16</td>
<td>Comets</td>
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<tr>
<td>17-18</td>
<td>Planetary rings</td>
</tr>
<tr>
<td>19-20</td>
<td>Magnetic fields and Magnetospheres</td>
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<tr>
<td>21-22</td>
<td>The Sun and Stars</td>
</tr>
<tr>
<td>23-24</td>
<td>Planetary formation</td>
</tr>
<tr>
<td>25-26</td>
<td>Exoplanets and Exobiology</td>
</tr>
<tr>
<td>27-28</td>
<td>Review</td>
</tr>
</tbody>
</table>

Lecture notes
Slides and scripts will be posted at the moodle site: https://moodle-app2.let.ethz.ch/course/view.php?id=1658

Literature
It is recommended but not mandatory to buy one of these books:
Fundamental Planetary Science, by Jack J. Lissauer & Imke de Pater (paperback), Cambridge University Press, 2013. (books.ch Fr64.90, amazon.co.uk £35.00, amazon.de €38.61, amazon.com $49.26).

Open Choice Modules
Modules from the complete offerings of the Earth Science Program

Electives
Courses can be chosen from the complete offerings of the ETH Zurich and University of Zurich (according to prior agreement with the MSc Committee).
### 651-1615-00L Colloquium Geophysics

**Abstract**

This colloquium comprises geophysical research presentations by invited leading scientists from Europe and overseas, advanced ETH Ph.D. students, new and established ETH scientists with specific new work to be shared with the institute. Topics cover the field of geophysics and related disciplines, to be delivered at the level of a well-informed M.Sc. graduate/early Ph.D. student.

**Objective**

Attendees of this colloquium obtain a broad overview over active and frontier research areas in geophysics as well as opened questions.

### 651-1851-00L Electron Microscopy in Material Science

**Objective**

Introduction in scanning electron microscopy and microanalysis. Obtain practical experience in operating a SEM.

**Content**

- Functional principles and operation modes of a scanning electron microscope. Methods and application fields for imaging (SE, BSE, FSE, AE, CL), X-ray spectroscopy (EDX), Electron diffraction (EBSD, Channeling, Orientation Imaging).
- Methods for sample preparation
- Practical exercises.

**Lecture notes / Literature**

Scripts and operation manuals are provided during the course.

**Prerequisites / notice**

Full day block course after the end of HS.

### 651-0048-00L Electron Microprobe Course

**Objective**


**Content**

- Physical principles of electron optics, interaction of electrons with matter, production of X-rays, interaction of X-rays with matter. Detection of X-rays. Laboratory work in the field of Earth sciences.

**Lecture notes / Literature**

- Kurunterlagen

**Prerequisites / notice**

7 full days.

### 327-0703-00L Electron Microscopy in Material Science

**Abstract**

A comprehensive understanding of the interaction of electrons with condensed matter and details on the instrumentation and methods designed to use these probes in the structural and chemical analysis of various materials.

**Objective**

A comprehensive understanding of the interaction of electrons with condensed matter and details on the instrumentation and methods designed to use these probes in the structural and chemical analysis of various materials.

**Content**

This course provides a general introduction into electron microscopy of organic and inorganic materials. In the first part, the basics of transmission- and scanning electron microscopy are presented. The second part includes the most important aspects of specimen preparation, imaging and image processing. In the third part, recent applications in materials science, solid state physics, structural biology, geochemistry and structural chemistry will be reported.

**Lecture notes / Literature**

- English

### 651-3541-00L Exploration and Environmental Geophysics

**Abstract**

Overview and understanding of the most important geophysical methods: Potential field methods (Gravimetrics and Magnetics), Electrical and electromagnetic methods, Refraction and reflection seismics, Georadar. Discussion of survey design, sources and receivers and data processing.

**Objective**

Overview and understanding of the most important geophysical methods. Proposed solutions to assess and observe problems relevant to exploration and environmental geophysics in soil, ice and lithosphere at different scales. Getting familiar with measuring- and interpretation procedures. Pointing out the possibilities and limitations of geophysical methods.

**Content**


**Lecture notes / Literature**

- Available through eDoz/ILIAS.
- Additional material will be provided by the lecturers.
- R. A. Wepf, F. Gramm, F. Krumeich, K. Kunze, R. A. Wegf

### 651-4086-00L Experimental Methods in Petrology

**Abstract**

Overview of the most common experimental methods employed in petrology to determine thermodynamic and physical properties and phase equilibria of minerals, mineral assemblages, magmas and fluids. The basic principals of low, moderate, high and ultrahigh pressure devices are discussed combined with an introduction into the synthesis of starting materials and the evaluation of run products.

**Prerequisites / notice**

7 full days.

**Prerequisites / notice**

Max. 8 participants (incl. PhD students and external participants).

-> Restricted attendance. Register with E. Reusser.

**Prerequisites / notice**

In the first part, the basics of transmission- and scanning electron microscopy are presented. The second part includes the most important aspects of specimen preparation, imaging and image processing. In the third part, recent applications in materials science, solid state physics, structural biology, geochemistry and structural chemistry will be reported.
FORTRAN 95 ist eine moderne Programmiersprache, die speziell für die wissenschaftliche und ingenieurtechnische Anwendung konzipiert wurde. Diese Kurslänge gibt einen Einstieg in die Programmierung mit FORTRAN95 und ist geeignet für Studenten mit minimalen Programmiererfahrungen, zum Beispiel

### Prerequisites / notice

Dieser Kurs geht an eine breite Öffentlichkeit (Master- und PhD-Studierende) an, die sich eine Einführung in die experimentellen Forschung in der Petrologie ansieht. Die Studenten werden aufgefordert, experimentelle Verfahren und Techniken zu üben, die in der Geowissenschaften eingesetzt werden. Die praktischen Arbeiten in den Laboratorien werden durchgeführt (mit Ausnahme von Übung #1) auf einer kleinen Forschungsprojekt, bei dem die verschiedenen experimentellen Techniken und Geräte demonstriert und der praktische Gebrauch geübt wird.

### Content

(1) Experimental methods at ambient pressure (1 bar) mit praktischer Übung, um die Freienergie von Wustit (FeO) zu bestimmen
(2) Experimental methods at ambient pressure (1 bar) mit praktischer Übung, um die Freienergie von Wustit (FeO) zu bestimmen
(3) Experimental methods at ambient pressure (1 bar) mit praktischer Übung, um die Freienergie von Wustit (FeO) zu bestimmen
(4) Experimental methods at ambient pressure (1 bar) mit praktischer Übung, um die Freienergie von Wustit (FeO) zu bestimmen
(5) Experimental methods at ambient pressure (1 bar) mit praktischer Übung, um die Freienergie von Wustit (FeO) zu bestimmen
(6) Experimental methods at ambient pressure (1 bar) mit praktischer Übung, um die Freienergie von Wustit (FeO) zu bestimmen
(7) Experimental methods at ambient pressure (1 bar) mit praktischer Übung, um die Freienergie von Wustit (FeO) zu bestimmen

Die praktische Arbeit in den Laboratorien wird durchgeführt (mit Ausnahme von Übung #1) auf einem kleinen Forschungsprojekt, bei dem die verschiedenen experimentellen Techniken und Geräte demonstriert und der praktische Gebrauch geübt wird.
651-1392-00L  Palaeontological Colloquium (University of Zurich)  E-  0 credits  1K  University lecturers

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: BIO571

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

Objective
Spezielle Vertiefung paläontologischer Kenntnisse.

Content
Vorträge von Institutsangehörigen und eingeladenen Gästen aus dem In- und Ausland über aktuelle Themen aus dem Gesamtgebiet der Paläontologie (Paleobotanik, Paläozoologie und Mikropaläontologie) mit anschliessender Diskussion.

651-4101-00L  Seminar in Seismology  W  3 credits  3G  M. Lüthi, G. Jouvèt, F. T. Walter

The seminar series provides an opportunity to convey the latest research results to students and staff.

Objective
Vorträge von Institutsangehörigen und eingeladenen Gästen aus dem In- und Ausland über aktuelle Themen aus dem Gesamtgebiet der Paläontologie (Paleobotanik, Paläozoologie und Mikropaläontologie) mit anschliessender Diskussion.

Content
Spezielle Vertiefung paläontologischer Kenntnisse.

Lecture notes
http://people.ee.ethz.ch/~luethim/teaching.html

651-1281-00L  Sedimentology and Palaeoceanography Seminar  W  1 credit  1S  G. Haug

Weekly seminar series on current topics in sedimentology and paleoceanography presented by invited speakers from national and international institutes, as well as from the ETH Zürich.

Objective
To disseminate advanced knowledge in the field of sedimentology and paleoceanography

Content
Invited speakers will present seminars on various topics of high research interest in the field of sedimentology and paleoceanography.

Lecture notes
none

Literature
none

651-4249-00L  Semester Paper in Palaeontology (University of Zurich)  W  3 credits  7A  University lecturers

Does not take place this semester.

Objective
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

Content
Invited speakers will present seminars on various topics of high research interest in the field of sedimentology and paleoceanography.

Lecture notes
none

Literature
none

651-0254-00L  Seminar Geochemistry and Petrology  E-  0 credits  2S  O. Bachmann, M. Schönbachler, C. A. Heinrich, M. W. Schmidt, D. Vance

Abstract
Seminar series with external and occasional internal speakers addressing current research topics. Changing programs announced via ERDW homepage (Veranstaltungskalender)

Objective
Presentations on isotope geochemistry, cosmochemistry, fluid processes, economic geology, petrology, mineralogy and experimental studies. Mostly international speakers provide students, department members and interested guests with insight into current research topics in these fields.

Content
Wöchentliches Seminar mit Fachvorträgen eingeladener oder interner Wissenschaftler, vornehmlich zu Themen der Geochemie, Isotopengeologie, Hydrothermalgeochemie, Lagerstättenbildung, Petrologie, Mineralogie und experimentelle Studien.

651-1692-00L  Seminar in Applied and Environmental Geophysics  E-  0 credits  1S  H. Maurer, J. Robertsson

651-2915-00L  Seminar in Hydrology  E-  0 credits  1S  P. Burlando, J. W. Kirchner, S. Lown, D. Or, C. Schär, M. Schirmer, S. I. Seneviratne, M. Stähli, C. H. Stamm, University lecturers

651-1694-00L  Seminar in Seismology  E-  0 credits  1S  S. Wiemer, D. Fäh, D. Giardini

Abstract
Short seminars on a variety of popular topics in Seismology. The seminars present current problems and research activities in the seismological community.

Objective
Understanding of a broad scope of current problems and state-of-the-art practice in seismology.

651-1180-00L  Research Seminar Structural Geology and Tectonics  E- Dr  0 credits  1S  N. Mancktelow, J. P. Burg, M. Frehner

Abstract
A seminar series with both invited speakers from both inside and outside the ETH.

Objective
The seminar series provides an opportunity to convey the latest research results to students and staff.

Content
Informal seminars with both internal and external speakers on current topics in Structural Geology, Tectonics and Rock Physics. The current program is available at: http://www.geology.ethz.ch/sgt/seminar/sgt_seminar.htm

651-0317-00L  Tunnelling I  W  3 credits  2G  G. Anagnostou, E. Pimentel

Abstract
Basic aspects of design and analysis of underground structures. Conventional tunnel construction methods. Auxiliary measures (ground improvement and drainage, forepoling, face reinforcement). Numerical analysis methods.

Objective
Basic aspects of design and analysis of underground structures. Conventional tunnel construction methods. Auxiliary measures (ground improvement and drainage, forepoling, face reinforcement). Numerical analysis methods.

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 541 of 1434
Numerical analysis methods in tunnelling.

Conventional excavation methods (full face, top heading and bench, side drift method, ...)

Auxiliary measures:
- Injections
- Jet grouting
- Ground freezing
- Drainage
- Forepoling
- Face reinforcement

Lecture notes

Literature

651-1091-00L Colloquium Department Earth Sciences E- Dr 0 credits 1K H. Busemann

Abstract
Invited speakers from the entire range of Earth Sciences.

Objective
Selected themes in sedimentology, tectonics, paläontology, geophysics, mineralogy, paleoclimate and engineering geology on a regional and global scale.

Content
According to variable program.

Lecture notes
No

Literature
No

651-2613-00L Humangeography III (Geographies of Difference) (Universität Zürich) W 5 credits 1G+2S University lecturers

Abstract
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
UZH Module Code: GEO232

Prerequisite: Human Geography II (UZH Module Code: GEO122)

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Objective
- Sie vertiefen ihre theoretischen, empirischen und methodischen Fähigkeiten in folgenden Themenbereichen:
  - Gesellschaft und Raum
  - Gesellschaft und Entwicklung
  - Gesellschaft und natürliche Umwelt/Ressourcen
  - Offenheit und Geschlossenheit in Wirtschaft und Gesellschaft
  - Chancen und Herausforderungen einer globalisierten Weltwirtschaft
  - Sie sind in der Lage, Verknüpfungen zwischen grundlegenden sozial- und wirtschaftswissenschaftlichen Theorien und deren Konkretisierung in der Geographie herzustellen.
  - Sie können die erwähnten Themen mit ausgewähltem Wissen verknüpfen und diskutieren
  - Sie schulen Ihre analytischen und theoretischen Fähigkeiten und können diese in Diskussionen einbringen
  - Sie können die Relevanz von weiterführenden wissenschaftlichen Texten diskutieren und mit einem Ausgangstext verknüpfen
  - Sie sind in der Lage, eine Diskussion über wissenschaftliche Themen zu strukturieren und - mit einfachen Moderationstechniken - zu moderieren

Prerequisites / notice
Besuch von GEO122.

651-2601-00L Human Geography I: One Earth - Many Worlds (University of Zurich) W 3 credits 2V University lecturers

Abstract
Imparting of research questions and basic principles in Human Geography

Objective
To get an overview about basic research questions and principles of Human Geography

Content
(1) Society and space (2) Society and development (structure and dynamic of population, urbanisation, disparities (3) Society and natural environment (natural resources; food security, sustainability)

Lecture notes
PowerPoint-slides (German)

Literature

651-4088-03L Physical Geography III (Geomorphology and Glaciology) (University of Zürich) W 5 credits 1V+1U University lecturers

Abstract
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
UZH Module Code: GEO231

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Objective
Imparting of research questions and basic principles in Human Geography

Content
(1) Society and space (2) Society and development (structure and dynamic of population, urbanisation, disparities (3) Society and natural environment (natural resources; food security, sustainability)
Das Modul bietet eine kurze Einführung in einige Komponenten und Prozesse des hydrologischen Kreislaufes. Dabei werden einzelne Wasserspeicher (Schnee-, Boden und Grundwasser) und Flüsse zwischen den Speichern (Verdunstung, Niederschlag und Abfluss) betrachtet. Übungen ergänzen die Vorlesung.

**651-4088-01L** Physical Geography I (Fundamentals and Spheres) (University of Zürich)  
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.  
UZH Module Code: GEO111

Mind the enrolment deadlines at UZH:  
http://www.uzh.ch/studies/application/mobilitaet_en.html

**651-4121-00L** Introduction to Cartography and Visualization (University of Zürich)  
Does not take place this semester.  
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH, course moved to spring semester.

UZH Module Code: GEO975

Mind the enrolment deadlines at UZH:  
http://www.uzh.ch/studies/application/mobilitaet_en.html

**651-1617-00L** Geophysical Fluid Dynamics and Numerical Modelling Seminar  
ob  0 credits  1S  P. Tackley, M. D. Ballmer, T. Gerya, D. A. May

**651-4931-00L** Heat and Mass Transfers in Magmatology  
W Dr  1 credit  1S  O. Bachmann

**651-1091-02L** Geological Colloquium  
ob  0 credits  2K  J.P. Burg, P. Nievergelt

**Compulsory Electives in Humanities, Social and Political Sciences**

Recommended GESS compulsory elective courses (Type B) for D-ERDW.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

**MSc Project Proposal**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4060-00L</td>
<td>MSc Project Proposal</td>
<td>O</td>
<td>10</td>
<td>21A</td>
<td>T. Schneider, Lecturers</td>
</tr>
</tbody>
</table>

Additional registration required in the Learning Agreement Tool on http://la.erdw.ethz.ch required.

The MSc Project Proposal is only offered in autumn semester, a registration in spring semester is subject to special approval by the study director.

All students writing the MSc Project Proposal must attend an introductory lecture on "Conduct as a Scientist" by Prof. Tapio Schneider held in autumn semester.

**Master Thesis**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-3001-AAL</td>
<td>Dynamic Earth I and II</td>
<td>E-</td>
<td>11 credits</td>
<td>24R</td>
<td>E. Kissling, M. Schönbächler</td>
</tr>
<tr>
<td>651-3341-AAL</td>
<td>Lithosphere</td>
<td>E-</td>
<td>3 credits</td>
<td>6R</td>
<td>E. Kissling, S. Wiemer</td>
</tr>
<tr>
<td>651-3070-AAL</td>
<td>Fundamentals of Geology</td>
<td>E-</td>
<td>6 credits</td>
<td>13R</td>
<td>S. Bernasconi, J.P. Burg</td>
</tr>
<tr>
<td>651-3400-AAL</td>
<td>Fundamentals of Geochemistry</td>
<td>E-</td>
<td>6 credits</td>
<td>21R</td>
<td>T. Driesner, O. Bachmann</td>
</tr>
<tr>
<td>406-0243-AAL</td>
<td>Analysis I and II</td>
<td>E-</td>
<td>14 credits</td>
<td>30R</td>
<td>M. Akveld</td>
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<tr>
<td>406-0062-AAL</td>
<td>Physics I</td>
<td>E-</td>
<td>5 credits</td>
<td>11R</td>
<td>A. Vaterlaus</td>
</tr>
</tbody>
</table>

Prerequisites / notice

Enrolment only for MSc students who need this course as additional admission requirement.

Additional registration required in the Learning Agreement Tool on http://la.erdw.ethz.ch required.
additional admission requirement.

Abstract
Introduction to the concepts and tools in physics: mechanics of point-like and rigid bodies, elasticity theory, elements of hydrostatics and hydrodynamics, periodic motion and mechanical waves.

Objective
Introduction to the scientific methodology. The student should develop his/her capability to turn physical observations into mathematical models, and to solve the latter. The student should acquire an overview over the basic concepts in mechanics.

Content

<table>
<thead>
<tr>
<th>Book</th>
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</table>

<table>
<thead>
<tr>
<th>Chapters:</th>
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<td>1, 2, 3, 4, 5, 6 (without: 6-5, 6-6, 6-8), 7, 8 (without 8-9), 9, 10 (without 10-10), 11 (without 11-7), 13 (without 13-13, 13-14), 14 (without 14-6), 15 (without 15-3, 15-5)</td>
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</table>

<table>
<thead>
<tr>
<th>Literature</th>
</tr>
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<tbody>
<tr>
<td>see &quot;Content&quot;</td>
</tr>
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</table>

Friedhelm Kuypers

Physik für Ingenieure und Naturwissenschaftler
Band 1: Mechanik und Thermodynamik
Wiley-VCH Verlag, 2002, 544 S, ca.: Fr. 68.-

---

651-3521-AAL  **Tectonics**  E-  3 credits  6R  T. Gerya, E. Kissling

Enrolment only for MSc students who need this course as additional admission requirement.

Abstract
Comprehensive understanding of role and evolution of oceanic and continental lithosphere in global plate tectonics and evolution of earth. Understanding principles of theoretical and experimental geothermics and fundamentals of mantle and lithosphere rheologies.

Objective
Comprehensive understanding of role and evolution of oceanic and continental lithosphere in global plate tectonics and evolution of earth. Understanding principles of theoretical and experimental geothermics and fundamentals of mantle and lithosphere rheologies.

Content

Lecture notes
Detailed scriptum in digital form and additional learning modules (www.lead.ethz.ch) available on intranet.

Prerequisites / notice
PPT-files of each lecture may be played back for rehearsal on www.lead.ethz.ch.

---

529-2001-AAL  **Chemistry I and II**  E-  9 credits  19R  H. Grützmacher, W. Uhlig

Enrolment only for MSc students who need this course as additional admission requirement.

Abstract
General Chemistry I and II: Chemical bond and molecular structure, chemical thermodynamics, chemical equilibrium, kinetics, acids and bases, electrochemistry.

Objective
Introduction to general and inorganic chemistry. Basics of the composition and the change of the material world. Introduction to the thermodynamically controlled physico-chemical processes. Macroscopic phenomena and their explanation through atomic and molecular properties. Using the theories to solve qualitatively and quantitatively chemical and ecologically relevant problems.

Content
1. Stoichiometry
2. Atoms and Elements (Quantenmechanical Model of the Atom)
3. Chemical Bonding
4. Thermodynamics
5. Chemical Kinetics
6. Chemical Equilibrium (Acids and Bases, Solubility Equilibria)
7. Electrochemistry

Lecture notes
Nivaldo J. Tro

Chemistry - A molecular Approach (Pearson), Chapter 1-18

Literature
Housecroft and Constable, CHEMISTRY
Oxtoby, Gillis, Nachtrieb, MODERN CHEMISTRY

---

406-0603-AAL  **Stochastics (Probability and Statistics)**  E-  4 credits  9R  M. Kalisch

Enrolment only for MSc students who need this course as additional admission requirement.

Abstract
Introduction to basic methods and fundamental concepts of statistics and probability theory for non-mathematicians. The concepts are presented on the basis of some descriptive examples. Learning the statistical program R for applying the acquired concepts will be a central theme.

Objective
The objective of this course is to build a solid fundament in probability and statistics. The student should understand some fundamental concepts and be able to apply these concepts to applications in the real world. Furthermore, the student should have a basic knowledge of the statistical programming language "R".

Content
From "Statistics for research" (online)
Ch 1: The Role of Statistics
Ch 2: Populations, Samples, and Probability Distributions
Ch 3: Binomial Distributions
Ch 6: Sampling Distribution of Averages
Ch 7: Normal Distributions
Ch 8: Student's t Distribution
Ch 8: Distributions of Two Variables

From "Introductory Statistics with R (online)"
Ch 1: Basics
Ch 2: The R Environment
Ch 3: Probability and distributions
Ch 4: Descriptive statistics and tables
Ch 5: One- and two-sample tests
Ch 6: Regression and correlation
**Literature**

- "Statistics for research" by S. Dowdy et. al. (3rd edition); Print ISBN: 9780471267355; Online ISBN: 9780471477433; DOI: 10.1002/0471477435
  
  From within the ETH, this book is freely available online under: http://onlinelibrary.wiley.com/book/10.1002/0471477435

  
  From within the ETH, this book is freely available online under: http://www.springerlink.com/content/m17578/

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<tr>
<th>Earth Sciences Master - Key for Type</th>
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<td>O</td>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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<tr>
<td>W</td>
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<td>Eligible for credits</td>
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<td>Z</td>
<td>Courses outside the curriculum</td>
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<td></td>
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<td>Suitable for doctorate</td>
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<td>V</td>
<td>lecture</td>
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<td>colloquium</td>
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<td>independent project</td>
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<td>A</td>
<td>diploma thesis</td>
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<td>D</td>
<td>revision course / private study</td>
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<td>R</td>
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**Special students and auditors need special permission from the lecturers.**
This course looks into scientific theories and also empirical
Folien werden zur Verfügung gestellt.
After successfully completing the module, students should be in a position:
Lecturers
L. Schalk
2G
Current Research on MINT Learning
1K
Support and Diagnosis of Knowledge Acquisition
This colloquium focusses on the presentation of research projects conducted by the professorships participating in the competence center
Human Learning (EW1)
E. Stern
P. Greutmann, E. Hafen,
A. Togni, A. Vaterlaus
"Human Learning (EW1)". This lecture is only apt for students who intend to enrol in the programs "Lehrdiplom" or "Didaktisches Zertifikat". It is about learning in childhood and adolescence.
Current Research on MINT Learning
W 1 credit
ECTS
3S
L. Schalk, S. Hofer
12 credits
36A
E. Hafen, J. Egli, W.D. Hardt, M. Zwicky
Specialised Biology Course with an Educational Focus: Teaching Diploma
Specialised Courses in the Respective Subject with an Educational Focus in Biology for Teaching Diploma.
In this seminar students learn advanced techniques to support and to diagnose knowledge acquisition processes in school.
The main goals are:
(1) You have a deep understanding about the cognitive mechanisms of knowledge acquisition.
(2) You have a basic understanding about psychological test theory and can appropriately administer tests.
(3) You know various techniques of formative assessment and can apply these to uncover students' misconceptions.
Für eine reibungslose Semesterplanung wird um persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.
Specialised Biology Course with an Educational Focus: Teaching Diploma
Specialised Courses in the Respective Subject with an Educational Focus in Biology for Teaching Diploma.
After successfully completing the module, students should be in a position:
- to call up more in-depth specialist knowledge of biology, covering a wide range of topics, and to impart this to others.
- to explain biological concepts and principles, as well as the way they fit together.
- to analyse controversial topics and to give factual explanations for these.
- to conduct more in-depth work on a research topic and to compile a tuition unit based on this topic
- to prepare tuition units involving complex learning matter at a high specialist level which are suitably tailored to the recipients, and to teach these in a manner conducive to learning.

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 547 of 1434
Content

Demanding biological topics are dealt with under consideration of the special needs of persons involved in teaching. The module comprises the parts:

1) Lecture (Tues. 08.00-09.45 hrs)
2) Colloquium (every second Tues. 10.15-12.00 hrs., begins on first lecture day)
3) Seminar with presentation (every second Tues. 10.15-12.00 hrs., begins in second lecture week)
4) Semester thesis in a research group (7 weeks)

Lecture notes

Unterlagen für den Unterricht werden online mit Hilfe der e-learning Platform OLAT abgegeben.

Literature

Lektüren und Literaturhinweise werden mit der e-learning Platform OLAT abgegeben.

Prerequisites / notice

This course lasts for two semesters. It can be started in autumn or in spring. Booking is only required once.

Performance Assessment:

Performance is assessed during the course of the entire modul, with a final test. Active participation in the colloquia and group seminars is required. The thesis report and an oral presentation have to be completed.

The Specialized Biology Course with an Educational Focus (12 CP) can be acknowledged, in agreement with the advisor of the respective elective major, as one of the two obligatory research projects (each 15 CP). In such a case, additional 3 CP must be obtained in another course.

In case of overbooking of the course, students enrolled in the Teaching Diploma in Biology will have priority for registration.

The course is organized jointly with the University of Zurich (Fachbereich Biologie) and is held at the Life Science Zurich Learning Center of the ETH Zurich and the University of Zurich.

551-0963-02L

Specialized Biology Course with an Educational Focus II: Teaching Diploma

Specialised Courses in the Respective Subject with an Educational Focus in Biology ONLY for students upgrading TC to Teaching Diploma.

Abstract

Specialized aspects of biology are dealt with under the viewpoint of their presentation, their historical development, their significance for the field, the individual and society.

Objective

The goal is to promote the ability to understand biological concepts, principles and their interrelationships and to communicate specialist knowledge to various groups of recipients in an understandable manner.

Content

Demanding biological topics are dealt with under consideration of the special needs of persons involved in teaching. The module:

1) Lecture (Tues. 08.00-09.45 hrs)
2) Colloquium (every second Tues. 10.15-12.00 hrs., begins on first lecture day)
3) Seminar with presentation (every second Tues. 10.15-12.00 hrs., begins in second lecture week)
4) Semester thesis in a research group (3.5 weeks)

Lecture notes

None.

Literature

Specific references will be made available for the individual projects.

Prerequisites / notice

The program of this course represents one half (6 CP) of that of the Specialized Biology Course with an Educational Focus (551-0963-00, 12 CP).

Subject Didactics

Number  Title  Type  ECTS  Hours  Lecturers
551-0913-00L  Professional Exercises in Biology  W  2 credits  2U  P. Faller

Abstract

Students conduct a series of "classical" biological school experiments and therefore gain practice and experience in this area.

Objective

Implementation of Subject Didactics I and II with the focus on conducting biological experiments in schools. This includes finding, testing and further developing suitable protocols for different subject areas of school biology. Working out how to didactically embed the experiments in lessons. Students can perform, off the cuff, 12 school experiments (which they have tested themselves), from the different subject areas, and conduct these correctly in technical terms. They can incorporate these experiments in their tuition in a didactically meaningful manner.

Comments:

By contrast to the Subject Specialisation 1 and 2 course units, these are "basic tests" and do not involve the implementation of current research topics. The students' compilations are available in a data archive.

Content

2. Die Studierenden führen alle ausgearbeiteten Experimente selber durch.

Lecture notes

Hand out of course material.

Prerequisites / notice

Der Teil biologische Experimente findet im Rahmen von 7 Halbtagen statt.

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 548 of 1434
Among other things, students are put in a position where they can comprehend the topics that are to be taught in a wider and, to some extent, unconventional context and critically assess pupils’ prior knowledge, clarify it in greater detail and take it into account for planning lessons.

- divide up the subject matter into contents that can be learned by heart or accessed intellectually, and communicate these contents.
- establish which subject matter can be presented with which teaching techniques and methods that have been recognised as efficient in teaching terms, and adapt these tools to the learning content in question.
- reliably identify stumbling blocks in the contents and get round these.
- plan school experiments, incorporate them in lessons, perform them in accordance with all the rules of the art, and also evaluate them in a beneficial manner.

### Subject Didactics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0950-00L</td>
<td>Subject Didactics Chemistry I</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>A. Baertsch</td>
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<td></td>
<td>Simultaneous enrolment in Introductory Internship Chemistry - course 529-0968-00L - is compulsory.</td>
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</tbody>
</table>

Abstract

Implementing findings from research into teaching and learning for chemistry lessons and coverage of subject-specific teaching and learning specialties.

Objective

Among other things, students are put in a position where they can:

- design a sequential curriculum suitable for the levels in question and put it into practice.
- reliably identify stumbling blocks in the contents and get round these.
- establish which subject matter can be presented with which teaching techniques and methods that have been recognised as efficient in teaching terms, and adapt these tools to the learning content in question.
- assess pupils’ prior knowledge, clarify it in greater detail and take it into account for planning lessons.
- break down technically complex contents to the right level for a class and still present these in a stringent, error-free manner in their simplified form.
- Wechselwirkungen zwischen Beobachtungen in der realen Welt und Deutungsversuchen auf der Modell-Ebene
- Sprache und Fachsprache im Chemieunterricht
- Modellbegriff in der Naturwissenschaften, insbesondere der Chemie
- Auswahl gymnasiumsrelevanter Lerninhalte
- Modellbegriff in der Naturwissenschaften, insbesondere der Chemie
- Sprache und Fachsprache im Chemieunterricht
- Wechselwirkungen zwischen Beobachtungen in der realen Welt und Deutungsversuchen auf der Modell-Ebene
- Interdisziplinarität mit Biologie, Mathematik und Physik
- Leistungserhebung und -beurteilung im Theorie- und Laborunterricht
- Atommodelle und chemische Bindung
- Mathematische Beschreibung chemischer Systeme (z.B. Stöchiometrie und Gleichgewichtssysteme)
- Experimenten

**Lecturer Note:** U. Wuthier: Chemie unterrichten. Eine Didaktik für Höhere Schulen.
Prerequisites / notice

Anhand der Diskussion ausgearbeiteter und bewährter Beispiele, aber auch durch selbständiges Probieren und mit Hilfe selbst zu erstellender kleiner Unterrichtsbausteine soll die zukünftige Lehrkraft befähigt werden, einen den spezifischen Rahmenbedingungen angepassten eigenen Unterricht zu konzipieren und durchzuführen, der diesem hohen Qualitätsanspruch genügen kann.

402-0091-00L  Teaching science in Higher Education  W 2 credits  1V  G. Schiltz

Abstract
This course imparts fundamental didactic concepts that are relevant to teaching science in a Higher Education context.

Objective
Students are able to characterize and to discuss the model of outcomes based education. Students are able to transfer the basic concepts of this model (ILO, TLA, assessment, constructive alignment) to science education.

Lecture notes
keines

Literature

(bitte das Buch in der Auflage von 2011 vor dem ersten Treffen erwerben!)

Physical Direction

Specialised Courses

Introductory Courses

Spec. Courses in Respective Subject with Educational Focus

Number  Title  Type  ECTS  Hours  Lecturers
402-0737-00L  Energy and Environment in the 21st Century (Part I)  W  6 credits  2V+1U  M. Dittmar

Abstract
The energy and related environmental problems, the physics principles of using energy and the various real and hypothetical options are discussed from a physicist point of view. The lecture is intended for students of all ages with an interest in a rational approach to the energy problem of the 21st century.

Objective
Scientists and espially physicists are often confronted with questions related to the problems of energy and the environment. The lecture tries to address the physical principles of todays and tomorrow energy use and the resulting global consequences for the world climate.

Content
Introduction: energy types, energy carriers, energy density and energy usage. How much energy does a human needs/uses?

Energy conservation and the first and second law of thermodynamics

Fossil fuels (our stored energy resources) and their use.

Burning fossil fuels and the physics of the greenhouse effect.

Physics basics of nuclear fission and fusion energy

Controlled nuclear fission energy today, the different types of nuclear power plants, uranium requirements and resources, natural and artificial radioactivity and the related waste problems from the nuclear fuel cycle.

Nuclear reactor accidents and the consequences, a comparison with risks from other energy using methods.

The problems with nuclear fusion and the ITER project.

Nuclear fusion and fission: "exotic" ideas.

Hydrogen as an energy carrier: ideas and limits of a hydrogen economy.

New clean renewable energy sources and their physical limits (wind, solar, geothermal etc)

Energy perspectives for the next 100 years and some final remarks

Lecture notes
many more details (in english and german) here:

http://ihp-lx2.ethz.ch/energy21/

Literature

Environmental Physics: Boeker and Egbert New York Wiley 1999
Prerequisites / notice

Science promised us truth, or at least a knowledge of such relations as our intelligence can seize: it never promised us peace or happiness.
Gustave Le Bon

Physicists learned to realize that whether they like a theory or they don't like a theory is not the essential question. Rather, it's whether or not the theory gives predictions that agree with experiment.
Richard Feynman, 1985

402-0944-00L

Science in School (Current Topics for the Classroom)
Enrolment in Physics Didactics I (402-0910-00L) and Physics Didactics II (402-0910-00L) is mandatory.

Content
Kennenlernen und erarbeiten (Übungen) von Unterrichtssequenzen zu modernen Themen der Physik.

Lecture notes
Wird angegeben.

Literature

Subject Didactics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>402-0910-00L</td>
<td>Physics Didactics I: Special Didactics of Physics Teaching</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>M. Mohr</td>
</tr>
</tbody>
</table>

Further information is available from the lecturer via email: mamohr@ethz.ch

Simultaneous enrolment in Introductory Internship Physics - course 402-0920-00L - is compulsory for Teaching Diploma Physic

Objective


Content
Thematische Schwerpunkte
Fachspezifisches: Sachstrukturen der gängigen Unterrichtsthemen, Alltagsbezüge, Fehlvorstellungen, Demonstrations- und Schülerexperimente, Arbeitsmittel zu physikalischen Themen des Grundlagen- und Schwerpunktunterrichts
Einsatz verschiedener Unterrichtsmaterialien: Experimente, Computer, Taschenrechner, Video, Simulation Unterrichtsformen: Lernaufgabe, Werkstatt, Puzzle, Projekt, Gruppenarbeit, Praktikum Lernformen
Interaktive Lehr-Lernveranstaltung mit Vorträgen und Demonstrationen des Dozenten, studentischer Einzel- und Kleingruppenarbeit, kurzen Präsentationen der Studierenden, Vertiefung der Inhalte durch Bearbeitung von Aufträgen ausserhalb der Kontaktstunden

Lecture notes
Folien und weitere Unterlagen werden zur Verfügung gestellt
Prerequisites / notice
Die Veranstaltung ist zusammen mit dem Einführungspraktikum zu belegen

402-0091-00L

Teaching science in Higher Education

Abstract
This course imparts fundamental didactic concepts that are relevant to teaching science in a Higher Education context.

Objective
Students are able to characterize and to discuss the model of outcomes based education. Students are able to transfer the basic concepts of this model (ILO, TLA, assessment, constructive alignment) to science education.

Literature

(bitte das Buch in der Auflage von 2011 vor dem ersten Treffen erwerben!)

Science Education Master - Key for Type

<table>
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<tr>
<th>Type</th>
<th>ECTS</th>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
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<tr>
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<td>Eligible for credits</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
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Key for Hours

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<thead>
<tr>
<th>V</th>
<th>lecture</th>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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</table>

P practical/laboratory course
A independent project
D diploma thesis
R revision course / private study

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### General Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<td>851-0587-00L</td>
<td>CIS Colloquium</td>
<td>Z Dr</td>
<td>2 credits</td>
<td>2K</td>
<td>L.E. Cederman, M. Steenbergen</td>
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<tr>
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<tr>
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<td>Center for Comparative and International Studies, CIS.</td>
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<td>Abstract: In this seminar staff members of the Center for Comparative</td>
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<td>and International Studies (CIS) and external guests present and</td>
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<td>discuss their research.</td>
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<td>Comparative and International Studies (CIS) and external guests</td>
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<td>present and discuss their research.</td>
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<td>Content: Presentation and discussion of current research.</td>
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<tr>
<td>851-0551-00L</td>
<td>Colloquium for Master and Ph.D. Students</td>
<td>Z Dr</td>
<td>2 credits</td>
<td>1K</td>
<td>D. Gugerli</td>
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<td>Abstract: Colloquium for master and doctoral students preparing a</td>
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<td>thesis in the history of technology.</td>
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<td>methodological problems that emerge while elaborating a master or</td>
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<td>doctoral thesis.</td>
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<tr>
<td>851-0158-02L</td>
<td>Collective Constructivism. Philosophy and Sociology of Science in the</td>
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<td>2S</td>
<td>H. von Sass</td>
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<td></td>
<td>Abstract: In his seminal monograph &quot;The Structure of Scientific</td>
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<td></td>
<td>Revolutions&quot; Thomas Kuhn referred to an author who anticipated some</td>
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<td>of his groundbreaking ideas. That was, however, an understatement:</td>
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<td></td>
<td>Ludwik Fleck (1896-1961), a doctor, microbiologist and bacteriologist,</td>
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<td>forgotten for a long time, defended a collective constructivism,</td>
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<td>sociologically informed.</td>
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<td>Objective: The seminar aims into introducing the work of Ludwik</td>
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<td>Fleck with special regard to the philosophy of science. It gives also</td>
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<td>the opportunity to deal with basic problems of the subject of the</td>
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<td>philosophy of science in general, but also of the sociology and</td>
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<td>parts of the history of science - and all this by well accessible</td>
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<td>and well written texts.</td>
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<tr>
<td>851-0158-03L</td>
<td>Scientific Research Between Anomaly and Orthodoxy</td>
<td>Z</td>
<td>2 credits</td>
<td>1S</td>
<td>H. W. Atmanspacher</td>
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<td>Abstract: Scientific research takes place in the field of tension</td>
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<td>between established (coherent) knowledge and not understood, not</td>
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<td>integrated fragments: between orthodoxy and anomaly. We will work</td>
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<td>out a topography of anomalies based on their potential of being</td>
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<td>connected with the accepted body of knowledge and discuss</td>
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<td>examples from particular scientific disciplines.</td>
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<td>Objective: This seminar attempts to generate awareness that</td>
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<td>scientific work is most interesting at the frontier between</td>
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<td>established knowledge and</td>
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<td></td>
<td>unknown territory -- between the understood and the non- or not-yet</td>
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<td></td>
<td>understood. We will collect examples of historical anomalies in</td>
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<td></td>
<td>science and develop a systematic classification for them. Then we</td>
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<td>will look at anomalies in contemporary science and try to assess</td>
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<td>them according to the topography developed. Students will be</td>
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<td>requested to assess particular issues with anomalies in working</td>
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<td>papers up to 6 pages.</td>
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<td>Anomalies are the salt in the soup of science. Sometimes they can</td>
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<td>turn into knowledge when they are understood, but this may require</td>
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<td>a long way of hard work.</td>
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<tr>
<td>851-0158-04L</td>
<td>Economization and Commercialization in Science</td>
<td>Z</td>
<td>1 credit</td>
<td>2S</td>
<td>G. Folkers, H. von Sass</td>
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<td>Objective: The entrepreneurial university is a reality. *In this</td>
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<td>sense, the entrepreneurial university must maximize profit,</td>
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<td>countable, in the capture of research funds, recruiting distinguished</td>
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<td>scientists, the number of applicants for a study place and,</td>
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<td>ultimately, as controversial as they may be, the placement</td>
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<td>in rankings.* (Richard Münch 2003)</td>
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<tr>
<td>851-0158-05L</td>
<td>Relations between Descriptive Levels in Science: Reduction or</td>
<td>W</td>
<td>2 credits</td>
<td>1S</td>
<td>H. W. Atmanspacher</td>
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<td>Emergence?</td>
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<td>Number of participants limited to 20</td>
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<td>Objective: Reduction and emergence are relations between different</td>
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<td>levels of descriptions of a system, its states and properties, or</td>
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<td>their dynamical behavior. Their general characteristics and</td>
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<td>differences will be introduced and discussed for selected examples</td>
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<td>in particular scientific disciplines. The representation of such</td>
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<td>interlevel relations in the pertinent literature will be critically</td>
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<td>assessed.</td>
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<td>1. Students will be introduced to different approaches to conceive</td>
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<td>interlevel relations in individual sciences.</td>
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<td>2. They will be guided to identify and compare their basic</td>
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<td>structure, in order to locate commonalities and differences.</td>
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<td>3. Specific examples will be used to show how the basic structure</td>
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<td>is realized.</td>
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<td>4. The discussion of (some of) these examples in the philosophy of</td>
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<td>science will be studied and critically assessed.</td>
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<td>5. Essays (up to 6 pages) by the students will be required so that</td>
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<td>they learn how to combine in-depth disciplinary insights with</td>
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<td>an interdisciplinary outlook concerning structural determinants of</td>
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<td>research in general.</td>
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<tr>
<td>851-0300-99L</td>
<td>Science Fiction in Theory and Practice (University of Zurich)</td>
<td>W</td>
<td>6 credits</td>
<td>2S</td>
<td>P. Theisohn</td>
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<td>Objective: Following Bourdieu's argument, Science Fiction is not to</td>
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<td>be understood as &quot;Para-Literature&quot;, but as a type of literature</td>
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<td>with its own poetics. Science Fiction is not to be understood as the</td>
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<td>precise and get familiar with its programmatic outlines as well as</td>
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<td>its crucial debates. We are going to read authors such as Darko</td>
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<td>Suvin, Stanislav Lem, Dietmar Dath and Reinhard Jirgl.</td>
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<td>Literature: Mind the enrolment deadlines at  UZH:</td>
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<td><a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
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Data: 06.02.2019 13:00
Autumn Semester 2015
Page 552 of 1434
### Military Studies

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>853-0037-01L</td>
<td>Military Psychology and Pedagogy I (without Exercises)</td>
<td>Z</td>
<td>3 credits</td>
<td>2V</td>
<td>H. Annen</td>
</tr>
<tr>
<td>853-0063-00L</td>
<td>Military History I (with Exercises)</td>
<td>Z</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>M. Olsansky</td>
</tr>
<tr>
<td>853-0082-00L</td>
<td>Strategic Studies I</td>
<td>Z</td>
<td>3 credits</td>
<td>2V</td>
<td>M. Mantovani</td>
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<tr>
<td>853-0102-00L</td>
<td>Military Business Administration II - Case Examples</td>
<td>Z</td>
<td>3 credits</td>
<td>2V</td>
<td>M. Keupp</td>
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</table>

#### Abstract
- Examine the fundamentals of the two sciences and establish links with military life. Discuss various schools of thought in psychology and focus on content and process theories of motivation. Explore characteristics of pedagogical thinking and discuss the values of military education with reference to the young adult serving in the armed forces.

#### Objective
- Becoming acquainted with basic psychological views of human behaviour and experience
- Knowing content- and process theories of motivation and being able to transfer them to the military context
- Knowing the possibilities and limitations of military education and deriving consequences

#### Content
- History of military psychology
- Psychological images of humanity (psychoanalysis, behaviourism, behavioural biology, humanistic psychology, cognitivism)
- Motivational theories
- Defence-, service-, operational- and combat motivation
- Swiss military pedagogy
- Education as defining feature of pedagogic thinking and acting

#### Literature
- Stadtmann, J.: Führung unter Belastung, Huber, Frauenfeld 1998 (provided as pdf)

The lecture is supported by a virtual learning environment containing relevant documents (presentations and texts) and information to further literature.

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<tr>
<td>853-0037-01L</td>
<td>Military Psychology and Pedagogy I (without Exercises)</td>
<td>Z</td>
<td>3 credits</td>
<td>2V</td>
<td>H. Annen</td>
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#### Abstract
- The participants know the classical conceptions of strategy and war theory from antiquity to the present against their specific background.

#### Literature

The lecture is structured along the lines of the concept of "Military Revolution" and starts with the formation of modern, European armed forces after the Oranian Army reform in the 17th century. Based on the "Military Revolution" approach, the lecture examines the structural changes regarding the armed forces and the development of warfare from the 18th to the 20th century. Special emphasis will be put on how the battlefield was revolutionized due to the Napoleonic wars, the industrialization in the 19th century, the First World War, the mechanization and totalization during the Second World War and the period of the Cold War.

#### Literature
- Stadelmann, J.: Führung unter Belastung, Huber, Frauenfeld 1998 (provided as pdf)

#### Lecture notes
A textbook with primary sources and a list of further reading are available with the lecturer or electronically on the MILAK website (Lehre und Forschung/Dozentur/Vorlesungsunterlagen). Slides are being distributed.

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<tr>
<td>853-0037-01L</td>
<td>Military Psychology and Pedagogy I (without Exercises)</td>
<td>Z</td>
<td>3 credits</td>
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The elective course Military Business Administration II builds on the mandatory course Military Business Administration I and adds to it. It deals with in-depth case studies from international security and economic policy with a special emphasis on the economic and practical relevance of these issues for the Swiss Armed Forces.

#### Objective
- Students who are intrinsically interested in business-related issues will be provided with a big picture that transcends the micro view of business administration. Students learn how to integrate security and resource-related issues into a global economic analysis and how to derive relevant consequences, particularly economic ones, for Switzerland.
The program of the course is organized into 14 units of 90 minutes each. The units combine the elements of lecture (where analytical concepts are taught) and application (where these concepts are applied). Additionally, guest lecturers will hold talks on selected issues.

- Global resource positions and world trade: Implications for the Swiss Armed Forces I
- Global resource positions and world trade: Implications for the Swiss Armed Forces II
- Economic causes of military instability
- Aggressive emerging economies: Economic growth and rearmament
- The process of an arms deal
- Costs and financing of a military conflict
- Economic analysis of terrorism
- Economic analysis of cyberwar
- Economic analysis of the present GSOA initiative: Compulsory military service vs. voluntary militia
- Global arms production and international arms trade
- The privatization of military security
- Standardisation and interoperability: Does NATO membership increase Swiss military efficiency
- Swiss economic autarchy - madness or option?

Lecture notes
As this course has been completely redesigned and is being offered for the first time in the fall semester of 2013, a script is not yet available. However, the lecturer will distribute all necessary course material in time and directly to the students, either in the classroom or by uploading files to a public server.

Literature
The Lecturer will distribute all necessary literature directly to the students by disseminating pdf files or citing links to online references.

Prerequisites / notice
Exam "Military Business Administration I" passed successfully or profound basic knowledge of business administration and economics. The course is open to external participants.

853-0064-00L
Military Sociology I
Z
3 credits
2V
T. Szwircsev Tresch

Abstract
Beside of the most important terms of sociology, demographic changes and the related value and structure change will be analysed. The second part focuses on organizational sociology. Thirdly, the course examines to which extent armed forces can be considered as organizations like any other and to which extent they constitute a special case from an organizational and normative point of view.

Objective
Recognize and explain current changes (social change) in modern society (individualisation, pluralisation); describe demographic changes in Switzerland; explain the structures of societies; define issues and fields of research in modern military sociology and explain the foundations of organisational sociology; explain the military in terms of organisational sociology and identify specific traits of the military as an organisation.

Content
Societal change; organizations as societal phenomena; aims, structures, environments of organizations; specifics of the military as an organization; impacts of technological and societal changes on the armed forces in modern societies.

Literature
A reader with a set of texts will be handed out.

Specialized Continuing Education
Special internal ETH courses offered by LET and the Teaching Specialists.

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<tr>
<td>999-9999-99L</td>
<td>EduApp Course</td>
<td>E-</td>
<td>0 credits</td>
<td>1V+1U</td>
<td>G. Schiltz</td>
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This course unit is not a genuine ETH course unit. It is used by LET and the Teaching Specialists for EduApp demonstration purposes.

Humanities, Social and Political Sciences (General Courses) - Key for Type

| O       | Compulsory   | E-    | Recommended, not eligible for credits |
| W+      | Eligible for credits and recommended | Z    | Courses outside the curriculum |
| W       | Eligible for credits | Dr   | Suitable for doctorate |

Key for Hours

| V       | lecture      | P    | practical/laboratory course |
| G       | lecture with exercise | A    | independent project |
| U       | exercise     | D    | diploma thesis |
| S       | seminar      | R    | revision course / private study |
| K       | colloquium   |      |                             |

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
The course offers a historical introduction to modern economic thought. It looks at texts of 'classical economics' as well as 'neo-classical', 'modern', and 'post-Keynesian' economic thought - and their potential for the enrichment of mainstream economic thought. The seminar deals with the history of technology since the 1960s. The course wants to develop the students ability to critically read and assess historic texts. A detailed program and course materials will be made available during the semester on www.tg.ethz.ch.

**History**

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<tr>
<td>851-0549-12L</td>
<td>Sharing. The History of an Attractive Technology</td>
<td>W</td>
<td>3 credits</td>
<td>2S</td>
<td>D. Gugerli</td>
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<tr>
<td>851-0101-46L</td>
<td>Introduction in the History of Economic Thought</td>
<td>W</td>
<td>3 credits</td>
<td>2S</td>
<td>D. Gugerli</td>
</tr>
<tr>
<td>851-0549-00L</td>
<td>Science in the Twentieth Century: A Global Perspective WEBCLASS</td>
<td>W</td>
<td>3 credits</td>
<td>2S</td>
<td>V. Bharadwaj, B. Schär</td>
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<tr>
<td>851-0535-10L</td>
<td>Yemen: A Failed State?</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>E. Manea</td>
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**Yemen: A Failed State?**

1. Examine the concept of failed state within the International relations literature.
2. Take a closer look at Yemen(s) political history(ies), its/their political and social structures, and power dynamics.
3. Introduce the concept of the 'cunning state' and its exploitation of the discourse of failed state.
This seminar looks at the concept of failed states and how useful it can be in describing the situation in a country like Yemen. It will also take a closer look at Yemen(s) political history(ies) and its/their political and social structures. Students are expected to write a paper and make a presentation.

853-0725-00L History Part One: Europe

**W** 3 credits 2V M. Mühlheim

**Abstract**
Using concrete regional examples, this lecture offers a survey and analysis of the crucial historical transformations that engendered "modernity" in Europe from the late 18th to the mid 20th centuries.

**Objective**
At the end of this lecture course, students can: (a) highlight the most important changes in the "long nineteenth century" in Europe (b) explain their long-term effects; and (c) relate these changes to global developments.

**Content**
The thematic foci include: the economic and social consequences of the industrial revolution, the genesis of political ideologies and social movements, shifts in gender roles, colonialism and imperialism, as well as the emergence of consumerism and a "leisure society."

**Lecture notes**
Power Point Slides and handouts will be made available at https://ilias-app2.let.ethz.ch/goto.php?target=crs_85655&client_id=ilias_lda in the course of the semester.

**Literature**
Mandatory and further reading will be made available at https://ilias-app2.let.ethz.ch/goto.php?target=crs_85655&client_id=ilias_lda.


051-0363-00L History of Urban Design I

**W** 2 credits 2G V. Magnago Lampugnani

**Abstract**
The lecture covers the time from the beginning of urban culture until the mid 19th century. With selected examples it emphasizes on the historical plantings and methods of European cities. Each specific urban development will be presented within a broader context.

**Objective**
This course analyzes the history of urban architecture primarily in its existing three dimensional form as a complex human artefact. It also explores the inspirations that prompted the creation of this artefact: philosophical and religious concepts, social conditions, property relationships and the mechanisms that exploit the economics of real estate and the influence of building technology. Intellectual, literary or artistic modes of thought will also be assessed with regard to their impact on urban development. Urbanism has its own distinctive approach as a discipline, but it is also clearly responsive to the influence of related disciplines. Study is made of actual cities and urban expansion plans which are in the process of implementation, as well as unrealized projects and visions of the future. These projects sometimes illustrate ways of thinking that are equal to, or clearer than, actual urban situations.

**Content**
In the first semester an introduction to the discipline and the methods are given along the thematic issues from the beginning of urban culture until the mid-19th century.

01. Introduction to the discipline and method: The history of urban design as a historical project

02. Athens and Rome in the ancient world: Myth, self-portrayal and speculation

03. From the spirit of equality to the colonial module: Greek and Roman City foundings

04. From the urban ideal to new cities in the cities of the Middle Ages and the Renaissance

05. Baroque strategies: The new organisation of Rome under Sixtus V, the production of Versailles under Louis XIV and the invention of St. Petersburg

06. The city between Absolutism and Enlightenment: baroque defence-designs, the European colonization of the American continent and the reconstruction of Lisbon

07. Ideology and speculation after the Glorious Revolution: landscapegardens and urban figurations in England from 1650-1850

08. Between modernization, Grandeur and repression: Embellishment in Paris from 1750-1830

09. The construction of the bourgeois city: Georges-Eugène Haussmann transforms Paris into the capital of the 19th century

10. Architectural insertion and plan for the expansion of the city: From the Berlin of Karl Friedrich Schinkel to James Hobrecht

11. Neoabsolute power, bourgeois self-confidence and Marxian Idealism: The Viennese Ringstrasse and Idefonso Cerdas Ensanche for Barcelona

**Lecture notes**
The lectures are accompanied by a script (two semesters of the bachelor studies), that can be purchased at the chair for the history of urban design (HIL D 75.2) at the price of CHF 30.-. The script serves as an auxiliary means to the attended lecture compiling the most important illustrations showed and the names and dates of the buildings and its builders along with a short introductory note.

**Literature**
Further recommended literature to consult is listed within the script.

051-0331-00L History of Art and Architecture I

**W** 4 credits 4G L. Schmitt, U. Schulte-Umberg

**Abstract**
The lecture conveys historical knowledge about architecture and art as well as methodical knowledge as a preparation for the independent handling of historical sources and scientific literature. The main focus will be laid on the architecture of the Greco-Roman antiquity, the Middle Ages, the Renaissance and the era between Baroque, Enlightenment, and Modernity.

**Objective**
Acqurement of basic knowledge of the history of art and architecture, resp. of methodical basic knowledge of historical working.

**Content**
The history of art and architecture is part of our reality: it confronts us in the historically shaped environment of the city and plays an essential role in the creation of architecture. The historical lectures are therefore part of the fundamental courses of the undergraduate programme in architecture. On the basis of cultural and art-historical research the courses impart knowledge about architecture and art from ancient times to the present. At the same time they sharpen the perception for the conditions and capabilities of building activity in history. Moreover, they convey methodical knowledge and technical language skills and are meant as a preparation for the independent handling of historical sources and scientific literature.

The first one-year course aims at these goals in the form of exemplary epoch representations which through light upon the historical continuities. The main focus will be laid on the architecture of the Greco-Roman antiquity, the Middle Ages, the Renaissance and the era between Baroque, Enlightenment, and Modernity.

**Lecture notes**
3 Skripte sind auf der Professur, HIL C 70.5-8, erhältlich:
- Architektur der Klassischen Antike, Fr. 15.-
- Renaissance und Barock, Fr. 15.-
- Aufklärung bis Moderne, Fr. 15.-

**Prerequisites / notice**
Zu beziehen am Dienstag und Donnerstag

The course can not be taken by Master students of the D-ARCH, who have already completed it within the Bachelor programme.

051-0311-00L History of Art and Architecture III

**W** 3 credits 2V L. Stalder

**Abstract**
The course analyzes the history of urban architecture primarily in its existing three dimensional form as a complex human artefact. It also explores the inspirations that prompted the creation of this artefact: philosophical and religious concepts, social conditions, property relationships and the mechanisms that exploit the economics of real estate and the influence of building technology. Intellectual, literary or artistic modes of thought will also be assessed with regard to their impact on urban development. Urbanism has its own distinctive approach as a discipline, but it is also clearly responsive to the influence of related disciplines. Study is made of actual cities and urban expansion plans which are in the process of implementation, as well as unrealized projects and visions of the future. These projects sometimes illustrate ways of thinking that are equal to, or clearer than, actual urban situations.
The two-semester course offers an introduction to the history and theory of architecture from the industrial revolution up to now. Based on current questions a variety of case studies will be discussed.

The aim is to give an overview on crucial events, works of art, buildings and theories since the beginning of the 19th century up to today. The course should enhance the comprehension of historical and theoretical issues, and allow the students to localize their own practice within a broader historical context.

The subject of this lecture course is the history and theory of architecture since the beginning of the 19th century up to now. It examines the architectural answers to the changing technical inventions and social practices. Consequently, the focus will be less on individual architects or buildings than on various themes that determined the architecture of the period.

The two-semester course offers an introduction to the history and theory of architecture from the industrial revolution up to now. Based on current questions a variety of case studies will be discussed. The aim is to give an overview on crucial events, works of art, buildings and theories since the beginning of the 19th century up to today. The course should enhance the comprehension of historical and theoretical issues, and allow the students to localize their own practice within a broader historical context. The subject of this lecture course is the history and theory of architecture since the beginning of the 19th century up to now. It examines the architectural answers to the changing technical inventions and social practices. Consequently, the focus will be less on individual architects or buildings than on various themes that determined the architecture of the period.

2S

S. S. Leuenberger

http://www.stalder.arch.ethz.ch/courses

2S

Environmental History - Introduction and Overview

W 2 credits

D. Speich Chassé

Number of participants limited to 100.

Our society faces a serious ecological crisis. Of what historical dimension is this crisis? How have human societies already in earlier times changed their environment, and, consequently, perhaps also ours? What were the main ecological challenges for societies and how did they change over time? And how did societies adapt to changing environmental conditions?

Introduction into environmental history; survey of long-term development of human-nature-interrelations; discussion of selected problems.

Improved ability to assess current problems from a historical perspective and to critically interrogate one's own standpoint.

Course material is provided on OLAT.


Uekötter, Frank (Ed.) 2010. The turning points of environmental history, Pittsburgh: University of Pittsburgh Press.


Prerequisites / notice

Students are asked to write an exam during the second last session (11.12.2015).

Literature

Andreas B. Kilcher (Hrsg.); Metzler Lexikon der deutsch-jüdischen Literatur. 2., aktualisierte und erweiterte Auflage, Stuttgart 2012.

851-0300-95L

Writing Between Cultures. German-Jewish Literature and Cultural Knowledge 1822-1933

W 3 credits

A. Kilcher

Abstract

German-Jewish literature, which includes famous modern authors from Heine to Kafka, is remarkable because it is a cultural double. This lecture course shows the at once productive and problematical, transcultural relationship of its history. The key question is how, in this relationship, cultural knowledge is discussed in theoretical, political and literary terms.

Objective

Overview on the history of German-Jewish literature in Germany and Austria between ca. 1822 and 1933

- Discussion of key text of the most important German-Jewish authors (such as Heine, Börne, Herzl, Kafka, Döblin, Kraus, Roth, Wolfskehl, Lasker-Schüler)
- Analysis of theoretical and cultural reflections in German-Jewish literature, art and culture
- Answer to the general question: how cultural knowledge was theorized and discussed in (Jewish) modernity

Content


Literature

Andreas B. Kilcher (Hrsg.); Metzler Lexikon der deutsch-jüdischen Literatur. 2., aktualisierte und erweiterte Auflage, Stuttgart 2012.

851-0300-92L

German Art & Literary Magazine, Edited by Herwarth

W 3 credits

S. S. Leuenberger

German Art & Literary Magazine, Edited by Herwarth

Abstract

Based on the contributions published between 1910 and 1932 in "Der Sturm", the seminar gives an overview on the unique diversity of literary and cultural movements in Berlin between the turn of the century and the Weimar Republic. Besides the reading of literary texts, the lecture focuses on the aesthetic, philosophical and political discourses of the epoch.

Objective

The students will get to know the literature and the art of an epoch during which a specific large town culture emerged in Berlin. This lecture course shows the at once productive and problematical, transcultural relationship of its history. The key question is how, in this relationship, cultural knowledge is discussed in theoretical, political and literary terms.

Content

Knowledge of Diversity in the Work of Oskar Panizza

Students are asked with different relations between literature and technology. They can verbalise and analyse central contentions.


851-0300-05L

Literature and Technology - Simulations, Prototypes, Machines

W 3 credits

J. Reidy

Does not take place this semester.

Particularly suitable for students of D-ITET, D-MAVT, D-MATL

Abstract

Literature about technology transposes models, products and procedures of scientific progress into the logic of poetry. This literature converts not only technology into fiction, but it also creates new cultural and social contextualisations, which reveal alternative readings of configurations of knowledge.

Objective

Students are familiar with different relations between literature and technology. They can verbalise and analyse central contentions.

Content

"Materialmöränen": Thomas Mann's Zauberberg from the Point of View of the History of Knowledge

Number of participants limited to 20.

Abstract

This seminar is dedicated to Thomas Mann's "Zauberberg", the great Bildungsroman and "Zeitroman" (Mann) from the author's middle period. Mann himself feared that the novel might be intellectually overburdened with contexts and concepts. The seminar will attempt to elucidate these contexts from the point of view of the history of ideas and knowledge and will take into account current research.

Objective

- Students familiarize themselves with one of the great novels of the 20th century in the context of a diligent reading accompanied by the lecturer.
- On the basis of the primary text, the seminar establishes several perspectives grounded in cultural history, the history of knowledge and ideas, economic and social history and the history of medicine.

851-0325-01L

Censorship, Caricature and System Criticism: Knowledge of Diversity in the Work of Oskar Panizza

W 3 credits

Does not take place this semester.

Number of participants limited to 10.

Abstract

"Materialmöränen": Thomas Mann's Zauberberg, the great Bildungsroman and "Zeitroman" (Mann) from the author's middle period. Mann himself feared that the novel might be intellectually overburdened with contexts and concepts. The seminar will attempt to elucidate these contexts from the point of view of the history of ideas and knowledge and will take into account current research.

Objective

- Students familiarize themselves with one of the great novels of the 20th century in the context of a diligent reading accompanied by the lecturer.
- On the basis of the primary text, the seminar establishes several perspectives grounded in cultural history, the history of knowledge and ideas, economic and social history and the history of medicine.
Number of participants limited to 25.

Abstract
The seminar is dedicated to the texts of scandal author Oskar Panizza. Especially the dogmas and beliefs of the Christian churches caused in this perception the grievances in society. Other the subject regimented categories such as ethnicity and gender are denounced by Panizza and discussed in his writings in many ways.

Objective
- Acquiring cultural scientific aspects and perspectives of literature and literary history:alterity, ethnicity, gender constructions, social differences, religion, etc.
- Critical analysis of recent research positions and research questions
- Training problem oriented circumvention of literature and its social functions in historical contexts
- Developing genre typological and narratological foundations
- Independent balancing researching and writing of one's ideas

Content

851-0300-94L
Combinatorics: History of a Method Between Mathematics and Literature
Particularly suitable for students of D-MATH

Abstract
Combinatorics is a procedure shared by various disciplines. In mathematics it concerns the calculation of quantas and probabilities, in philosophy the creation of encyclopedic experience, in literature, finally, experimental writing. This course investigates these different forms of combinatorics.

Objective
- comparative understanding of combinatorics as a transcultural and transdisciplinary procedure to generate knowledge
- cultural and epistemic history of combinatorics since the medieval ages
- combinatorics in theology, mysticism and occultism
- combinatorics in philosophy and the natural sciences
- combinatorics in literature and literary theory

Content
Kombinatorik, die Verknüpfung von Elementen, tritt als ein Verfahren in unterschiedlichen Disziplinen und Bereichen des Wissens auf: In der Mathematik, wo man sie zuerst vermutet, ermöglicht sie die Berechnung von Anzahlen und Wahrscheinlichkeiten. Zugleich spielt die Kombinatorik auch eine grosse Rolle in der Philosophie (als ein Verfahren zur Erzeugung eines enzyklopädischen Wissens), in der Mystik (zur Erlangung ekstatischer Erfahrung) und in der Literatur (als ein experimentelles Schreibverfahren). In dem Seminar werden these vielfältigen Formen und Funktionen von kombinatorischen Verfahren zwischen mathematischer, philosophischer, mystischer und ästhetischer Anwendung verglichen und analysiert.

851-0300-96L
Literature and Photography

Abstract
The course focuses on writers (such as Henry James, Virginia Woolf, Margaret Atwood, Arthur Miller, Charles Dickens, George Elliot and Oscar Wilde) who by approaching the technique of photography i.e. its optical and chemical procedures have discovered novel modes and methods of representation.

Objective
The course introduces students to what an interdisciplinary approach to literature implies. Students are familiar with the main techniques of photography and relate these to the literary discourse of specifically the 20th century.

851-0300-97L
Return of Religions, 'Religious turn', Postsecularity: On the Contemporary Prominence of Religions

Abstract
Facing the recent return of religion in the public sphere, we discuss concepts of the relation of religion and modernity: the classical theories of secularization and the actual discussion of the post-secular, anthropology of religion, political theology, psychoanalytic and postcolonial theories of religion.

Objective
The students get familiar with different theories of religion and of the relation of religion and modernity in particular. They discuss the conceptual and epistemological implications of these theories and understand the problems of determining religion, especially under modern conditions. They reflect on the differences and even conflicts between different approaches and face their respective ideas about modernity. The course thus also aims to deepen the self understanding of our modern standpoint in relation both to one's own religious identity and history and to the religion of 'Others'.

851-0300-98L
History and/or "Rigorous" Science?

Abstract
The difference between the natural sciences and the humanities is often characterized in terms of their relation to history: here rigorous method & transculturality, there historically conditioned, and hence relative, understanding. But the discrepancy between transhistorical immanence and historical constitution figures also within both disciplines. We will discuss precisely this discrepancy.

Objective
- reflect on the ideal of scientific rigor, as well as the historical constitution of all knowledge;
- question the paradigm of historicity with regard to both the natural sciences and the humanities;
- critical reading of theoretical and literary texts that deal with the tension between scientificity and historicity.

Content

Literature

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More informations will follow in the lecture.

**Recommended Reading:** Zadie Smith: White Teeth; Emile Zola: The Experimental Novel

In this course we shall analyze and apply conditions and criteria for literary writing on the basis of our own texts.

When we write a literary text we also enter into a set-up for experiments and explore the possibilities ensuing from the specific structure and consistency of such a text. Literary writing allows us to go over to another kind of knowledge. Thus, the question: what is it that I want to write about? is replaced by: what do I write?

Content

- **Prerequisites:** Those wishing to participate are required to send in between two and three pages text of their own writing that will be discussed in class.

- **Prerequisites / notice:** Die Teilnehmerzahl ist begrenzt. SCHRIFTLICHE ANMELDUNG erforderlich (bis 31. August): uwe.justus.wenzel@nzz.ch

- **ECTS:** 2V

- **Type:** Study TABLE

- **Lecturers:** C. Hölscher, H.D. Daniel, A. Brand-Kilcher, A. Diekmann, D. Helbing, R. O. Murphy, V. Schinzari, R. Schubert, C. Stadtfeld, E. Stern
Content

This colloquium offers an opportunity for students to discuss their ongoing research and scientific ideas in the behavioral sciences, both at the micro- and macro-levels of cognitive, behavioral and social science. It also offers an opportunity for students from other disciplines to discuss their ideas in so far as they have some relation to behavioral science. The possible research areas are wide and may include theoretical as well as empirical approaches in Social Psychology and Research on Higher Education, Sociology, Modelling and Simulation in Sociology, Decision Theory and Behavioral Game Theory, Economics, Research on Learning and Instruction, Cognitive Psychology and Cognitive Science. Ideally the students (from Bachelor, Master, Ph.D. and Post-Doc programs) have started to start work on their thesis or on any other term paper.

Course credit can be obtained either based on a talk in the colloquium plus a written essay, or by writing an essay about a topic related to one of the other talks in the course. Students interested in giving a talk should contact the course organizers (Schinazi, Hoelscher) before the first session of the semester. Priority will be given to advanced / doctoral students for oral presentations. The course credits will be obtained by a written report of approximately 10 pages. The colloquium also serves as a venue for invited talks by researchers from other universities and institutions related to behavioral and social sciences.

851-0609-05L The Economics of Climate Change W 3 credits 2V

Abstract

Climate change is one of the most pressing issues that governments and the global community have to face. This course outlines the problem of climate change and discusses the economic solutions (both domestic and international) to this problem.

Objective

This course has a number of objectives: (i) To outline the problem of climate change (ii) to discuss and compare the theoretical economic solutions to combating climate change (iii) to present existing climate change mitigation actions in an economic context and (iv) to outline possible future climate policy issues.

Content

Economics of pollution, Optimal level of greenhouse gases, International Environmental Agreements, Tradable pollution permit markets, Carbon Taxes, Technological innovation and R&D, The optimal approach to control Climate change, The future of Climate change policy

Literature

Required reading: Perman et al. (2003), Natural Resource and Environmental Economics, Pearson Addison Wesley.

Also, Journal articles will be cited

Prerequisites / notice

Prerequisites: The course relies heavily on the concepts and techniques used in basic game theory. Therefore prior knowledge is recommended

851-0626-01L International Aid and Development W 2 credits 2V I. Günther

Abstract

Does not take place this semester.

Prerequisites: Basic knowledge of economics

Objective

The course gives economic and empirical foundations for a sound understanding of the instruments, prospects and limitations of international development aid.

Content

Introduction to the Determinants of Underdevelopment; History of Aid; Aid and Development: Theories and Empirics; Aid, Politics and Trade

Literature

Articles and book abstracts will be uploaded to a course website.

151-0757-00L Environmental Management W 2 credits 2G R. Züst

Abstract

An environmental management system has the objective to continuously improve the environmental performance of the activities, products and services of a company. The company has to introduce different management processes. The goal of this lecture is to provide basics and specific procedure to implement the environmental dimension in the planning and decision making processes of an organisation.

Objective

Overview on environmental management and environmental management systems, general methods and principles.

Content

Introduction to environmental management / environmental management systems; energy and material flows; economical and ecological problems in industry; characterisation of an enterprise (incl. management handbook); structur and contents of an environmental management system; overview on the ISO 14001 ff. series; methods for environmental evaluation and assessment; integrated management systems; planning methodology and life-cycle-design design; planning exampl.

Lecture notes

Information about environmental management and environmental management systems will be provided by a CD or mail.

Literature

A list with literatures and links will be provided

Prerequisites / notice

Delivery of a case study, worked out in groups. Language: Teaching in English on request.

860-0006-00L Statistical Data Analysis W 3 credits 3G M. Höglinger, I. Günther, K. Harttgen

Abstract

Number of participants limited to 20.

This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with statistical software such as Stata.

Objective

Students

- have a sound understanding of linear and logit regression
- know some basics about regression models for multinomial, ordered, or censored response variables, as well as for count data
- know strategies to test causal hypotheses using regression analysis with experimental and quasi-experimental methods
- are able to formulate and implement a regression model for a particular research question and a particular type of data
- are able to critically interpret results of a regression model, in particular, regarding causal inference

Content

The topics covered in the first part of the course are linear and logit regression analysis. Extensions to regression models for ordered, multinomial or censored response variables, as well as for count data will be addressed briefly. The second part of the course focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, propensity score matching, and randomized controlled trials.

The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs. Students will be enabled to critically read and assess published empirical social science studies.

Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover topics at the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of one fourth. Students are assisted in solving the assignments during the exercises session. Support is provided for the analysis software Stata, but students are free to choose R, SPSS or any other software to solve the assignments.

363-1027-00L Introduction to Health Economics and Policy W 3 credits 2V W. Mimra

Abstract

Health expenditures constitute about 10% of GDP in OECD countries. Extensive government intervention is a typical feature in health markets. Risk factors to health have been changing with growing importance of lifestyle factors such as smoking, obesity and lack of physical activity. This course gives an introduction to the economic concepts and empirical findings in health economics.
## Principles of Microeconomics

**Objective**
Introduce students without prior economics background to the main concepts of health economics and policy to enhance students understanding of how health care institutions and markets function.

**Content**
The course gives an introduction to the economic concepts and empirical findings in health economics to enhance students understanding of how health care institutions and markets function. First, the three important decisions made by individuals will be analyzed: What determines the health behaviors, like the intensity of preventive measures like sport, that an individual undertakes? What types and amount of personal health care services does an individual demand? How much health insurance coverage will be purchased?

In a second part, the major participants on the supply side of health care markets - physicians, hospitals, nurses and pharmaceutical manufacturers - will be discussed. E.g., how important are financial incentives in the choice of medicine as a career, specialty choice and practice location? What does it mean and imply that a physician is an agent for a patient? How do pharmaceutical firms decide on investments in new products and how can public policy encourage pharmaceutical innovation?

The choices made by societies about how health care services are financed and about the types of organizations that supply health care will be addressed in a third part. One important choice is whether a country will rely on public financing of personal health care services or encourage private health insurance markets. How could and should a public health insurance system be designed? What health care services should be included or excluded from a public system? Another important choice is whether a society relies on government provision of health care services, private provision by not-for-profit or for-profit organizations or some combination. The advantages and disadvantages of the alternatives will be discussed to provide a framework for analyzing specific types of health care systems.

**Literature**

### Literature

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tr>
<td>363-0387-00L</td>
<td>Corporate Sustainability</td>
<td>W</td>
<td>3</td>
<td>V. Hoffmann</td>
</tr>
<tr>
<td>363-0503-00L</td>
<td>Principles of Microeconomics</td>
<td>W</td>
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<td>M. Filippini</td>
</tr>
<tr>
<td>363-0561-00L</td>
<td>Financial Market Risks</td>
<td>W</td>
<td>3</td>
<td>D. Sornette</td>
</tr>
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</table>

### Abstract
- **Corporate Sustainability**
  We introduce the concept of corporate sustainability; discuss its implications focusing on strategy, technology, and financial markets; and offer e-modules to train relevant critical thinking skills. With this input, students explore the practical challenges of corporate sustainability in a group project, focusing on one of the four sustainability challenges of water, energy, mobility, and food.

- **Principles of Microeconomics**
  The course introduces basic principles, problems and approaches of microeconomics.

- **Financial Market Risks**
  I aim to introduce students to the concepts and tools of modern finance and to make them understand the limits of these tools, and the many problems met by the theory in practice. I will put this course in the context of the on-going financial crises in the US, Europe, Japan and China, which provide fantastic opportunities to make the students question the status quo and develop novel solutions.

### Content
- **Objective**
  Understand the limits and the potential of corporate sustainability for sustainable development.

- **Content**
  Develop critical thinking skills that are useful for corporate sustainability (argumentation, communication, evaluative judgment).

- **Lecture notes**
  Presentation slides will be distributed prior to lectures.

- **Literature**
  Literature recommendations will be distributed during the lecture.

- **Correlation**
  Complementary:

- **Autumn Semester 2015**
### Content

1. The Financial Crises: what is really happening? Historical perspective and what can be expected in the next decade(s). Bubbles and crashes. The illusion of the perpetual money machine.

2. Risks in financial markets
   - What is risk?
   - Measuring risks of financial assets
   - Introduction to three different concepts of probability
   - History of financial markets, diversification, market risks

3. Introduction to financial risks and its management.
   - Relationship between risk and return
   - Portfolio theory: the concept of diversification and optimal allocation
   - How to price assets: the Capital Asset Pricing Model
   - How to price assets: the Arbitrage Pricing Theory, the factor models and beyond

4. Financial markets: role and efficiency
   - What is an efficient market?
   - Financial markets as valuation engines: exogeneity versus endogeneity (reflexivity)
   - Deviations from efficiency, puzzles and anomalies in the financial markets
   - Financial bubbles, crashes, systemic instabilities

5. An introduction to Options and derivatives
   - Calls, Puts and Shares and other derivatives
   - Financial alchemy with options (options are building blocks of any possible cash flow)
   - Determination of option value; concept of risk hedging

6. Valuation and using options
   - A first simple option valuation model
   - The Binomial method for valuing options
   - The Black-Scholes model and formula
   - Practical examples and implementation
   - Realized prices deviate from these theories: volatility smile and real option trading
   - How to imperfectly hedge with real markets?

7. Real options
   - The value of follow-on investment opportunities
   - The timing option
   - The abandonment option
   - Flexible production
   - Conceptual aspects and extensions

8. Government bonds and their valuation
   - Relationship between bonds and interest rates
   - Real and nominal rates of interest
   - Term structure and Yields to maturity
   - Explaining the term structure
   - Different models of the term structure

9. Managing international risks
   - The foreign exchange market
   - Relationship between exchange rates and interest rates, inflation, and other economic variables
   - Hedging currency risks
   - Currency speculation
   - Exchange risk and international investment decisions

### Lecture notes

Lecture slides will be available on the site of the lecture

### Literature

- Corporate finance
- Brealey / Myers / Allen
- Eight edition

- + additional paper reading provided during the lectures

### Prerequisites / notice

- Development Economics II is a follow-up of "Development economics I".
- The objectives of this course are to: understand the role of agriculture in the development process; learn about the relevant actors, the small-scale farmers, and how to integrate them into economic development and to be able to derive sound policy measures.

The main topic is the role of agriculture and in the development process. The main features of this sector will be presented. In many developing countries that are at the beginning of economic development the largest share of the population is often involved in agriculture. In agriculture the production factor land is more important than in other sectors. Agriculture together with fisheries is the only sector that produces food. Food can either be produced locally or imported.

Farmers, even small-scale farmers, are integrated in the monetary world. Trade is very important for growth, food security and environment conservation.

The following topics will be tackled: role of agriculture in economic development, definition of sustainability, role of the various stakeholders in the agricultural sector.

- PPT and selected articles. A monograph is also distributed.


- Prerequisite: Attendance of introductory micro- and macroeconomics classes. Development economics I & II are one unit.


World Food Economy and Agricultural Markets

Abstract
Following microeconomic courses we teach in this course economic aspects of the world food situation and the international and national agricultural markets. It contains aspects of supply, demand, price determination, market structures and instruments of the agricultural trade.

Objective
Economic understanding of agricultural markets and the aspects of the world food problem.

Content
Part I: Principles of agricultural economics
Microeconomic analysis of supply, demand, and price determination in agricultural markets.

Part II: Aspects of globalization, development, natural resources and public health.

Part III: Analysis of selected agricultural and commodity markets: grains, oilseeds, sugar, ethanol and crude oil, milk and meat.

Lecture notes
Handouts (power point presentations)

Literature
Southgate. D. et al., 2010. The World Food Economy, Blackwell Publishing, Malden MA,USA

351-0555-00L

Open- and User Innovation

Abstract
The course introduces the students to the long-standing tradition of actively involving users of technology and other knowledge-intensive products in the development and production process, and through own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies.

Objective
The course includes both lectures and exercises alternately. The goal is to understand the opportunity of user innovation for management and develop strategies to harness the value of user-developed ideas and contributions for firms and other organizations.

The students actively participate in discussions during the lectures and contribute presentations of case studies during the exercises. The combination should allow to compare theory with practical cases from various industries.

The course presents and builds upon recent research and challenges the students to devise innovation strategies that take into account the availability of user expertise, free and public knowledge, and the interaction with communities that span beyond one organization.

Grading is based on the final exam, the class presentations (including the slides) as well as class participation.

Content
This course on user innovation extends courses on knowledge management and innovation as well as marketing. The students are introduced to the long-standing tradition of actively involving users of technology and other knowledge-intensive products in the development and production process, and through own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies. Theoretical underpinnings taught in the course include models of innovation, the structuration of technology, and an introduction to entrepreneurship.

Lecture notes
The slides of the lectures are made available and updated continuously through the SMI website:

Literature
Relevant literature for the exam includes the slides and the reading assignments. The corresponding papers are either available from the author online or distributed during class.

Reading assignments: please consult the SMI website:

351-0778-00L

Discovering Management

Abstract
Discovering Management offers an introduction to the field of business management and entrepreneurship for engineers and natural scientists. The module provides an overview of the principles of management, teaches knowledge about management that is highly complementary to the students' technical knowledge, and provides a basis for advancing the knowledge of the various subjects offered at D-MTEC.

Objective
Discovering Management offers an integrated learning system, which combines in an innovate format a set of lectures, an advanced business game simulation and a set of group exercises involving industry speakers (ranging from leading venture capitalists to executives at established corporations). Unlike more traditional courses, the learning model for Discovering Management involves 'learning by doing'.

While the 13 different lectures, in-class discussions and assigned readings provide the theoretical and conceptual foundations, the experiential learning outcomes result from the interrelated group activities: 1) the interactive case studies and exercises, 2) the business game simulation.

By discovering the key aspects of entrepreneurial management, the purpose of the course is to advance students' understanding of factors driving company success, where success is understood as a broad construct including financial return, employee, customer and supplier satisfaction as well as social and ecological responsibility.

Discovering Management is designed to suit the needs and expectations of Bachelor students at all levels as well as Master and PhD students not belonging to D-MTEC. By providing an overview of Entrepreneurial Management, this course is an ideal enrichment of the standard curriculum at ETH Zurich. No prior knowledge of business or economics is required to successfully complete this course.

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Politics of Environmental Problem Solving in Developing Countries

Abstract
The course focuses on processes and drivers of decision-making on natural resources management issues in developing countries. It gives insights into the relevance of ecological aspects in developing countries. It covers concepts, instruments, processes and actors in environmental politics at the example of specific environmental challenges of global importance.

Objective
After completion of the module, the student will be able to:
- Identify and appraise ecological aspects in development cooperation, development policies and developing countries’ realities
- Analyze the forces, components and processes, which influence the design, the implementation and the outcome of ecological measures
- Characterize concepts, instruments and drivers of environmental politics and understand, how policies are shaped, both at national level and in multilateral negotiations
- Study changes (improvements) in environmental politics over time as the result of the interaction of processes and actors, including international development organizations
- Analyze politics and design approaches to influence them, looking among others at governance, social organization, legal issues and institutions

Content
Key issues and basic concepts related to environmental politics are introduced. Then the course predominantly builds on case studies, providing information on the context, specifying problems and potentials, describing processes, illustrating the change management, discussing experiences and outcomes, successes and failures. The analysis of the cases elucidates factors for success and pitfalls in terms of processes, key elements and intervention strategies.

Different cases not only deal with different environmental problems, but also focus on different levels and degrees of formality. This ranges from local interventions with resource user groups as key stakeholders, to country level policies, to multi- and international initiatives and conventions. Linkages and interaction of the different system levels are highlighted. Special emphasis is given to natural resources management.

The cases address the following issues:
- Land use and soil fertility enhancement: From degradation to sustainable use
- Common property resource management (forest and pasture): Collective action and property rights, community-based management
- Ecosystem health (integrated pest management, soil and water conservation)
- Payment for environmental services: Successes in natural resources management
- Climate change and agriculture: Adaptation and mitigation possibilities
- Biodiversity Convention: Implications for conservations and access to genetic resources
- Biodiversity as a means for more secure livelihoods: Agroforestry and intercropping
- The Millennium Development Goals: Interactions between poverty and the environment
- Poverty and natural resources management: Poverty reduction strategies, the view of the poor themselves
- Food security: Policies, causes for insecurity, the role of land grabbing
- Biofuels and food security: Did politics misfire?

Lecture notes
Information concerning the case studies and specific issues illustrated therein will be provided during the course (uploaded on Moodle).

Literature

Prerequisites / notice
The performance assessment will consist of an individual essay to be written by each student based on at least five references in addition to the sources provided in the course. Students can choose from a list of topics. Criteria for assessment will be communicated at the beginning of the course.

Environmental Policy of Switzerland I

Abstract
This course presents the basics of policy analysis and the specific characteristics of Swiss environmental policy. Political instruments, actors and processes are addressed both theoretically as well as by means of current Swiss environmental policy examples.

Objective
Beyond acquiring basic knowledge about policy analysis, this course teaches students how to analytically address current and concrete questions of environmental policy. Through exercises the students learn about political science concepts and frameworks as well as real-life political decision-making processes. The well-grounded examination of complex political conflict situations is an important precondition for the entry into the environmental policy workforce or a future research career.

Content
The processes of change, overuse or destruction of the natural environment through humans have historically placed high demands on social and political institutions. In the interplay between the environment, society and economy, the environmental policy field encompasses the sum of public measures that have the goal to eliminate, reduce or avoid environmental degradation. The course provides insight into the development of Swiss environmental policy and systematically presents the basics of environmental policy actors, instruments, programs and processes as well as their change over time. A key aspect is the distinction between politics and political science and specifically environmental policy.

Lecture notes
Instead of lecture notes different texts on policy analysis and Swiss environmental policy are made available to the students.

Literature

Prerequisites / notice
The detailed semester program (syllabus) is made available to the students at the beginning of the semester.

Principles of Economics

Abstract
This course covers the basics for understanding micro- and macroeconomic issues and theories. Participants are given the tools to argue in economic and political terms and to evaluate the corresponding measures. Group and individual exercises deepen the knowledge gained.
Position | Description
--- | ---
Objective | Students are able to
- describe fundamental micro- and macroeconomic issues and theories.
- apply suitable economic arguments to a given theme.
- evaluate economic measures.

Content | Supply and demand behaviour of firm and households; market equilibrium and taxation; national income and indicators; inflation; unemployment; growth; macroeconomic policies

Lecture notes | available on electronic platform


ECTS | Conference of Disarmament: Simulation of
Negotiations

Number | 701-0985-00L
Title | Social Intercourse with Current Environmental Risks

Abstract | The lecture treats the social intercourse with risks of technical systems. The notion of risk and the perception of risk are discussed by case studies (e.g. nanotechnology) and socio-political instruments for decision-making are presented. Methods are presented that can be applied to deal with environmental risks and how they can be used for sustainable innovation.

Objective | - Getting acquainted to the extended risk concept
- Evaluation of the risks caused by technology within the societal context
- Knowledge about the mode science and society handle current environmental risks (examples gene- and nanotechnology)
- Knowledge about handling risks (e.g. precautionary principle, protection goal, damage definition, ethics)

Content | Knowledge about possibilities for sustainable innovation
- Risks and technical systems (risk categories, risk perception, risk management)
- Illustration with case studies (nanotechnology)
- Implementation (politics, science, media, etc.)
- Decision making (technology assessment, cost/benefit analysis etc.)
- The role of the media
- prospects for future developments

Lecture notes | Copies of slides and selected documents will be distributed

Prerequisites / notice | The lecture is held biweekly (for 2 hours). The dates are 21.9., 28.9 (attention, out of schedule); 19.10; 21.11; 16.11; 30.11; 14.12

Number | 363-1050-00L
Title | Conference of Disarmament: Simulation of Negotiations

Abstract | The Global Studies Institute (University of Geneva) is organizing a simulation seminar on nuclear disarmament in collaboration with the Chair of Negotiation and Conflict Management (ETH), experts from the United Nations Institute for Disarmament Research and the Geneva Center for Security Policy.

Objective | Students will have the possibility to participate in simulated diplomatic negotiations and to analyse and assess the negotiation logic behind the situations. They should gain insight in the basic information on disarmament issues and on the functioning of the Conference on Disarmament as well as on negotiation techniques in general.

Content | The simulation project is intended for Master's or Doctoral students of the Global Studies Institute (GSI) of the University of Geneva, of the ETH and for interested students of the Geneva Centre for Security Policy (GCSP). The simulation will be in French and English and is conducted by Prof. Calmy-Rey, former President of Switzerland.

In the lectures, students will be provided with basic information on disarmament issues and on the functioning of the Conference on Disarmament as well as on negotiation techniques in general. Students will take the role of negotiators in the simulation (including the heads of the delegations); of keeper of the minutes or of observers and analysts.

Students will co-develop their mandates for the negotiation and be assisted by experts that are specialized in international negotiations as well as in the topic of disarmament. The negotiation tables will be chaired by former diplomats. Representatives of diplomatic missions in Geneva will play the role of the "Capitals" to which the heads of delegations will have to give account of the ongoing negotiations.

More details on the program, timetable, reading lists and performance assessment will be published here: https://chamilo.unige.ch/home/courses/M165/?id_session=0

The simulation will take place on the 26 and 27 November 2015 at the University of Geneva.

Languages: English and French

Dates/Time/Location (GE = University of Geneva)

22 Sept. | ETH HG D 22 | 10:15-12:00 | Introduction
29 Sept. | GE Uni Mail Salle 1170 | 10:15-12:00 | Introduction to Negotiation Techniques (Dr. Vitalij Butenko and Dr. Sibylle Zürcher, ETH)
6 Oct. | ETH HG D 16.2 | 10:15-12:00 | Distribution of the roles, composition of the negotiation tables, preparation of mandates for the HA (humanitarian approach)
13 Oct. | ETH HG D 22 | 10:15-12:00 | Preparation of the mandates for the FMCT (Fissile Material Cut-off Treaty)
20 Oct. | GE Uni Mail Salle 1170 | 10:15-12:00 | No session; Students deepen and summarize their mandates on one page (A4)
27 Oct. | GE Uni Mail Salle 1170 | 10:15-12:00 | Discussion of the Mandates I (FMCT)
10 Nov. | GE Uni Mail Salle 1170 | 10:15-12:00 | Discussion of the Mandates II (HA)
17 Nov. | GE Uni Mail Salle 1170 | 10:15-12:00 | Preparation Meeting
26 & 27 Nov. | GE Salles 407 et 408 | 10:00-18:00 | Simulation at Uni Dufour
1 Dec. | GE Uni Mail Salle 1170 | 10:15-12:00 | Discussion of the results

Note: The participation in the simulation on 26. and 27. November in Geneva is necessary. The two hours lectures on the 22. September, 6. and 13. October have to be attended in Zürich via conference call (ETH HG D 16.2). The other lectures during the semester can be attended via Skype.

To get the 3 ECTS, students have to participate at the 2 days simulation in Geneva, attend the 3 mandatory lecture parts via conference call an Zürich and write a report of 5 pages at the end of the course.

(Philosophy)
<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>Semester</th>
<th>Lecturer(s)</th>
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<tbody>
<tr>
<td>851-0125-53L</td>
<td>What is Knowledge?</td>
<td>W</td>
<td>3</td>
<td>2G</td>
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<td>The seminar aims at a clarification of the concept of knowledge, as</td>
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<td>L. Wingert</td>
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<td>it is built in our experiential relations to the world. An analysis</td>
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<td>is needed of the difference between knowledge and belief, of the</td>
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<td>relation between objectivity and knowledge, and of the role of</td>
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<td>reasons for having knowledge. Additionally, the legitimacy of</td>
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<td>different types of knowledge claims should be evaluated.</td>
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<td>851-0125-03L</td>
<td>Research Colloquium for PhD Students and Members of Staff</td>
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<td>Open for Master students on personal invitation.</td>
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<td>L. Wingert, M. Hampe</td>
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<td>Ph.D. students and members of staff report on their research.</td>
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<td>851-0125-18L</td>
<td>Self-Ownership - Philosophical and Juridical Perspectives</td>
<td>W</td>
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<tr>
<td></td>
<td>Rights in Objects are founded by an inalienable Self-Ownership. These</td>
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<td>B. Hilmer</td>
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<td>Idea ist central for personal rights. We speak of my body, my</td>
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<td>genes, my name, my portrait, my ideas oder ways of expression.</td>
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<td>851-0125-41L</td>
<td>Introduction Into Philosophy of Technology</td>
<td>W</td>
<td>3</td>
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<td></td>
<td>Particularly suitable for students of D-ITET, D-MATL, D-MAVT</td>
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<td>O. Müller</td>
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<td>Since antiquity philosophy reflects about and evaluates technology.</td>
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<td>The technical developments in the 19th and 20th century have led to</td>
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<td>an autonomous philosophy of technology, which had become important</td>
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<td>also for other philosophical disciplines (e.g. in Heidegger’s</td>
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<td>philosophy).</td>
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<tr>
<td>851-0125-48L</td>
<td>Wisdom, Certainty, Insecurity</td>
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<td>Wisdom is widely - maybe even universally, at all times and</td>
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<td>N. El Kassar</td>
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<td>everywhere - regarded as one of the highest virtues. But what</td>
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<td>constitutes wisdom? Is wisdom compatible with uncertainty? Does a</td>
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<td>wise person have to be certain or can she be uncertain? These and the</td>
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<td>related questions will be discussed in the seminar to gain an</td>
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<td>understanding of what wisdom, certainty and uncertainty are.</td>
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<td>1. Analysis and discussion of different interpretations of the</td>
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<td>virtue &quot;wisdom&quot;.</td>
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<td>3. Discussion of the questions what constitutes wisdom today and</td>
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<td>whether wisdom is a goal of the good life.</td>
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<td>4. Examination of the relevance of wisdom in practical and</td>
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<td>theoretical contexts.</td>
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<td>851-0125-51L</td>
<td>Man and Machine</td>
<td>W</td>
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<td>2G</td>
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<td>Particularly suitable for students of D-CHAB, D-HEST, D-MAVT</td>
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<td>M. Hampe, D. A.</td>
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<td>This lecture gives an overview about the different Man-Machine-</td>
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<td>Relations since the 16th century. Different models of machines will</td>
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<td>be important here: the clockwork, the steam engine and the computer.</td>
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<td>851-0125-52L</td>
<td>Central Questions in Bioethics</td>
<td>W</td>
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<td>2S</td>
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<td>Particularly suitable for students of D-BIOL, D-CHAB, D-HEST, D-</td>
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<td>Bioethics deals with the evaluation and regulation of technology</td>
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<td>based interventions into life. What are valid principles guiding</td>
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<td>biethical decision, principles like &quot;Protect the dignity of the living</td>
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<td>being&quot;, or &quot;Respect a person's self-determination!&quot; Besides</td>
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<td>answering such questions, the social, scientific and political</td>
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<td>processes linked with biotechnologies should be taken into account.</td>
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<td>Dürfen Embryonen unter dem Aspekt selektiert werden, ob sie als</td>
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<td>Rettungsgeschwister geeignet sind, deren Zeitgewebe einem schon</td>
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<td>geborenen anderen Kind durch Implantation das Leben retten kann? Soll</td>
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<td>die Forschung an Pillen erlaubt sein, die das menschliche</td>
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<td>Gedächtnis teilweise auslöschen und damit zum Beispiel traumatische</td>
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<td>Erlebnisse beseitigen können? Spricht wirklich mehr gegen Hirndoping</td>
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<td>als gegen Kaffeekonsum? Darf es Patente auf menschliche Stammzellen</td>
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<td>geben? Das sind Fragen der Bioethik. Der Kurs hat das Ziel, einige</td>
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<td>der wichtigsten bioethischen Fragen zu erforschen. Es sollen</td>
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<td>normative Prinzipien identifiziert werden, die oft faktisch</td>
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<td>bioethischen Entscheidungen zu Grunde liegen. Und es sollen</td>
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<td>überzeugende Prinzipien ermittelt werden. Zugleich sollen die</td>
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<td>Teilnehmer Kenntnisse erwerben über die Entwicklungen in</td>
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<td>individuellen Grundrechten, kapitalistischer Marktwirtschaft und</td>
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<td>systematische wissenschaftlicher Forschung), die mit der Dynamik von</td>
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<td>Biotechniken zusammenhängen.</td>
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### Literature

1. Dieter Sturma/Bert Heinrichs (Hg.), Handbuch Bioethik, Stuttgart: Metzler 2015.

### 851-0144-01L Introduction to the Philosophy of Physics

**W** 3 credits 2S  N. Sieroka

**Abstract**

This is an introductory course in different areas and positions in the philosophy of physics. It falls into different parts, including one on the concepts of space and time and one on the reality of structures in physics.

**Objective**

Students should be able to name and critically evaluate different topics and approaches in the philosophy of physics.

### 851-0144-07L The Infinite in Philosophy and in the Exact Sciences: Logic, Mathematics, Physics

**W** 3 credits 2S  G. Sommaruga

**Abstract**

On the one hand, the topic of the infinite will be dealt with historically by discussing philosophical texts, by e.g., Kant, Bolzano and Cantor. On the other hand, the topic will be treated from a (non-historical) scientific point of view: the point of view of logic, mathematics, and physics.

**Objective**

To get acquainted with different types of infinitness; to study what is intriguing or problematic about the infinite; to inquire whether these different types of infinitness have (important) features in common.

### 851-0144-15L The Beginning of Scientific Enquiry - History and Impact of Presocratic Natural Philosophy

**W** 3 credits 2V  N. Sieroka

**Abstract**

Several questions and notions introduced by presocratic natural philosophy are still considered important (albeit in historically altered forms, of course). This applies, e.g., to the notion of the infinite, the process character of nature, and atomism. The present lecture discusses both, the origin of these notions and their persistent relevance for later approaches in philosophy.

**Objective**

By the end of the lecture the students are able to describe and classify different approaches and notions in presocratic philosophy. Moreover, they are able to critically compare and evaluate them in relation to later approaches in natural philosophy.

### 851-0145-04L History and Philosophy of Pharmacy

**W** 3 credits 2S  S. Baier

**Abstract**

The course provides an insight into selected topics and questions of the history and philosophy of pharmacy by reading and discussing both modern and historical texts.

**Objective**

The course provides an insight into selected topics and questions of the history and philosophy of pharmacy by reading and discussing both modern and historical texts.

### 851-0148-02L Manifolds and Individuation in Mathematics and Philosophy

**W** 3 credits 2S  T. Böhm

**Abstract**

Manifolds and individuation are concepts which allow to reconsider notorious problems such as the relationship between general and particular, substance and modi, physical processes and persons. They may incorporate heterogeneous elements as needed to overcome traditional categories and classifications, and also describe processes leading to the existence of things.

**Objective**

The students should become familiar with some conceptual possibilities to recognise and deal with structures across the usual division of subjects. The problem areas are discussed on the basis of texts of various mathematicians and philosophers, with a wide range of applications such as psychology and life sciences.

### 851-0180-00L Research Ethics

**W** 2 credits 2G  G. Achermann

**Abstract**

This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.

**Objective**

The main goal of this course is to enhance the student's ability to:
- recognize and identify ethical issues and conflicts,
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.
I. Ethics & the Process of Ethical Inquiry

Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)

Integrity in Research & Research Misconduct
- What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 R's (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks;
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Literature
Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.

851-0300-93L Philosophy of Biology
Particularly suitable for students of D-BIOL, D-USYS

Abstract
The philosophy of biology deals with concepts and problems that occur specifically while dealing with living entities. Accordingly, it covers the historical as well as systematic aspects of concepts like gene or species, or theories explaining diversity or stability, competitive or cooperative action. Another important topic is the role of technology while affording biological objects.
A reader will be available for students.

Students learn to engage with problems in the philosophy of science and to relate them to natural and environmental sciences, thus developing their skills in critical thinking about science and its use. They know the most important positions in philosophy of science and the objections they face. They can identify, structure and discuss issues raised by the use of science in society.

The exercises in philosophy of science serve to develop skills in critical thinking by discussing seminal texts about the rationality of science.

This course covers the basic questions, concepts, theories, methods, and empirical findings of political science.

A list of literature will be distributed to the students together with the reader.

Oral examination during the Prüfungssession.

The optional exercises accompany the lecture and serve to develop skills in critical thinking with a focus on the rationality of science, based on discussing seminal texts. The texts cover important positions in the philosophy of science and their critics. Topics discussed include the significance and limits of empirical, mathematical and logical methods, as well as problems and ethical issues raised by the use of science in society.

851-0577-00L Principles of Political Science

This course covers the basic questions, concepts, theories, methods, and empirical findings of political science.

**Political Science**

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>851-0577-00L</td>
<td>Principles of Political Science</td>
<td>W Dr</td>
<td>4</td>
<td>2V+1U</td>
<td>S. Mohrenberg, Q. Nguyen</td>
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The overarching objective of this seminar is to get an impression of the specificity of biological problems and to develop an appropriate philosophical sensibility. Accordingly, philosophical traditions in biology will be discussed, just as the application of the history of concepts in the context of biology. The seminar reader will consist of contributions of biologists as well as philosophers of biology. Besides the basic concepts in biology such as gene, species, evolution, or diversity, we will be also reflecting on the relationship between technology, experimenting, and biological objects. Depending on the interests of the seminar participants, the examples to be discussed may be chosen from systems biology, molecular or synthetic biology, ecology or else.

801-0701-00L Philosophy of Science

The lecture explores various strands in philosophy of science in a critical way, focusing on the notion of rationality in science, especially with regards to environmental research. It addresses the significance and limits of empirical, mathematical and logical methods, as well as problems and ethical issues raised by the use of science in society.

Students learn to engage with problems in the philosophy of science and to relate them to natural and environmental sciences, thus developing their skills in critical thinking about science and its use. They know the most important positions in philosophy of science and the objections they face. They can identify, structure and discuss issues raised by the use of science in society.

Content

1. Core differences between classical Greek and modern conceptions of science.
2. Classic positions in the philosophy of science in the 20th century: logical empiricism and critical rationalism (Popper); the analysis of scientific concepts and explanations.
3. Objections to logical empiricism and critical rationalism, and further developments: What is the difference between the natural sciences, the social sciences and the arts and humanities? What is progress in science (Kuhn, Fleck, Feyerabend)? Is scientific knowledge relativistic? What is the role of experiments and computer simulations?
4. Issues raised by the use of science in society: The relation between basic and applied research; inter- and transdisciplinarity; ethics and accountability of science.

Lecture notes

A reader will be available for students.

Literature

A list of introductory literature and handbooks will be distributed to the students.

Prerequisites / notice

The optional exercises accompany the lecture and offer the opportunity for an in-depth discussion of selected texts from the reader.

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 569 of 1434
The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a
This course is based on the following textbook:
Slides and reading material will be made available at www.ib.ethz.ch (teaching, materials, then menu on the left side of the screen). They
2S
This course focuses on the conditions under which cooperation in international environmental politics emerges and the conditions under
T. Bernauer
Science and Technology Policy is normally associated with the improvement of national competitiveness; yet, it is also an integral part of
Technology and Innovation for Development
2V
This course is based on the following textbook:
Prerequisites / notice
Students attending this course and passing the required tests (one in the middle, the other at the end of the semester) will obtain 4 ECTS credit points.

851-0594-00L International Environmental Politics W 4 credits 2V T. Bernauer

Abstract
This course focuses on the conditions under which cooperation in international environmental politics emerges and the conditions under which such cooperation and the respective public policies are effective and/or efficient.

Objective
The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a social sciences viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems.

Content
This course deals with how and why international cooperation emerges, and under what circumstances such cooperation is effective and efficient. Based on theories of international political economy and theories of government regulation very examples of international environmental politics are discussed: the management of international water resources, the problem of unsafe nuclear power plants in eastern Europe, political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

The course is open to all ETH students. Participation does not require previous coursework in the social sciences.

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 4 ECTS credit points. The workload is around 120 hours (meetings, reading assignments, preparation of test).

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory (http://www.rektorat.ethz.ch/students/admission/auditors/specialstudents_uzh/index_EN; see menu on left side of that webpage for students from other universities).

Lecture notes
Slides and reading material will be made available at www.ib.ethz.ch (teaching, materials, then menu on the left side of the screen). They are password protected. Use your Netzh username and password to access the material.

Literature
See www.ib.ethz.ch (teaching, materials)

Prerequisites / notice
Students from ETH will receive 4 ECTS credit points if they attend classes regularly and obtain a grade of 4.0 or higher for the written exam in the final week of the semester. Students who obtain a grade of less than 4.0 for the end-of-semester test will have a second chance in the following semester. The rules of the game are defined in detail on the course syllabus. Students who do not participate in the end of semester test will not have access to the repeat exam unless they submit compelling and documented reasons for why they were unable to participate in the first test. Except for language dictionaries, no additional materials and no laptops and mobile phones are allowed during the exam.

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory (http://www.rektorat.ethz.ch/students/admission/auditors/specialstudents_uzh/index_EN; see menu on left side of that webpage for students from other universities).

The workload for this course is approx. 120 hours (all inclusive).

851-0595-01L International Organizations W 3 credits 2S Z. Bakaki

Abstract
This course offers a comprehensive examination of the role of international organizations (IOs) in world politics. Besides teaching the basic theories and methods that are necessary for studying IOs, this course considers the application of those theories and methods to a range of special institutions.

Objective
The first part of this course offers an introduction and will seek to explain how, if at all, IOs obtain some measure of authority in international affairs, i.e., why states delegate certain tasks to IOs instead of dealing unilaterally or multilaterally outside of an institutional context. The second part of the course focuses on the impact and effectiveness of international institutions. We assess whether and how IOs influence state compliance with agreements, and whether IOs socialize states to behave in certain ways. The third and final part of the course examines a special set of IOs: international alliances and international regimes, i.e., explicit principles, norms, rules, and decision-making procedures that define expected behavior in a specific problem field.

851-0589-00L Technology and Innovation for Development W Dr 3 credits 2V P. Aerni

Abstract
Technological change plays a crucial role in efforts to create a more sustainable future. In this context, policy decision makers must design rules that minimize its risks and maximize its benefits for society at large. The course discusses this challenge from an interdisciplinary perspective taking into account legal, economic, historical, developmental and environmental aspects.

Objective
- to recognize the challenges and opportunities of technological change in terms of sustainable development
- to become familiar with policy instruments to promote innovation
- to improve understanding of political decision-making processes in the regulation of science & technology
- improved understanding of the role of science and technology in the context of human and societal development

Content
Science and Technology Policy is normally associated with the improvement of national competitiveness; yet, it is also an integral part of effective environmental and development policies.

The course will discuss the challenges and opportunities of technological change in terms of sustainable development and show how public policy on the national and the international level is responding to this change.

In this context, students are to become familiar with the basic principles of political economy and New Growth Theory and how such theories help explain political decisions as well as political outcomes in the area of Science, Technology and Innovation. State interventions are either designed to regulate (e.g. environmental regulations, anti-trust law) or facilitate (e.g. intellectual property rights protection, public investment in R&D and technical education, technology transfer) technological change. This will be illustrated by looking at different industries and different national systems of innovation. Subsequently the positive and negative consequences for society and the natural environment will be discussed from a short-term and a long-term perspective.
A reading list will be handed out at the beginning of the semester. cf. "Diploma Supplement"

Lecture notes

Reader with issue-specific articles. E-version is partly available under http://www.ib.ethz.ch/teaching/material/stpp


Prerequisites / notice


The 2-hour course (5-7 p.m.) will be held as a series of lectures. The course materials will be available in form of an electronic Reader at the beginning of the semester.

The class will be taught in English.

Students will be asked to give a (a) presentation (15 Minutes) or write a review paper based on a article selected from the electronic script, and (b) they will have to pass a written test at the end of the course in order to obtain 3 credit points in the ECTS System. In the final mark (a) will have a weight of 40% and (b) 60%.

853-0038-00L

Swiss Foreign Policy

W 3 credits 2V D. Möckli

Abstract

This course analyzes the foundations and central challenges of Swiss foreign policy. After reviewing the history of foreign and neutrality policy conceptions since the early 20th century, the determining factors of Swiss foreign policy will be discussed, and issues such as the Ukraine crisis, Swiss-EU relations, and Switzerland and the Middle East will be examined.

Objective

Students should acquire a sound understanding of Swiss foreign policy and the relevant academic and political debates associated with it. After introducing the field of Foreign Policy Analysis, this course will first deal with the historical foundations and the conceptual development of Swiss foreign policy. The focus will be on Switzerland's different reactions to the new international orders after 1918, 1945, and 1989 as well as on the significance of the 9/11 terrorist attacks and the global financial and debt crises since 2009 for Swiss foreign policy. We will also discuss the extent to which the Ukraine crisis and the annexation of Crimea by Russia mark a watershed in the international order - and how Switzerland should respond to these challenges. Subsequently, key determinants of Swiss foreign policy will be analyzed, with specific attention on neutrality, direct democracy, and the special case paradigm. Finally, the discussion will center on current challenges and issues such as Swiss-EU relations, the Ukraine crisis and the OSCE engagement, Switzerland's role in the UN, Swiss peacebuilding efforts, Swiss policy in the Middle East, and development cooperation.

Content

The first hour will consist of a lecture; in the second hour, we will deepen and discuss the respective issues together with guest speakers from the Swiss foreign ministry, including Secretary of State Rossier.

Literature

A reading list will be handed out at the beginning of the semester.

The course will be supported by an e-learning environment.

Lecture notes

Students will receive a handout of slides accompanying the lectures.

853-0047-01L

World Politics Since 1945: The History of International Relations (Without Exercises) W 3 credits 2V A. Wenger

Abstract

This lecture series provides students with an overview of the development of international relations since the end of World War II. The first part of the series deals with the development of and changes in Cold War security policy structures. The second part deals with the period after the transformation of 1989/91; the focus here is on current issues in international security policy.

Objective

By the end of the semester, participants of the lecture should have a solid knowledge on the history and theoretical foundations of International Relations since the end of the Second World War.

Content

Compulsory Reading:


Prerequisites / notice

The lecture is being supported by a virtual classroom. If you have any questions, please contact Lukas Meyer, lukas.meyer@sipo.gess.ethz.ch.

853-0015-00L

Conflict Research I: Causes of War in Historical Context W 4 credits 2V+1U L.E. Cederman

Abstract

This course offers an introduction to research on causes of wars. War as a social phenomenon is covered from the pre-state world to today's state system after the end of the Cold War. Topics include state formation and collapse, nationalism, decolonization, democracy, and ethnic conflict.
European Integration: Seminar

**Objective**
Developing an understanding for causes of war and their development over the last 500 years. Knowledge of fundamental concepts in research on causes of war.

**853-0302-00L** European Integration: Seminar

| W | 4 credits | 3S | F. Schimmelfennig |

**Abstract**
The seminar covers the theory, development, and core policy fields of European integration as well as structures and processes of the EU as a decision- and policy-making system.

**Objective**
The seminar is designed to help students understand the European Union as a particular kind of political system that differs both from the nation-state and from other international organizations. It imparts basic knowledge on the development, institutions, procedures, and policies of the EU and provides an introduction to major approaches to integration theory and political science research on the EU.

**Content**
1. Introduction
2. Development of European integration
3. Integration theories
4. Deepening
5. Widening and differentiation
6. Attitudes and public opinion
7. The institutions of the EU
8. Legislation and adjudication in the EU
9. Democracy in the European Union
10. Internal market and monetary union
11. Foreign and security policy
12. Justice and home affairs
13. EEA, Switzerland, and Neighbourhood Policy

**Literature**
Basislektüre

**Prerequisites / notice**
Die Leistungskontrolle findet durch eine Seminarpräsentation und einen schriftlichen Schlusstest statt.

Current Issues in Security Policy

**Objective**
Participants should gain a solid understanding of current issues in international security policy as well as of the central academic debates.

**Content**
The aim of the course is to provide the participants with an overview of international security politics in a globalized world. After dealing with the major challenges of the international security environment as compared to the cold war era, we will concentrate on some of the key challenges (international terrorism, proliferation of weapons of mass destruction etc.). The third part of the lecture focuses on security strategies pursued by the 'Western' world.

**Lecture notes**
Participants are expected to study the compulsory texts provided at the beginning of the semester via the online platform Moodle.

**Literature**
A reading list will be distributed at the beginning of the spring semester.

**Prerequisites / notice**
An online learning platform serves as a supplement to the lecture course.

Leadership I

**Objective**
The lectures "Leadership I" (WS) and "Leadership II" (SS) have been designed as a two-semester lecture series, but may also be followed independently of one another or in reverse order. "Leadership I" covers the following fields: leadership basics, leadership theories and leadership styles, the concept of leadership responsibility and the role of communication in practical leadership.

**Content**
The aim of this lecture is to give students an introductory overview of relevant topics regarding leadership research and practice, thus enabling them to gain a deeper understanding of the leadership phenomenon. Students should understand different concepts of leadership in the complex interaction between individuals, groups, organisation, context and situation. They should be informed about the evolution of the understanding of mankind in relation to working processes and its impact on organizations and the understanding of leadership theory in the past 100 years. They should grasp the concept of leadership responsibility (leadership ethics) and be able to derive consequences for leadership in practical situations. They should recognize the fundamental importance of communication in leadership situations and receive input which enables them to communicate adequately in specific situations.

**Prerequisites / notice**
The 1-hour written exam will take place during the last lecture in the semester.

Public Institutions and Policy-Making Processes

**Objective**
Public policies result from decision-making processes that take place within formal institutions of the state (parliament, government, public administration, courts). That is, policies are shaped by the characteristics of decision-making processes and the characteristics of public institutions and related actors (e.g. interest groups). In this course, students acquire the contextual knowledge for analyzing public policies. They learn why and how public policies and laws are developed, designed, and implemented at national and international levels. The course is organized in three modules. The first module (Stefan Bechtold) examines basic concepts and the role of law, law-making, and law enforcement in modern societies. The second module (Thomas Bernauer) deals with the functioning of legislatures, governments, and interest groups. The third module (Frank Schimmelfennig) focuses on the European Union and international organisations.

**Content**
Students acquire the contextual knowledge for analyzing public policies. They learn why and how public policies and laws are developed, designed, and implemented at national and international levels.

**Schedule:**
W1: (no class because of ISTP cornerstone course)
W2: Bechtold, Bernauer: Introduction
W3: Bechtold: Why do we need laws and why do people and other actors (e.g. firms) usually obey the law?
W4: Bechtold: How is the law enforced, and when do laws fail to influence the behavior of individuals and other actors (e.g. firms)?
W5: Bechtold: Courts as policy-makers
W6: Bernauer: How are parliaments (legislatures) elected, how do they work, and how do their characteristics and processes affect policy-making?
W7: Bernauer: Why do forms of government differ and how does this affect policy-making? Why and in what respect are public administrations efficient/effective, and why sometimes not?
W8: Bernauer: How do interest groups and social movements affect policy-making?
W9: Schimmelfennig: Governance beyond the state: why and how states create international institutions.
W10: Schimmelfennig: International organizations and regimes: case studies of global governance.
W11: Schimmelfennig: Governance in the European Union: policy-making and policy enforcement.
W12: Schimmelfennig: The international diffusion of policies: how states learn from each other.
W13: study week, Q&A meeting
W14: End of semester test
End of January: deadline for review essay

**Literature**
Number of participants limited to 25.
Priority for ISTP MSc students.

**Prerequisites / notice**
Reading materials will be distributed to the students before the semester starts.
Prerequisites / notice

This is a Master level course. The course is capped at 25 students, with ISTP Master students having priority.

★★ Psychology, Pedagogics

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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>851-0240-00L</td>
<td>Human Learning (EW1)</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>E. Stern</td>
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<tr>
<td></td>
<td>This lecture is only apt for students who intend to enrol in the programs “Teaching Diploma” or “Teaching Certificate”. It is about learning in childhood and adolescence.</td>
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<tr>
<td>Abstract</td>
<td>This course looks into scientific theories and also empirical studies on human learning and relates them to the school.</td>
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<tr>
<td>Objective</td>
<td>Anyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.</td>
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<tr>
<td>Content</td>
<td>Thematiche Schwerpunkte: Lernen als Verhaltensänderung und als Informationsverarbeitung; Das menschliche Gedächtnis unter besonderer Berücksichtigung der Verarbeitung symbolischer Information; Lernen als Wissenskonstruktion und Kompetenzentwicklung unter besonderer Berücksichtigung des Wissenstransfers; Lernen durch Instruktion und Erkundigen; Die Rolle von Emotion und Motivation beim Lernen; Interindividuelle Unterschiede in der Lernfähigkeit und ihre Ursachen; Intelligenztheorien, Geschlechtsunterschiede beim Lernen</td>
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<td>Lecture notes</td>
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<tr>
<td>Prerequisites / notice</td>
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<tr>
<td>851-0252-01L</td>
<td>Human-Computer Interaction: Cognition and Usability (Number of participants limited to 20).</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>C. Hölscher, I. Barisic, S. Ogjanovic</td>
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<tr>
<td></td>
<td>Particularly suitable for students of D-ARCH, D-INFK, D-ITET</td>
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<tr>
<td>Abstract</td>
<td>This seminar introduces theory and methods in human-computer interaction and usability. Cognitive Science provides a theoretical framework for designing user interfaces as well as a range of methods for assessing usability (user testing, cognitive walkthrough, GOMS). The seminar will provide an opportunity to experience some of the methods in applied group projects.</td>
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<tr>
<td>Objective</td>
<td>This seminar will introduce key topics, theories and methodology in human-computer interaction (HCI) and usability. Presentations will cover basics of human-computer interaction and selected topics like mobile interaction, adaptive systems, human error and attention. A focus of the seminar will be on getting to know evaluation techniques in HCI. Students form work groups that first familiarize themselves with a select usability evaluation method (e.g. user testing, GOMS, task analysis, heuristic evaluation, questionnaires or Cognitive Walkthrough). They will then apply the methods to a human-computer interaction setting (e.g. an existing software or hardware interface) and present the method as well as their procedure and results to the plenary. Active participation is vital for the success of the seminar, and students are expected to contribute to presentations of foundational themes, methods and results of their chosen group project. In order to obtain course credit a written essay / report will be required (details to be specified in the introductory session of the course).</td>
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<tr>
<td>Abstract</td>
<td>How can behavioral and cognitive science inform architecture? This project-oriented seminar investigates contributions of cognitive science to architectural design with an emphasis on orientation and navigation in complex buildings and urban settings. It includes theories on spatial memory and decision-making as well as hands-on observations of behavior in real and virtual reality.</td>
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<td>Objective</td>
<td>Taking the perspectives of building users (occupants and visitors) is vital for a human-centered design approach. Students will learn about relevant theory and methods in cognitive science and environmental psychology that can be used to understand human behavior in built environments. The foundations of environmental psychology and human spatial cognition will be introduced. A focus of the seminar will be on how people perceive their surroundings, how they orient in a building, how they memorize the environment and how they find their way from A to B. Students will learn about a range of methods including real-world observation, virtual reality experiments, eye-tracking and behavior simulation for design. Students will reflect on the roles of designers and other stakeholders with respect to human-centered design and an evidence-based design perspective. The seminar is geared towards a mix of students from architecture / planning, engineering, computer science and behavioral science as well as anybody interested in the relation between design and cognition. Architecture students can obtain course credit in &quot;Verteilungsfach&quot; or &quot;Wahlfach&quot;</td>
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<tr>
<td>Abstract</td>
<td>This colloquium offers an opportunity for students to discuss their ongoing research and scientific ideas in the behavioral sciences, both at the micro- and macro-levels of cognitive, behavioral and social science. It also offers an opportunity for students from other disciplines to discuss their research ideas in relation to behavioral science. The colloquium also features invited research talks.</td>
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<td>Objective</td>
<td>Students know and can apply autonomously up-to-date investigation methods and techniques in the behavioral sciences. They achieve the ability to develop their own ideas in the field and to communicate their ideas in oral presentations and in written papers. The credits will be obtained by a written report of approximately 10 pages.</td>
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Content

This colloquium offers an opportunity for students to discuss their ongoing research and scientific ideas in the behavioral sciences, both at the micro- and macro-levels of cognitive, behavioral and social science. It also offers an opportunity for students from other disciplines to discuss their ideas in so far as they have some relation to behavioral science. The possible research areas are wide and may include theoretical as well as empirical approaches in Social Psychology and Research on Higher Education, Sociology, Modeling and Simulation in Sociology, Decision Theory and Behavioral Game Theory, Economics, Research on Learning and Instruction, Cognitive Psychology and Cognitive Science. Ideally the students (from Bachelor, Master, Ph.D. and Post-Doc programs) have started to start work on their thesis or on any other term paper.

Course credit can be obtained either based on a talk in the colloquium plus a written essay, or by writing an essay about a topic related to one of the other talks in the course. Students interested in giving a talk should contact the course organizers (Schinazi, Hoelscher) before the first session of the semester. Priority will be given to advanced / doctoral students for oral presentations. The course credits will be obtained by a written report of approximately 10 pages. The colloquium also serves as a venue for invited talks by researchers from other universities and institutions related to behavioral and social sciences.

851-0252-02L  Introduction to Cognitive Science

Number of participants limited to 70.
Particularly suitable for students of D-ITET

Abstract

The lectures provide an overview of the foundations of cognitive science and investigate processes of human cognition, especially perception, learning, memory and reasoning. This includes a comparison of cognitive processes in humans and technical systems, especially with respect to knowledge acquisition, knowledge representation and usage in information processing tasks.

Objective

Cognitive Science views human cognition as information processing and provides an inter-disciplinary integration of approaches from cognitive psychology, informatics (e.g., artificial intelligence), neuroscience and anthropology among others. The lectures provide an overview of basic mechanisms of human information processing and various application domains. A focus will be on matters of knowledge acquisition, representation and usage in humans and machines. Models of human perception, reasoning, memory and learning are presented and students will learn about experimental methods of investigating and understanding human cognitive processes and representation structures.

851-0253-00L  Embodied Cognition

Number of participants limited to 25

Abstract

This seminar offers an introduction to embodiment. Does the representation of thought and emotion depend upon the sensory and motor system? Highlights: the figurative processing of “go” still evokes voltage changes in foot muscles, conceptualizing time activates the eyes to look along a mental time line, abstract causality might still be grounded in motor control, emotion shows in the way we walk

Objective

Looking at the degree of embodiment in cognition and emotion naturally leads to the question how the mind works. What is the nature of human thoughts and emotions? How deep are they dependent upon features of our physical body as an agent? Do the sensory and motor system play a physically constitutive role in conceptualizing thought and emotion? We will look at these questions by examining the degree of embodiment in basic thinking types of our mind (space, time, and causality thinking) as well as in abstract thought (e.g., logical thinking) and in emotion processing. As will be discussed, the topic of how the mind works is not only of central importance in the humanities (psychology, linguistics, philosophy, anthropology, education), but is also relevant for parts of the natural and technological sciences (physiology, neuroscience, medicine, computer science, artificial intelligence). Active participation is expected. Each participant can choose a topic for which they will give an oral presentation (about 30 min.) and write a related written report (about 3000 words).

851-0253-02L  Reflections on Design Processes

Particularly suitable for students of D-ARCH.

Abstract

This will be a seminar on design processes. We will review the body of work directed at understanding design processes from the 1950s to the present time. The students will be expected to prepare for and lead the presentations for some of the topics and write a final paper.

Objective

Designing artifacts is a critically important, if not unique, human cognitive activity. While we have engaged in design activity since we have been human, it has only been an object of study for the past 50 years. The initial focus during the 1960s was on "design methodologies." This body of work, motivated by large, technically sophisticated, geographically dispersed projects like the Polaris missile project, sought to develop an analytic, mathematically based, teachable doctrine about the design process that would serve the same role for design as the "scientific method" served for science. During the 1980s interest shifted from a normative approach to a descriptive approach, focusing on the cognitive and computational processes of designers. More recently, several researchers are using neuropsychological methodologies to understand the design process.

Learning objectives: to understand the design process from a normative methodological perspective, and descriptive computational, cognitive, and neural perspectives.

Learning outcomes: By the end of the seminar the student should be familiar with these literatures, should be able to discuss relative strengths and weaknesses, and identify what each has contributed to our ability to design, and to our understanding of the design process itself.

851-0238-01L  Support and Diagnosis of Knowledge Acquisition Processes (EW3)

Enrolment only possible with matriculation in Teaching Diploma, except for students of Sport Teaching Diploma, who complete the sport-specific course unit EW3.

Prerequisites: successful participation in 851-0240-00L "Human Learning (EW1)"

Abstract

In this seminar students learn advanced techniques to support and to diagnose knowledge acquisition processes in school.

Objective

The main goals are:
(1) You have a deep understanding about the cognitive mechanisms of knowledge acquisition.
(2) You have a basic understanding about psychological test theory and can appropriately administer tests.
(3) You know various techniques of formative assessment and can apply these to uncover students’ misconceptions.

227-0802-01L  Social Psychology

The lecture covers the following main topics: Social perception and interpersonal judgement; attitudes; group dynamics and group performance; leadership behavior and leadership styles.

Objective

The aim of the lecture is to impart a well-founded scientific understanding of social influence processes in individuals, groups, organizations, and social settings. The participants should develop competencies in the structuring of communication, interaction, and management processes.
There is no script, but slides will be made available before the lectures. C. Jäger, C. Keller, M. Siegrist

**Basic concepts of law, sources of law.**

**Environmental Law: Topics and Case Studies**

2V

**Introduction to Law**

2 credits

3 credits

**Psychology**

- understand basic components of risk management in organizations
- know and apply methods for risk identification/evaluation, risk mitigation, risk communication
- know psychological foundations of risk perception, decision-making under risk, and risk communication
- know organizational principles for managing uncertainty
- apply theoretical foundations to applied issues such as safety management, regulatory activities, and technology design and implementation in different domains (e.g. transport systems, IT, insurance)

The syllabus includes the following topics:

Elements of risk management

- risk identification and evaluation
- risk mitigation
- risk communication

Psychological and organizational concepts relevant in risk management

- decision-making under uncertainty
- risk perception
- resilient organizational processes for managing uncertainty

Case studies on different elements of risk management (e.g., rule making, training, managing project risks, automation)

Group projects related to company case studies

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**Psychological Aspects of Risk Management and Technology**

3 credits

2V

G. Grote, S. A. Maurer, J. Schmutz, R. Schneider, M. Zumbühl

**Psychological Aspects of Risk Management and Technology**

W

- apply basic forms of psychological experiment.
- formulate a problem for psychological investigation.
- structure the conclusions and significance of an experiment. according to a theory of psychology.
- describe the areas, concepts, theories, methods and findings of psychology.

The course provides an introduction to psychological research and modelling, focusing on cognitive psychology and the psychological experiment. Participants learn to formulate problems for psychological investigation and apply basic forms of psychological experiment.

Participants are able to identify basic structures of the legal system. They understand selected topics of public and private law and are able to apply the fundamentals in more advanced law classes.

Students who have attended or will attend the lecture "Introduction to Law for Civil Engineering and Architecture" (851-0708-00), cannot register for this course unit.

- know organizational principles for managing uncertainty
- know psychological foundations of risk perception, decision-making under risk, and risk communication
- resilient organizational processes for managing uncertainty
- apply theoretical foundations to applied issues such as safety management, regulatory activities, and technology design and implementation in different domains (e.g. transport systems, IT, insurance)

The syllabus includes the following topics:

Elements of risk management

- risk identification and evaluation
- risk mitigation
- risk communication

Psychological and organizational concepts relevant in risk management

- decision-making under uncertainty
- risk perception
- resilient organizational processes for managing uncertainty

Case studies on different elements of risk management (e.g., rule making, training, managing project risks, automation)

Group projects related to company case studies

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**Law**

**Introduction to Law**

2 credits

6 credits

O. Streiff Gnöpff

*Students who have attended or will attend the lecture "Introduction to Law for Civil Engineering and Architecture" or "Introduction to Law" (851-0708-00), cannot register for this course unit.*

Particularly suitable for students of D-MAVT, D-MATL

This class introduces students into basic features of the legal system. Fundamental issues of constitutional law, administrative law, private law and the law of the EU are covered.

Students are able to identify basic structures of the legal system. They understand selected topics of public and private law and are able to apply the fundamentals in more advanced law classes.

Basic concepts of law, sources of law.

Private law: Contract law (particularly contract for work and services), tort law, property law.

Public law: Human rights, administrative law, procurement law, procedural law.

Insights into the law of the EU and into criminal law.

**Environmental Law: Topics and Case Studies**

W

2 credits

2S

C. Jäger

Further documents will be available online (see https://moodle-app2.let.ethz.ch/course/view.php?id=1596).

Prerequisites: Environmental Law: Conceptions and Fields (851-0705-01L) offered in spring semester.
This workshop offers to the students the opportunity to intensify their environmental legal knowledge on the basis of individual topics or cases of their respective programmes or professional interest in a guided self-study. They develop a better understanding for the practical application of legal regulations on environmental matters.

The aim of this workshop is to equip students with legal skills and methods to solve or treat problems and questions of the environmental law and foster the understanding on the possibilities and limits of legal problem-solving. The students choose an inquiry with practical relevance. To this end they work out the legal basis demonstrating a legal correct solution or approach to a solution. In doing so, students will get to know legal methods and research possibilities.

At the beginning of the workshop the students are introduced to the legal methods and sources as well as in the aim and the process of the workshop. The participants will organize themselves in a team of two persons giving themselves an inquiry on topics of the environmental law. It is also possible to choose questions at the interfaces of e.g. zoning law, energy law, transport law. A proposal, which will be presented to the lecturer, as well as an optional Q&A-session in class will facilitate the start. Next the working on topics will follow by self-study. The results will be presented in form of a memo/paper with a maximum of ten pages (excluding graphs and tables). At the end of the workshop, a presentation of ten minutes will be made to the plenum including a question-and-answer session. Class language will be German.

The Vorlesung basiert wesentlich auf der Mitwirkung der Studenten. Es finden 3 Sitzungen im Hörsaal statt, in welchen sich in der Praxis E-Business-Law H. Peter

Introduction to Civil Law 2 credits
System of swiss planning law, Space planning and fundamental rights, Relationship between space planning and constitutional law (especially property rights), solving of practical cases.


Haller, Walter;Karlen, Peter, Raumplanung-, Bau- und Umweltrecht, 3.A., Zürich 1999

Hänni, Peter, Planungs-, Bau- und besonderes Umweltschutzrecht, 5.A., Bern 2008

851-0707-00L Space Planning Law and Environment W 2 credits 2G O. Bucher

Objective
Basic understanding of nature and function of space planning from a legal point of view. Basic knowledge of space planning instruments.

851-0709-00L Introduction to Civil Law W 2 credits 2V H. Peter

Objective

Content
Le cours de droit civil porte notamment sur le droit des obligations (droit des contrats et responsabilité civile) et sur les droits réels (propriété, gages et servitudes). De plus, il est donné un bref aperçu du droit de la procédure et de l'exécution forcée.

Sont indispensables:
- le Code civil et le Code des obligations;
- Sont conseillés:
- Nef, URS Ch.: Le droit des obligations à l'usage des ingénieurs et des architectes, trad. Bovay, J., éd. Payot, Lausanne

Prerequisites / notice
Remarques
- Le cours de droit civil et le cours de droit public (2e sem.) sont l'équivalent des cours "Recht I" et "Recht II" en langue allemande et des exercices y relatifs.
- Les examens peuvent se faire en français ou en italien.
- Examen au 1er propédeutique; convient pour travail de semestre.

E-Business-Law 2 credits

Objective
The objective is knowing and understanding key legal concepts relevant for doing e-business, in particularly understanding how e-business is regulated by law nationally and internationally, how contracts are concluded and performed electronically, which rules have to be obeyed in particular in the Internet with regard to third party and own content and client data, the concept of liability applied in e-business and the role of the law in the practical implementation and operation of e-business applications.
Vorgesehene Strukturierung der Vorlesung:

1) Welches Recht gilt im E-Business?
- Internationalität des Internets
- Reguliert Branche

2) Gestaltung und Vermarktung von E-Business-Angeboten
- Verwendung fremder und Schutz der eigenen Inhalte
- Haftung im E-Business (und wie sie beschränkt werden kann)
- Domain-Namen

3) Beziehung zu E-Business-Kunden
- Verträge im E-Business, Konsumentenschutz
- Elektronische Signaturen
- Bearbeitung von Daten über Kunden
- Spam

4) Verträge mit E-Business-Providern


Lecture notes
Es wird mit Folien gearbeitet, die als PDF über die elektronische Dokumentenablage (ILIAS) auf dem System der ETHZ vorgängig abrufbar sind. Auf dem Termin- und Themenplan (ebenfalls online abrufbar) sind Links zu Gesetzesstexten und weiteren Unterlagen abrufbar.

Schliesslich wird jede Vorlesung auch als Podcast aufgezeichnet, der jedoch nur für die Studierenden mit einem Passwort (erhältlich beim Dozenten) zugänglich sind.


Literature

Prerequisites / notice
Die Semestereprüfung ist in Form eines schriftlichen Kurztests (normalerweise MC) in voraussichtlich der letzten Doppelstunde geplant. Es wird angegeben, welche Unterlagen beim jeweiligen Thema den Prüfungsstoff definieren. Der Test wird möglicherweise elektronisch durchgeführt.


Ferner bietet Ursula Widmer eine Vorlesung zum Thema Informationssicherheit an, welche die rechtlichen Aspekte der Sicherheit von ICT-Infrastrukturen und Netzen und der transportierten und verarbeiteten Informationen behandelt.

- A. Heine, G. Hertig

**851-0733-00L** Traffic Law / Traffic Commercial Law

*Abstract*
Within the scope of the lecture "Traffic Law / Traffic Commercial Law", besides an introduction into the legal basis of the national and international traffic, the main interest will be laid on actual political and economical questions and problems with respect to traffic (e.g. financing of traffic, road pricing, rail reform, air traffic vs. environment law etc.).

*Objective*
Participants are required to acquire a comprehensive summary about the system Traffic Law / Traffic Commercial Law in Switzerland. With practical exercises and subsequent detailed reviews themes and subjects of special interest to participants are being treated more thoroughly.

*Content*
Within the scope of the lecture "Traffic Law / Traffic Commercial Law", besides an introduction into the legal basis of the national and international traffic, the main interest will be laid on actual political and economical questions and problems with respect to traffic (e.g. financing of traffic, road pricing, rail reform, air traffic vs. environment law etc.). With practical exercises and subsequent detailed reviews themes and subjects of special interest to participants are being treated more thoroughly.

*Lecture notes*
Script will be distributed during the lecture.

**851-0735-10L** Business Law

*Abstract*
Particularly suitable for students of D-ITET

The students shall obtain a basic knowledge about business law. They shall be able to recognize and evaluate issues in the area of business law and suggest possible solutions.

*Objective*
The students shall obtain the following competence:
- They shall obtain a working knowledge on the legal aspects involved in setting up and managing an enterprise.
- They shall be acquainted with corporate functions as contracting, negotiation, claims management and dispute resolution.
- They shall be familiar with the issues of corporate compliance, i.e. the system to ascertain that all legal and ethical rules are observed.
- They shall be able to contribute to the legal management of the company and to discuss legal issues.
- They shall have an understanding of the law as a part of the corporate strategy and as a valuable resource of the company.

*Lecture notes*
A comprehensive script will be made available online on the moodle platform.

**851-0735-04L** Workshop and Lecture Series in Law and Finance

*Abstract*
The Workshop and Lectures Series in Law & Finance is a joint seminar of ETH Zurich, the University of Zurich and the University of St. Gallen. Each semester, several guest scholars from law, finance and related fields give a lecture and/or discuss their ongoing research. All speakers are internationally well-known experts from Europe, the U.S. and beyond.

*Objective*
The Lecture and Workshop Series in Law & Finance aims at providing students with current financial regulation and corporate governance issues with leading academics.

*Content*
Participants discuss current Law & Finance issues with guest scholars from Europe and the U.S. In addition, participants write a comment on one of the discussed papers.

*Lecture notes*
To be discussed papers are posted in advance on the course’s web page

- Viral Acharya et al., Regulating Wall Street (Wiley 2011)

**851-0735-09L** Workshop & Lecture Series on the Law & Economics of Innovation

*Abstract*

*Objective*

*Content*

*Lecture notes*

Data: 06.02.2019 13:00
Autumn Semester 2015
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Environmental Regulation: Law and Policy

Number of participants limited to 15.
Particularly suitable for students of D-USYS

851-0735-11L

Environmental Regulation: Law and Policy

W 3 credits 1S J. van Zeben

Abstract
This series is a joint project by ETH Zurich and the University of Zurich. It provides an overview of interdisciplinary research on intellectual property, innovation, antitrust and technology policy. Scholars from law, economics, management and related fields give a lecture and/or present their current research. All speakers are internationally well-known experts from Europe, the U.S. and beyond.

Objective
The aim of this course is to make students with a technical scientific background aware of the legal and political context of environmental policy in order to place technical solutions in their regulatory context.

Content
The aim of this course is to equip students with a legal and regulatory skill-set that allows them to translate their technical knowledge into a policy brief directed at legally trained regulators. More generally, it aims to inform students with a technical scientific background of the legal and political context of environmental policy. The focus of the course will be on international and European issues and regulatory frameworks - where relevant, the position of Switzerland within these international networks will also be discussed.

Literature
Susanne Scotchmer, Innovation and Incentives, 2004
Bronwyn Hall / Nathan Rosenberg (eds.), Handbook of the Economics of Innovation, 2 volumes, Amsterdam 2010
Bronwyn Hall / Dietmar Harhoff, Recent Research on the Economics of Patents, 2011
Robert Litan (ed.), Handbook of Law, Innovation and Growth, Cheltenham 2011
Paul Belleflamme / Martin Peitz, Industrial Organization; Markets and Strategies, Cambridge 2010
Eimer Elhauge / Damien Geradin, Global Competition Law and Economics, 2007
Dennis Carlton / Jeffrey Perloff, Modern Industrial Organization, 4th edition, 2004

Environmental Governance

Particularly suitable for students of D-USYS

851-0738-00L

Intelligent Property: Introduction

W 2 credits 2V M. Schweizer

Abstract
The course provides an introduction to Swiss and European intellectual property law (trademarks, copyright, patent and design rights). Aspects of competition law are treated insofar as they are relevant for the protection of intellectual creations and source designations. The legal principles are developed based on current cases.
The aim of this course is to enable students at ETH Zurich to recognize which rights may protect their creations, and which rights may be infringed as a result of their activities. Students should learn to assess the risks and opportunities of intellectual property rights in the development and marketing of new products. To put them in this position, they need to know the prerequisites and scope of protection afforded by the various intellectual property rights as well as the practical difficulties involved in the enforcement of intellectual property rights. This knowledge is imparted based on current rulings and cases.

Another goal is to enable the students to participate in the current debate over the goals and desirability of protecting intellectual creations, particularly in the areas of copyright (keywords: fair use, Creative Commons, Copyleft) and patent law (software patents, patent trolls, patent thickets).

The lecture gives students an overview of the basic aspects of intellectual property. The lecture aims to make participants aware of the various methods of protection and to put them in a position to be able to use this knowledge in the workplace. In recent years, knowledge about intellectual property has become increasingly important for engineers. In both production and distribution as well as in research and development, engineers are increasingly being confronted with questions concerning the patenting of inventions and the utilisation of patent information. With up to 80% of publicly-available technical information being stored in patents only, it is of great importance for engineers to know the basics of the patent system and to be in a position to be able to extract relevant information from the flood of patent information available. This relates to daily work in industry as well as in research, where protecting inventions has gained in importance.

Patents are also an important source of information - from competitors and potential cooperation partners to the development of markets and the risk of coming into conflict with third party IP rights. Respectively, a knowledge of patents has also become a key qualification at a company's strategic level.

The seminar is customised to the needs of engineers. Participants will become familiar with practice-relevant aspects of intellectual property with the emphasis being placed on patents. Participants will be able to use the acquired knowledge in the protection and commercialisation of their own inventions.

The topics covered will include:
- The importance of innovation in industrialised countries and high-tech sectors
- The protection of inventions and the safeguarding of commercial implementation - the role and importance of intellectual property
- Patents as a source of technical and business information
- Practical aspects of intellectual property for day-to-day research work, for the formation of start-ups and at the workplace.

The seminar contains practical exercises on the use and research of patent information. Basic knowledge on how to read and evaluate patent documents, as well as how to use publicly available patent databases in order to obtain the required patent information will also be provided.

The lecture is coordinated to the needs of the following degree programs: Agricultural science, architecture, civil engineering, computational science and engineering, computer science, electrical engineering and information technology, environmental engineering, geomatic engineering and planning, interdisciplinary sciences, materials science, mathematics, mechanical engineering, physics.

For students of chemistry-related degree programs, the lecture 'Protecting inventions in chemistry' will be offered, which is coordinated to the needs of students in these degree programs.

Investments in the development of new substances and active components in these sectors are traditionally secured by patents because publicly known inventions, generally chemical substances, may easily be reproduced by others. In the last years, the know-how about intellectual property has become increasingly important for chemists and engineers. Both in the production process and in the distribution sector, chemists and engineers are increasingly concerned with questions related to patenting inventions and the use of patent information. As more than three-quarters of all publicly available technical information is reportedly available only in patents, it is more and more important for researchers and engineers to be capable of extracting relevant information from the flood of patents.

Patents are not only a measure to protect investments and inventions in chemistry-related sectors but also an important source of information about competitors and potential cooperation partners, about the development of markets and the risk of infringing others' patents. Accordingly, the know-how about patents and patent information has also become a key qualification at a strategic level.

The seminar is customised to the needs of chemists and students of related degree programs. Participants will become familiar with practice-relevant aspects of intellectual property with the emphasis being placed on patents. Participants will be able to use the acquired knowledge in the protection and commercialisation of their own inventions.

The topics covered will include:
- The importance of innovation in industrialised countries and high-tech sectors
- The protection of inventions and the safeguarding of commercial implementation - the role and importance of intellectual property
- Patents as a source of technical and business information
- Practical aspects of intellectual property for day-to-day research work, for the formation of start-ups and at the workplace.
- Special aspects of protecting inventions in chemistry-related sectors, including polymorphs and inventions in the field of nanotechnology.

The seminar contains practical exercises on the use and search of patent information in chemistry-related sectors. Basic know-how on how to read and evaluate patent documents, as well as how to use publicly available patent databases in order to obtain the required patent information will also be provided.

For engineering and physics students, the lecture 'The Role of Intellectual Property in daily routine: A Practical Introduction' will be offered, which is coordinated to the needs of students in these degree programs.

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This course teaches the possibilities and limits of the law in order to protect natural resources and landscapes against harm and nuisance. The learning concept is based on the coordinated implementation of the relevant legislations. The complexity of the legal situation will be discussed by analysing virtual and real law cases focused on spatial projects and planning.

Objective
The students know the opportunities and restrictions which are given by the law when using natural resources. They have insights into the complex environmental legal system and their application in concrete cases. The students are able to formulate typical legal questions, to understand the argumentation of courts and to solve simple legal problems with respect to environmental problems.

Content
- Waldrecht - Natur- und Landschaftsschutzrecht - Wasserrecht - Raumplanungsgrecht - Umweltschutzrecht - Verfahrensrecht

Lecture notes
Den Studierenden werden Unterlagen wie eine Übersicht über den behandelten Stoff auf PP-Folien, typische Gerichtsentsehede, Zeitungsartikel etc. über neue Vorhaben mit Auswirkungen auf die Umwelt und entsprechenden Rechtsfragen abgegeben.

Literature
Griffel, A.; Raumplanungs- und Baurecht in a nutshell, Dike Verlag, Zürich/St. Gallen 2012
Rausch, H.; Panorama des Umweltrechts - Kompendium der Umweltrechtstvorschriften des Bundes, BUWAL-Schriftenreihe Umwelt Nr. 226, 4. A., Bern 2005
Kees/Zimmermann; Bundesgerichtliche Rechtsprechung zur Waldgesetzgebung. In URP 2009/3
Griffel,A.; Raumplanungs- und Baurecht, Entwicklungen 2007, Bern 2008
Umweltrecht in der Praxis URP (Juristische Fachzeitschrift für Umweltrechtsfragen, herausgegeben von der Vereinigung für Umweltrecht (VUR)
Weitere Literaturangaben erfolgen in der ersten Veranstaltung.

Prerequisites / notice

Data: 06.02.2019 13:00
Autumn Semester 2015
Page 580 of 1434
Students know and can apply autonomously up-to-date investigation methods and techniques in the behavioral sciences. They achieve the Rational-Choice-Theory has become one of sociology's general theoretical approaches. The seminar concerns itself with major ideas, in collaboration with Prof. Dr. Norman Braun, Dr. Thomas Hinz, University of Munich, and Dr. Axel Franzen, University of Cologne. Behavioral Studies Colloquium.

The focus will be on the interplay between neural and cognitive systems. The course will have a bias towards "higher" cognitive functions. Recent Debates in Social Networks Research.

Social Networks research is a highly interdisciplinary fields. For example, scholars in Sociology, Psychology, Political Sciences, Computer Science, Physics, Mathematics and Statistics contribute to the development of theories and methods. This course aims at understanding, comparing and structuring recent debates in the field of Social Networks.

Social Networks research is a highly interdisciplinary fields. At the end of this seminar, students will understand and be able to compare different subject-specific approaches to social networks research (e.g., from Sociology, Psychology, Political Sciences, Computer Science, Physics, Anthropology, Mathematics and Statistics). They will be familiar with recent publications in this area and will be able to critically participate in a number of recent debates. Amongst others, these debates touch upon the co-evolution of selection and influence mechanisms, appropriateness of statistical models, generic mechanisms and features of social networks, models for the analysis of dynamic networks.

This seminar offers an introductory course in cognitive neuroscience. We will examine both human neurophysiology and cognitive functioning and explore how the latter is underwritten by the former. Topics will include brain anatomy and development, cellular mechanisms, CNS methodologies, visual perception, object recognition, memory, hemispheric specialization, and complex cognition.

This will be an introductory course in cognitive neuroscience. We will examine both human neurophysiology and cognitive functioning and explore how the latter is underwritten by the former. Topics will include brain anatomy and development, cellular mechanisms, CNS methodologies, visual perception, object recognition, memory, hemispheric specialization, and complex cognition.

This seminar offers an opportunity for students to discuss their ongoing research and scientific ideas in the behavioral sciences, both at the micro- and macro-levels of cognitive, behavioral and social science. It also offers an opportunity for students from other disciplines to discuss their ideas in so far as they have some relation to behavioral science. The possible research areas are wide and may include theoretical as well as empirical approaches in Social Psychology and Research on Higher Education, Sociology, Modeling and Simulation in Sociology, Decision Theory and Behavioral Game Theory, Economics, Research on Learning and Instruction, Cognitive Psychology and Cognitive Science. Ideally the students (from Bachelor, Master, Ph.D. and Post-Doc programs) have started to start work on their thesis or on any other term paper. Course credit can be obtained either based on a talk in the colloquium plus a written essay, or by writing an essay about a topic related to one of the other talks in the colloquium. Students interested in giving a talk should contact the organizers (Schinazi, Hoelscher) before the first session of the semester. Priority will be given to advanced / doctoral students for oral presentations. The course credits will be obtained by a written report of approximately 10 pages. The colloquium also serves as a venue for invited talks by researchers from other universities and institutions related to behavioral and social sciences.

This seminar offers an introductory course in cognitive neuroscience. We will examine both human neurophysiology and cognitive functioning and explore how the latter is underwritten by the former. Topics will include brain anatomy and development, cellular mechanisms, CNS methodologies, visual perception, object recognition, memory, hemispheric specialization, and complex cognition.

This seminar offers an opportunity for students to discuss their ongoing research and scientific ideas in the behavioral sciences, both at the micro- and macro-levels of cognitive, behavioral and social science. It also offers an opportunity for students from other disciplines to discuss their ideas in so far as they have some relation to behavioral science. The possible research areas are wide and may include theoretical as well as empirical approaches in Social Psychology and Research on Higher Education, Sociology, Modeling and Simulation in Sociology, Decision Theory and Behavioral Game Theory, Economics, Research on Learning and Instruction, Cognitive Psychology and Cognitive Science. Ideally the students (from Bachelor, Master, Ph.D. and Post-Doc programs) have started to start work on their thesis or on any other term paper. Course credit can be obtained either based on a talk in the colloquium plus a written essay, or by writing an essay about a topic related to one of the other talks in the colloquium. Students interested in giving a talk should contact the organizers (Schinazi, Hoelscher) before the first session of the semester. Priority will be given to advanced / doctoral students for oral presentations. The course credits will be obtained by a written report of approximately 10 pages. The colloquium also serves as a venue for invited talks by researchers from other universities and institutions related to behavioral and social sciences.
The seminar aims at three-fold integration: (1) bringing modeling and computer simulation of techno-socio-economic processes and
recent developments will be supplemented and made available online.

Particularly suitable for students of D-MAVT, D-INFK, D-

II. Numerous forms of political terrorism, their origins, effects and possible counter-strategies

Prerequisites / Literature
The number of participants is limited to the size of the available computer teaching room. The MATLAB code related to the seminar thesis
should be well enough documented for further use by others and must be handed over to the Chair of Sociology, in particular of Modeling
and Simulation, for further free and unrestricted use.

Number of participants limited to 70.

Abstract

Political Violence

Number of participants limited to 30

Objective

The goal is to deliver clear concepts and typologies which help for a better understanding of the various forms of political violence whether
in pure form or mixed with other forms of conflict. The focus is on making known a large number of empirical theories.

Literature
Numerous German and English literature will be supplemented and made available online.

Prerequisites / notice

A fresh mind, some historical and contemporary knowledge, experience in controlled explanations.

Graded essay, own choice of topic according to the syllabus and upon consulting the lecturer. Submission of the essay is 31st January,
2016.

1. Political violence needs to be clearly delineated (definitions and typologies)
2. Numerous forms of political violence from protests via internal wars to revolutionary challenges are discussed in search for empirical
   theory-building
3. Forms of political terrorism, their origins, effects and possible counter-strategies

Recent developments will be supplemented

E. Zimmermann

2 credits

Objective

At the heart of the discourse is the handling of digital goods and intellectual property in society. Digitalization and the Internet allow handling
knowledge in a way, which directly contrasts with the traditional understanding of "intellectual property" and the industries based on it.
Starting from economic and legal basics, we compare proprietary and open/*free* models. Sustainable development as a concept is
transferred to digital goods, taking into account the particular nature of digital stuff.
After the lecture, you should (hopefully) be able to
- characterize the nature of digital goods vs. physical goods
- critique the basic concepts of copyright and patent rights
- explain the political/legal and economic differences between proprietary and open approaches to the production and use of digital goods
- using an example, explain the meaning of digital sustainability and argue why it is relevant for a knowledge society
- transfer the ideas of the free/open source software model to other digital goods (e.g., open content, open access)

M. M. Dapp

2 credits

Objective

How do various interest groups influence the methods of production, distribution, and use of digital resources? Current models focusing on
the handling of digital goods and intellectual property in society. Digitization and the Internet allow handling knowledge in a way, which
directly contrasts with the traditional understanding of "intellectual property" and the industries based on it.

Beyond the traditional approach of intellectual property, this course discusses concepts like open source, open content, and open access.

Prerequisites / notice

Due to a very limited number of possible participants please register early with the assistant at the Chair of Sociology
irene.urbanek@soz.gess.ethz.ch.
Doctoral students and post-doctoral students will be given priority.
The seminar will be held in German.
Participants are expected to write a paper or give a presentation.

DM-MAVT, D-MTEC, D-USYS

D. Helbing

3 credits

Objective

The seminar aims at three-fold integration: (1) bringing modeling and computer simulation of techno-socio-economic processes and
numerical data, and video animations of spatio-temporal data. With this knowledge, students are expected to implement themselves in MATLAB, models of various
social processes and systems, including agent-based models, e.g., models of interactive decision making, group dynamics, human crowds,
or game-theoretical models.

Part of this course will consist of supervised programming exercises in a computer pool. Credit points are finally earned for the
implementation of a mathematical model from the sociological literature in MATLAB and the documentation in a seminar thesis.

2V

This course introduces first the basic functionalities and features of the mathematical software package MATLAB, such as the simple
operations with matrices and vectors, differential equations, statistical tools, the graphical representation of data in various forms, and video
animations of spatio-temporal data. With this knowledge, students are expected to implement themselves in MATLAB, models of various
social processes and systems, including agent-based models, e.g., models of interactive decision making, group dynamics, human crowds,
or game-theoretical models.

The number of participants is limited to the size of the available computer teaching room. The MATLAB code related to the seminar thesis
should be well enough documented for further use by others and must be handed over to the Chair of Sociology, in particular of Modeling
and Simulation, for further free and unrestricted use.

851-0585-34L

Prerequisites / notice

The number of participants is limited to the size of the available computer teaching room. The MATLAB code related to the seminar thesis
should be well enough documented for further use by others and must be handed over to the Chair of Sociology, in particular of Modeling
and Simulation, for further free and unrestricted use.

From Computational Social Science to Global Systems Science

The seminar aims at three-fold integration: (1) bringing modeling and computer simulation of techno-socio-economic processes and
numerical data, and video animations of spatio-temporal data. With this knowledge, students are expected to implement themselves in MATLAB, models of various
social processes and systems, including agent-based models, e.g., models of interactive decision making, group dynamics, human crowds,
or game-theoretical models.

Part of this course will consist of supervised programming exercises in a computer pool. Credit points are finally earned for the
implementation of a mathematical model from the sociological literature in MATLAB and the documentation in a seminar thesis.

2 credits

Prerequisites / notice

Due to a very limited number of possible participants please register early with the assistant at the Chair of Sociology
irene.urbanek@soz.gess.ethz.ch.
Doctoral students and post-doctoral students will be given priority.
The seminar will be held in German.
Participants are expected to write a paper or give a presentation.

851-0585-04L

Lecture with Computer Exercises: Modelling and Simulating Social Systems with MATLAB

Number of participants limited to 70.

Content

This course introduces first the basic functionalities and features of the mathematical software package MATLAB, such as the simple
operations with matrices and vectors, differential equations, statistical tools, the graphical representation of data in various forms, and video
animations of spatio-temporal data. With this knowledge, students are expected to implement themselves in MATLAB, models of various
social processes and systems, including agent-based models, e.g., models of interactive decision making, group dynamics, human crowds,
or game-theoretical models.

Part of this course will consist of supervised programming exercises in a computer pool. Credit points are finally earned for the
implementation of a mathematical model from the sociological literature in MATLAB and the documentation in a seminar thesis.

2S

Digital Sustainability in the Knowledge Society

Abstract

How do various interest groups influence the methods of production, distribution, and use of digital resources? Current models focusing on
the handling of digital goods and intellectual property in society. Digitization and the Internet allow handling knowledge in a way, which
directly contrasts with the traditional understanding of "intellectual property" and the industries based on it.
Starting from economic and legal basics, we compare proprietary and open/*free* models. Sustainable development as a concept is
transferred to digital goods, taking into account the particular nature of digital stuff.
After the lecture, you should (hopefully) be able to
- characterize the nature of digital goods vs. physical goods
- critique the basic concepts of copyright and patent rights
- explain the political/legal and economic differences between proprietary and open approaches to the production and use of digital goods
- using an example, explain the meaning of digital sustainability and argue why it is relevant for a knowledge society
- transfer the ideas of the free/open source software model to other digital goods (e.g., open content, open access)

M. M. Dapp

2 credits

Objective

How do various interest groups influence the methods of production, distribution, and use of digital resources? Current models focusing on
the handling of digital goods and intellectual property in society. Digitization and the Internet allow handling knowledge in a way, which
directly contrasts with the traditional understanding of "intellectual property" and the industries based on it.
Starting from economic and legal basics, we compare proprietary and open/*free* models. Sustainable development as a concept is
transferred to digital goods, taking into account the particular nature of digital stuff.
After the lecture, you should (hopefully) be able to
- characterize the nature of digital goods vs. physical goods
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- using an example, explain the meaning of digital sustainability and argue why it is relevant for a knowledge society
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M. M. Dapp

2 credits

Objective

How do various interest groups influence the methods of production, distribution, and use of digital resources? Current models focusing on
the handling of digital goods and intellectual property in society. Digitization and the Internet allow handling knowledge in a way, which
directly contrasts with the traditional understanding of "intellectual property" and the industries based on it.
Starting from economic and legal basics, we compare proprietary and open/*free* models. Sustainable development as a concept is
transferred to digital goods, taking into account the particular nature of digital stuff.
After the lecture, you should (hopefully) be able to
- characterize the nature of digital goods vs. physical goods
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- using an example, explain the meaning of digital sustainability and argue why it is relevant for a knowledge society
- transfer the ideas of the free/open source software model to other digital goods (e.g., open content, open access)
Various studies are used to introduce basic sociological concepts, theories and empirical research methods, along with selected sociological topics. The goal of the course is to provide participants with an understanding of working practice in empirical sociology and comparative cultural sciences. Problems of the evolutionary perspective within various scientific disciplines, especially anthropology, psychology, empirical social research and comparative cultural sciences.

The problem is, that this reality poses a fundamental threat to today's business model of the knowledge and culture industries (starting from the music label and Hollywood, via publishers, up to software vendors). Powerful commercial interests are at stake as «knowledge» (the fourth factor of production) will become ever more important in the 21st century. Accordingly, «piracy» and «file-sharing» are attacked with all means. At the core lies the question about the design of property in digital assets. For that, we apply a concept of «intellectual property», which is several hundred years old and does not address digital reality in an adequate manner, sometimes leading to absurd situations. Its original goal seems to get forgotten: to help society develop by spreading knowledge as much as possible.

Using the PC becomes the new cultural technique of the 21st century. In contrast to «reading, writing and arithmetics», this new cultural technique cannot exist in isolation, but depends on a hard- and software infrastructure. This dependency extends to the provider of the infrastructure, who can define technical rules, which can take away or restrict the user's freedom. Even advanced users may have difficulties in recognizing these, often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible consequences we need to understand and investigate, because they decide about access, distribution and usage of digital knowledge.

Comparative to the environmentalist movement of the 60s and 70s, a growing political movement for «Free Software» exists today, with GNU/Linux as its most popular symbol. The movement fights against treating software code as private property but as a central cultural good available to all without private interests. Based on the success of the Free Software movement, new initiatives extend the concepts to other domains (e.g. scientific knowledge, music)...

As a «teaser» to the lecture, you are invited to read the essay «ETH Zurich - A Pioneer in Digital Sustainability!». It can be downloaded from www.essays2030.ethz.ch. More on teach.digisus.info starting from September. Stay tuned.

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### 851-0594-03L Institutions and Social Behavior

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<thead>
<tr>
<th>W</th>
<th>2 credits</th>
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<th>T. Voss</th>
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<td>Number of participants limited to 30.</td>
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**For registration, please contact: Irene Urbanek (irene.urbanek@soz.gess.ethz.ch)**

**Abstract**

Institutions are constraints or rules which determine the opportunities, beliefs and incentives in a given situation and induce stability in social life. There are two major questions: 1. What are the determinants of the emergence and change of institutions? 2. How can the diversity of institutions be explained? The lecture will give an overview and critical discussion of some answers.

**Objective**

In everyday language and in the social sciences, the term "institutions" is used in a broad and sometimes amorphous way. Using some elementary ideas from game theory the lecture will discuss conceptual issues and some important theoretical ideas related to the emergence and effects of institutions. Various approaches toward a "new institutionalism" will be analysed. Theoretical explanations of institutions are confronted with empirical results.

**Prerequisites / notice**


### 851-0597-01L Evolutionary Foundations of Social Behavior

<table>
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<th>E. Voland</th>
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<td>Number of participants limited to 30.</td>
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**Abstract**

This lecture will deal with the manifestations of the "selfish gene" principle in human social behavior. Cooperation and competition, selfishness and altruism, gender relations and parent-child conflicts are issues, the evolutionary backgrounds of which will be discussed. Special attention will be paid to the costly signaling theory.

**Objective**

You will receive an in-depth overview of the application of Darwinian theory on behavioral phenomena. This will enable you to approach the heuristic perspective of the so-called adaptationist program of social phenomena. Finally, you will be able to discern the benefits and the problems of the evolutionary perspective within various scientific disciplines, especially anthropology, psychology, empirical social research and comparative cultural sciences.

**Literature**


**Prerequisites / notice**


### 227-0802-02L Sociology

<table>
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<tr>
<th>W</th>
<th>2 credits</th>
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<th>A. Diekmann</th>
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</table>

**Abstract**

Various studies are used to introduce basic sociological concepts, theories and empirical research methods, along with selected sociological topics. The goal of the course is to provide participants with an understanding of working practice in empirical sociology and the central findings of sociological studies.

**Objective**

To learn about methods of empirical social research and key results of classic and modern sociological studies.
Content


Folgende Themen werden behandelt:


Gruppenarbeiten

- Schriftliche Arbeit in Soziologie (Durchführung einer kleinen empirischen Studie, Konstruktion eines Simulationsmodells sozialer Prozesse oder Diskussion einer vorliegenden soziologischen Untersuchung).

Literature

- Folien der Vorlesung im Internet

501-0811-00L Sociology I

W 1 credit 2V C. Schmid

Objective

This series of lectures should enable students to comprehend architecture in its social context. It approaches the architectural profession from two different angles: macro-sociological and micro-sociological.

Content

Sociology I deals with the macro-sociological point of view, and investigates the relation between social developments and the production of the built environment. In the first part some central aspects of social change are examined in particular the transition from Fordism to Postfordism and from Modernism to Postmodernism, and the interlinked processes of globalization and regionalization. The second part deals with historical and present-day forms of urbanization. Among other aspects treated here are the changed significance of urban-rural contrasts, the processes of suburbanization and periurbanization, the formation of global cities and metropolitan regions, the growth of new urban configurations in centres (gentrification) and on urban peripheries (edge city, exopolis). In the third part these general processes are illustrated by typical models of urbanization.

501-0813-15L Sociology: Planetary Urbanization - A Theory Workshop

W 2 credits 2S C. Schmid

Abstract

In the last decades, urbanization has become a planetary phenomenon, leading to an intense debate about a new conceptionalization of urbanization. This theory seminar aims at giving an introduction into the actual debate on planetary urbanization, into urban theory, theoretical thinking and the work with scientific texts.

Objective

This elective course highlights the sociological perspective on architectural practice and provides an introduction to sociological research. It focuses on two main procedures: on the one hand, a systematic reading and discussion of theoretical texts, and on the other, empirical case studies of social aspects of the production of the built environment. In this course, a wide set of qualitative research methods is used (including various forms of interview, participant observation, image and text analyses). This approach enables students to gain their own experience by dealing with the various participants and constellations in the social field of architecture and building construction, and to familiarize themselves with the approaches and perceptions of various different participants.

Content

In this theory seminar we read and discuss a range of recent papers and book chapters which analyze these new phenomena of planetary urbanization, such as the implosion and explosion of urban regions, the disintegration of contiguous "hinterlands", the emergence of corridor urbanization, the large scale industrialization and urbanization of agricultural areas, the production of extended urban fabrics of logistics, the creation and extension of operational landscapes, as well as processes that lead to the end of the "wilderness" and the urbanization of ocean space.

Literature

The relevant texts will be distributed in the seminar. A very good overview is provided in the following edited volume: Brenner, Neil (ed.): Implosions / Explosions: Towards a Study of Planetary Urbanization. Jovis, Berlin, 2014.

701-1541-00L Multivariate Methods

W 3 credits 2V+1U R. Hansmann

Abstract

One of the lectures 701-1541-00 (autumn semester) OR 752-2110-00 (spring semester) are highly recommended for students in Environmental Sciences with the Major Environmental systems and Policy.

The course teaches multivariate statistical methods such as linear regression, analysis of variance, cluster analysis, factor analysis and logistic regression.

Objective

Upon completion of this course, the student should have acquired:

(1) Knowledge on the foundations of several methods of multivariate data analysis, along with the conditions under which their use is appropriate

(2) Skill in the estimation, specification and diagnostics of the various models

(3) Hands-on experience with those methods through the use of appropriate software and actual data sets in the PC lab

Content

The course will begin with an introduction to multivariate analysis methods such as analysis of variance and multiple linear regression, where a metric dependent variable is "explained" by two or more independent variables. Then two methods for structuring complex data, cluster analysis and factor analysis will be covered. In the last part, procedures for the analysis of relationships involving dichotomous or polytomous dependent variables (e.g., the choice of a mode of transportation) will be discussed.

Literature

Will be announced at the beginning of the course.

701-0731-00L Environmental Sociology

W 2 credits 2S H. Bruderer Enzler

Abstract

This introductory class in environmental sociology covers different theoretical approaches but the main focus is on recent empirical research on topics such as environmental behavior, environmental concern, social dilemmas, social norms, environmental justice, and risk perception.

Objective

Basic knowledge of environmental sociology

Overview on current fields of research in environmental sociology and their relevance for environmental protection

Basic notion of the structure of empirical research papers in social sciences

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 584 of 1434
At the beginning of the 20th century, the artistic and social avantgarde movements developed visions of a 'New Man' with new modes of
Where in a field do innovative findings show up. This is a fundamental of discussion for every discipline. But what about problems that
According to a myth, the ancient Greek philosopher Democrit dissected animals, because he was in search of the seat of the soul. Current
By the end of this lecture, students should be familiar with essential positions in the scientific and philosophical treatment of questions
More often than not, classics are known by hearsay; they are quoted, but not read, or re-discovered and re-read selectively, so we can
2S, H. von Sass
3 credits
2S
- reading and understanding scientific papers beyond disciplinary boundaries
- gaining language competence to bridge the gap between disciplines

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>851-0111-08L</td>
<td>Transdisciplinary Journal Club am Collegium Helveticum</td>
<td>W</td>
<td>1 credit</td>
<td>1S</td>
<td>G. Folkers, H. von Sass</td>
</tr>
<tr>
<td>Abstract</td>
<td>Where in a field do innovative findings show up. This is a fundamental of discussion for every discipline. But what about problems that cannot be framed within one discipline? In terms of a Transdisciplinary Journal Club individual competences should be gained to lead and follow a scientific discussion beyond disciplinary boundaries.</td>
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</table>
| Objective    | - reading and understanding scientific papers beyond disciplinary boundaries
- gaining language competence to bridge the gap between disciplines |
| 851-0157-00L | Mind and Brain                                                         | W    | 3 credits | 2V    | M. Hagner       |
| Abstract     | In the last 2500 years, the mind-brain relationship has been articulated in various ways. In these lectures, we will explore the scientific and philosophical aspects of this relationship in the context of relevant cultural, historical and technological processes, with a focus on the modern neurosciences, but I will also discuss works of art and literature. |
| Objective    | By the end of this lecture, students should be familiar with essential positions in the scientific and philosophical treatment of questions relating the mind to the brain. It should also become clear that some of the most relevant problems in current neurosciences have a long history. |
| Content      | According to a myth, the ancient Greek philosopher Democrit dissected animals, because he was in search of the seat of the soul. Current neuroscientists use neuroimaging techniques like functional magnetic-resonance-tomography in order to localize cognitive and emotional qualities in the brain. Between these two dates lies a history of 2500 years, in which the relationship between the mind and the brain has been defined in various ways. Starting with ancient and medieval theories, the lecture will have its focus on modern theories from the nineteenth century onward. I will discuss essential issues in the history of the neurosciences such as localization theories, the neuron doctrine, reflex theory, theories of emotions, neurocybernetics and the importance of visualizing the brain and its parts, but I will also include works of art and literature. |
| 851-0157-56L | Avantgarde-Life: Utopia of the 'New Man' Between Science and Technology | W    | 3 credits | 2S    | M. Wulz         |
| Abstract     | At the beginning of the 20th century, the artistic and social avantgarde movements developed visions of a 'New Man' with new modes of perception and within new forms of social life. The seminar deals with the scientific, technological, artistic, pedagogical, and political designs for a new living. |
| Objective    | The seminar deals with the designs for a new living in the artistic and social avantgarde movements at the beginning of the 20th century. It focuses on the correlation of the contemporary scientific and technological developments and the conceptions of a 'New Man'. The discipline of psychotechnics together with scientific and technological designs of living and working environments formulated visions of new and enhanced ways of human living and perception. In the seminar, we will examine the utopian visions of life in the avantgarde movements. Touching upon the fields of the life sciences, economics, management, progressive education, architecture, and art we will reflect the diverse relations between science, technology, and human living. |
| 851-0157-57L | Classics in the History of Science: Approaches, History, Contexts      | W    | 3 credits | 2S    | N. Guettler, M. Stadler |
| Abstract     | More often than not, classics are known by hearsay; they are quoted, but not read, or re-discovered and re-read selectively, so we can quote them. That holds true for many 'classics' in the history of science, too - texts, that is, which have shaped approaches to, and understandings of, science. The aim of this introductory course is to critically read some of these seminal texts. |
| Objective    | This course is suited for all students with an interest in the history of science and knowledge. Conceived of as an advanced historiographical introduction to the subject, the course is to explore a selection of "classics" in the history of science - some of them well known, others less so. In this course, we shall be as much concerned with the positions and the perspectives on science that were advanced in these various texts as we shall be concerned with the historical circumstances, political meanings and wider cultural contexts of these perspectives. |
| 851-0157-59L | A Historical Epistemology of Exhibitions                              | W    | 3 credits | 2S    | M. Pratschke   |
| Abstract     | The seminar provides an introduction to epistemic practices. By means of various research approaches and examples from historical and current exhibitions we will discuss how knowledge is created by temporary spatial constellations of exhibited objects and the ways exhibitions act as laboratories of ideas. |
| Objective    | The seminar aims at getting to know the theoretical and practical conditions of exhibitions as temporary forms of knowledge. We will develop criteria to explore the various aspects and processes related to exhibitions, including: installations of exhibits, display cases, transporting devices, exhibition catalogues, exhibition architecture, visitor guidance, spatial arrangements of objects etc. Using selected historical and current examples, we will discuss different formats of exhibitions that range from trade fair booths to laboratory exhibitions, exhibitions in art museums as well as in science and natural museums. Being a specific humanistic way of creating knowledge experimentally we will pay particular attention to exhibitions that deal with topics at the intersection of the sciences and the humanities, thus acting as agents in the debate on the Two Cultures. |
### Literature


### Prerequisites / notice

We will discuss new trends in environmental communication with the focus on integral solutions.
**Type B: Reflection About Subject-Specific Methods and Contents**

Subject-specific courses: Recommended for doctoral, master and bachelor students (after first-year examination only).

### D-ARCH

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<thead>
<tr>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>051-0311-00L</td>
<td>History of Art and Architecture I</td>
<td>W</td>
<td>4 credits</td>
<td>4G</td>
<td>L. Schmitt, U. Schulte-Umbrecht</td>
</tr>
<tr>
<td>051-0311-00L</td>
<td>History of Art and Architecture III</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>L. Stalder</td>
</tr>
<tr>
<td>051-0363-00L</td>
<td>History of Urban Design I</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>V. Magnago Lampugnani</td>
</tr>
</tbody>
</table>

**Abstract**

The seminar deals with hot topics of the history of technology since the 1960s. Sharing of computer time, software and data will be discussed as a crucial offer and problem of late modernity.

The course wants to develop the students' ability to critically read and assess historic texts.

A detailed program and course materials will be made available during the semester on www.tg.ethz.ch.

The lecture conveys historical knowledge about architecture and art as well as methodical knowledge as a preparation for the independent handling of historical sources and scientific literature. The main focus will be laid on the architecture of the Greco-Roman antiquity, the Middle Ages, the Renaissance and the era between Baroque, Enlightenment, and Modernity.

The lecture conveys historical knowledge about architecture and art as well as methodical knowledge as a preparation for the independent handling of historical sources and scientific literature.

The course can be not taken by Master students of the D-ARCH, who have already completed it within the Bachelor programme.

**Objective**

Acquisition of basic knowledge of the history of art and architecture, resp. of methodical basic knowledge of historical working.

The history of art and architecture is part of our reality: it confronts us in the historically shaped environment of the city and plays an essential role in the creation of architecture. The historical lectures are therefore part of the fundamental courses of the undergraduate programme in architecture. On the basis of cultural and art-historical research the courses impart knowledge about architecture and art from ancient times to the present. At the same time they sharpen the perception for the conditions and capabilities of building activity in history. Moreover, they convey methodical knowledge and technical language skills and are meant as a preparation for the independent handling of historical sources and scientific literature.

The first one-year course aims at these goals in the form of exemplary epoch representations which through light upon the historical continuities. The main focus will be laid on the architecture of the Greco-Roman antiquity, the Middle Ages, the Renaissance and the era between Baroque, Enlightenment, and Modernity.

- The lecture covers the time from the beginning of urban culture until the mid 19th century. With selected examples it emphasizes on the historical plannings and methods of European cities. Each specific urban development will be presented within a broader context.

**Lecture notes**

- 3 Skripte sind auf der Professur, HIL C 70.5-8, erhältlich:
  - Architektur der Klassischen Antike, Fr. 15.-
  - Renaissance und Barock, Fr. 15.-
  - Aufklärung bis Moderne, Fr. 15.-

Zu beziehen am Dienstag und Donnerstag

**Prerequisites / notice**

The course can not be taken by Master students of the D-ARCH, who have already completed it within the Bachelor programme.

**Literature**


**Vorabsetzungen**: Die Vorlesung hat einführungsnamer Charakter.

**Current Trends and Areas for Future Research. In: Sociology Compass 5, H. 6, S. 399-412.**
Objective

This course analyzes the history of urban architecture primarily in its existing three dimensional form as a complex human artefact. It also explores the inspirations that prompted the creation of this artefact: philosophical and religious concepts, social conditions, property relationships and the mechanisms that exploit the economics of real estate and the influence of building technology. Intellectual, literary or artistic modes of thought will also be assessed with regard to their impact on urban development. Urbanism has its own distinctive approach as a discipline, but it is also clearly responsive to the influence of related disciplines. Study is made of actual cities and urban expansion plans which are in the process of implementation, as well as unrealized projects and visions of the future. These projects sometimes illustrate ways of thinking that are equal to, or clearer than, actual urban situations.

Content

In the first semester an introduction to the discipline and the methods are given along the thematic issues from the beginning of urban culture until the mid-19th century.

01. Introduction to the discipline and method: The history of urban design as a historical project

02. Athens and Rome in the ancient world: Myth, selfportrayal and speculation

03. From the spirit of equality to the colonial module: Greek and Roman City foundings

04. From the urban ideal to new cities in the Middle Ages and the Renaissance

05. Baroque strategies: The new organisation of Rome under Sixtus V, the production of Versailles under Louis XIV and the invention of St. Petersburg

06. The city between Absolutism and Enlightenment: baroque defence-designs, the European colonisation of the American continent and the reconstruction of Lisbon

07. Ideology and speculation after the Glorious Revolution: landscapegardens and urban figurations in England from 1650-1850

08. Between modernization, Grandeur and repression: Embellishment in Paris from 1750-1830

09. The construction of the bourgeois city: Georges-Eugène Haussmann transforms Paris into the capital of the 19th century

10. Architectural insertion and plan for the expansion of the city: From the Berlin of Karl Friedrich Schinkel to James Hobrecht

11. Neobourgeois power, bourgeois self-confidence and Marxian Idealism: The Viennese Ringstrasse and Ildefonso Cerda’s Ensanche for Barcelona

Lecture notes

The lectures are accompanied by a script (two semesters of the bachelor studies), that can be purchased at the chair for the history of urban design (HIL D 75.2) at the price of CHF 30.-. The script serves as an auxiliary means to the attended lecture compiling the most important illustrations showed and the names and dates of the buildings and its builders along with a short introductory note.

Literature

Further recommended literature to consult is listet within the script.

History of Urban Design from antiquity to the 19th century

851-0724-00L Property Law for Geometers: Land Registry and Geoinformation Law

Property Law for Geometers: Land Registry and Geoinformation Law

Particularly suitable for students of D-ARCH, D-BAUG, D-USYS

Abstract

Fundamental concepts of Land Register Law and Land Surveying Law (substantive and procedural rules of Land Register Law, the parts and the relevance of the Land Register; process of registration with the Land Register, legal problems of land surveying, reform of the official land surveying).

Objective

Overview of the legal norms of land registry and surveying law.

Content

Basic principles of material and formal land registry law, components of the land register, consequences of the land register, the registration process, legal problems of surveying, the reform of official surveying, liability of the geom-eter. The lecture unit is carried out within a frame of 8 sessions (2 hours): the first hour of each is given in the form of a lecture, the second in the form of a case-study.

Lecture notes

Abgegebene Unterlagen: Skript in digitaler Form

Pflichtlektüre: Meinrad Huser, Schweizerisches Vermessungsrecht, unter besonderer Berücksichtigung des Geoinformationsrechts und des Grundbuchrechts, Beiträge aus dem Institut für schweizerisches und internationales Baurecht der Universität Freiburg/Schweiz, Zürich 2014

Meinrad Huser, Geo-Informationsrecht, Rechtlicher Rahmen für Geographische Informationssysteme, Zürich 2005

Dieter Zobl, Grundbuchrecht, Zürich 1999

Meinrad Huser, Darstellung von Grenzen zur Sicherung dinglicher Rechte, in ZBGR 2013, 238 ff.


Meinrad Huser, Datenschutz bei Geodaten

Prerequisites / notice

Requirements: Property Law (12-722)

851-0705-02L Environmental Law: Topics and Case Studies

Environmental Law: Topics and Case Studies

Number of participants limited to 20.

Prerequisites: Environmental Law: Conceptions and Fields ((851-0705-01L) offered in spring semester).

Particularly suitable for students of D-ARCH, D-BAUG, D-USYS

Abstract

This workshop offers to the students the opportunity to intensify their environmental legal knowledge on the basis of individual topics or cases of their respective programme or professional interest in a guided self-study. They develop a better understanding for the practical application of legal regulations on environmental matters.

Objective

The aim of this workshop is to equip students with legal skills and methods to solve or treat problems and questions of the environmental law and foster the understanding on the possibilities and limits of legal problem-solving. The students choose an inquiry with practical relevance. To this end they work out the legal basis demonstrating a legal correct solution or approach to a solution. In doing so, students will get to know legal methods and research possibilities.
At the beginning of the workshop the students are introduced to the legal methods and sources as well as in the aim and the process of the workshop. The participants will organize themselves in a team of two persons giving themselves an inquiry on topics of the environmental law. It is also possible to choose questions at the interfaces of e.g. zoning law, energy law, transport law. A proposal, which will be presented to the lecturer, as well as an optional Q&A-session in class will facilitate the start. Next the working on topics will follow by self-study. The results will be presented in form of a memo/paper with a minimum of ten pages (excluding graphs and tables). At the end of the workshop, a presentation of ten minutes will be made to the plenum including a question-and-answer session. Class language will be German.

Prerequisites / notice

Die Veranstaltung erfordert die Bereitschaft, sich aktiv und selbständig mit einer selbstgewählten Fragestellung oder einem eigenen Fallbeispiel aus dem Gebiet des Umweltrechts und allenfalls aus Schnittstellengebieten auseinanderzusetzen. Damit die Interaktivität und die Beigleitung der Teams gewährleistet werden kann, ist die Teilnehmerzahl auf maximal 15 Personen beschränkt. Es handelt sich um eine Vertiefungsveranstaltung. Der Besuch der Vorlesung "Umweltrecht: Konzepte und Rechtsgebiete" (851-0705-01) ist Voraussetzung.

851-0707-00L Space Planning Law and Environment

| Objective | Practical training. |
| Content | Particularly suitable for students of D-ARCH, D-BAUG, D-USYS |
| Abstract | System of swiss planning law, Constitutional and statutory provisions, Space planning and fundamental rights, Instruments, Application, legal protection, enforcement, Practical training. |
| Literature | Rechtsgrundlagen, Literatur und Gerichtsentscheide werden themenspezifisch selber recherchiert, unter Mithilfe und Beratung des Dozenten. |

851-0252-01L Human-Computer Interaction: Cognition and Usability

| Objective | Particularly suitable for students of D-ARCH, D-INFK, D-ITET |
| Content | This seminar introduces theory and methods in human-computer interaction and usability. Cognitive Science provides a theoretical framework for designing user interfaces as well as a range of methods for assessing usability (user testing, cognitive walkthrough, GOMS). The seminar will provide an opportunity to experience some of the methods in applied group projects. |
| Literature | C. Hölscher, I. Barisic, S. Ognjanovic |

851-0252-03L Cognition in Architecture - Designing Orientation and Navigation for Building Users

| Objective | Particularly suitable for students of D-ARCH |
| Content | How can behavioral and cognitive science inform architecture? This project-oriented seminar investigates contributions of cognitive science to architectural design with an emphasis on orientation and navigation in complex buildings and urban settings. It includes theories on spatial memory and decision-making as well as hands-on observations of behavior in real and virtual reality. |
| Literature | V. Schinazi, B. Emo Nax, C. Hölscher |

851-0253-02L Reflections on Design Processes

| Objective | Particularly suitable for students of D-ARCH |
| Content | This will be a seminar on design processes. We will review the body of work directed at understanding design processes from the 1950s to the present time. The students will be expected to prepare for and lead the presentations for some of the topics and write a final paper. |
| Literature | V. Goel, C. Hölscher |

851-0157-55L Avantgarde-Life: Utopia of the 'New Man' Between

| Objective | Particularly suitable for students of D-ARCH |
| Content | Designing artifacts is a critically important, if not unique, human cognitive activity. While we have engaged in design activity since we have been human, it has only been an object of study for the past 50 years. The initial focus during the 1960s was on "design methodologies." This body of work, motivated by large, technically sophisticated, geographically dispersed projects like the Polaris missile project, sought to develop an analytic, mathematically based, teachable doctrine about the design process that would serve the same role for design as the "scientific method" served for science. During the 1980s interest shifted from a normative approach to a descriptive approach, focusing on the cognitive and computational processes of designers. More recently, several researchers are using neuropsychological methodologies to understand the design process. |
| Literature | M. Wulz |

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The seminar deals with the designs for a new living in the artistic and social avantgarde movements at the beginning of the 20th century. It focuses on the correlation of the contemporary scientific and technological developments and the conceptions of a ‘New Man’. The discipline of psychotechnics together with scientific and technological designs of living and working environments formulated visions of new and enhanced ways of human living and perception. In the seminar, we will examine the utopian visions of life in the avantgarde movements. Touching upon the fields of the life sciences, economics, management, progressive education, architecture, and art we will reflect the diverse relations between science, technology, and human living.

The seminar provides an introduction to exhibitions as epistemic practices. By means of various research approaches and examples from historical and current exhibitions we will discuss how knowledge is created by temporary spatial constellations of exhibited objects and the ways exhibitions act as laboratories of ideas.

The seminar aims at getting to know the theoretical and practical conditions of exhibitions as temporary forms of knowledge. We will develop criteria to explore the various aspects and processes related to exhibitions, including: installations of exhibits, display cases, transporting devices, exhibition catalogues, exhibition architecture, visitor guidance, spatial arrangements of objects etc.

Using selected historical and current examples, we will discuss different formats of exhibitions that range from trade fair booths to laboratory exhibitions, exhibitions in art museums as well as in science and natural museums. Being a specific humanistic way of creating knowledge experimentally we will pay particular attention to exhibitions that deal with topics at the intersection of the sciences and the humanities, thus acting as agents in the debate on the Two Cultures.

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The lecture gives engineering students an overview of the basic aspects of intellectual property. The lecture aims to make participants aware of the various methods of protection and to put them in a position to be able to use this knowledge in the workplace.

In recent years, knowledge about intellectual property has become increasingly important for engineers. In both production and distribution as well as in research and development, engineers are increasingly being confronted with questions concerning the patenting of inventions and the utilisation of patent information. With up to 80% of publicly-available technical information being stored in patents only, it is of great importance for engineers to know the basics of the patent system and to be in a position to be able to extract relevant information from the flood of patent information available. This relates to daily work in industry as well as in research, where protecting inventions has gained in importance.

Patents are also an important source of information - from competitors and potential cooperation partners to the development of markets and the risk of coming into conflict with third party IP rights. Respectively, a knowledge of patents has also become a key qualification at a company's strategic level.

The seminar is customised to the needs of engineers. Participants will become familiar with practice-relevant aspects of intellectual property with the emphasis being placed on patents. Participants will be able to use the acquired knowledge in the protection and commercialisation of their own inventions.

The topics covered will include:
- The importance of innovation in industrialised countries and high-tech sectors
- The protection of inventions and the safeguarding of commercial implementation - the role and importance of intellectual property
- Patents as a source of technical and business information
- Practical aspects of intellectual property for day-to-day research work, for the formation of start-ups and at the workplace.

The seminar contains practical exercises on the use and research of patent information. Basic knowledge on how to read and evaluate patent documents, as well as how to use publicly available patent databases in order to obtain the required patent information will also be provided.

The seminar is coordinated in particular to the needs of the following degree programs: Agricultural science, architecture, civil engineering, computational science and engineering, computer science, electrical engineering and information technology, environmental engineering, geomatic engineering and planning, interdisciplinary sciences, materials science, mathematics, mechanical engineering, physics.

For students of chemistry-related degree programs, the lecture 'Protecting inventions in chemistry' will be offered, which is coordinated to the needs of students in these degree programs.

**851-0724-00L Property Law for Geometers: Land Registry and Geoinformation Law**

*Notice: 2 credits*  
*Prerequisites / notice: 2V C. Jäger*

**Abstract**  
Fundamental concepts of Land Register Law and Land Surveying Law (substantive and procedural rules of Land Register Law, the parts and the relevance of the Land Register, process of registration with the Land Register, legal problems of land surveying, reform of the official land surveying).

**Objective**  
Overview of the legal norms of land registry and surveying law.

**Content**  
Basic principles of material and formal land registry law, components of the land register, consequences of the land register, the registration process, legal problems of surveying, the reform of official surveying, liability of the geo-meter. The lecture unit is carried out within a frame of 8 sessions (2 hours): the first hour of each is given in the form of a lecture, the second in the form of a case-study.

**Lecture notes**  
Abgegebene Unterlagen: Skript in digitaler Form

**Literature**  
- Meinrad Huser, Schweizerisches Vermessungsrecht, unter besonderer Berücksichtigung des Geoinformationsrechts und des Grundbuchrechts, Beiträge aus dem Institut für schweizerisches und internationales Baurecht der Universität Freiburg/Schweiz, Zürich 2014
- Dieter Zobl, Grundbuchrecht, Zürich 1999
- Meinrad Huser, Darstellung von Grenzen zur Sicherung dinglicher Rechte, in ZBGR 2013, 238 ff.
- Meinrad Huser, Datenschutz bei Geodaten

**Prerequisites / notice**  
Requirements: Property Law (12-722)

**851-0705-02L Environmental Law: Topics and Case Studies**

*Prerequisites: Environmental Law: Conceptions and Fields (851-0705-01L) offered in spring semester.*

**Number of participants limited to 20.**

**Abstract**  
This workshop offers to the students the opportunity to intensify their environmental legal knowledge on the basis of individual topics or cases of their respective programme or professional interest in a guided self-study. They develop a better understanding for the practical application of legal regulations on environmental matters.

**Objective**  
The aim of this workshop is to equip students with legal skills and methods to solve or treat problems and questions of the environmental law and foster the understanding on the possibilities and limits of legal problem-solving. The students choose an inquiry with practical relevance. To this end they work out the legal basis demonstrating a legal correct solution or approach to a solution. In doing so, students will get to know legal methods and research possibilities.

**Content**  
At the beginning of the workshop the students are introduced to the legal methods and sources as well as in the aim and the process of the workshop. The participants will organize themselves in a team of two persons giving themselves an inquiry on topics of the environmental law. It is also possible to choose questions at the interfaces of e.g. zoning law, energy law, transport law, A proposal, which will be presented to the lecturer, as well as an optional Q&A-session in class will facilitate the start. Next the working on topics will follow by self-study. The results will be presented in form of a memo/paper with a maximum of ten pages (excluding graphs and tables). At the end of the workshop, a presentation of ten minutes will be made to the plenum including a question-and-answer session. Class language will be German.

**Lecture notes**  
Den Studierenden werden Unterlagen zur juristischen Methoden- und Quellenlehre sowie zum Inhalt und Ablauf des Kurses zu Beginn der Veranstaltung kostenlos abgegeben.

**Literature**  
Rechtsgrundlagen, Literatur und Gerichtsentscheide werden themenspezifisch selber recherchiert, unter Mithilfe und Beratung des Dozenten.
851-0707-00L  
**Space Planning Law and Environment**  
Particularly suitable for students of D-ARCH, D-BAUG, D-USYS  

**Abstract**  
System of swiss planning law, Constitutional and statutory provisions, Space planning and fundamental rights, Instruments, Application, legal protection, enforcement, Practical training.

**Objective**  
Basic understanding of nature and function of space planning from a legal point of view. Basic knowledge of space planning instruments, relationship between space planning and constitutional law (especially property rights), solving of practical cases.

**Content**  

**Lecture notes**  
Haller, Walter/Karlen, Peter, Raumplanung-, Bau- und Umweltrecht, 3.A., Zürich 1999

Hänni, Peter, Planungs-, Bau- und besonderes Umweltschutzrecht, 5.A., Bern 2008

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051-0363-00L  
**History of Urban Design I**  

**Abstract**  
The lecture covers the time from the beginning of urban culture until the mid 19th century. With selected examples it emphasizes on the historical plannings and methods of European cities. Each specific urban development will be presented within a broader context.

**Objective**  
This course analyzes the history of urban architecture primarily in its existing three dimensional form as a complex human artefact. It also explores the inspirations that prompted the creation of this artefact: philosophical and religious concepts, social conditions, property relationships and the mechanisms that exploit the economics of real estate and the influence of building technology. Intellectual, literary or artistic modes of thought will also be assessed with regard to their impact on urban development. Urbanism has its own distinctive approach as a discipline, but it is also clearly responsive to the influence of related disciplines. Study is made of actual cities and urban expansion plans which are in the process of implementation, as well as unrealized projects and visions of the future. These projects sometimes illustrate ways of thinking that are equal to, or clearer than, actual urban situations.

**Notice**  
01. Introduction to the discipline and method: The history of urban design as a historical project
02. Athens and Rome in the ancient world: Myth, selfportrayal and speculation
03. From the spirit of equality to the colonial module: Greek and Roman City foundings
04. From the urban ideal to new cities in the Middle Ages and the Renaissance
05. Baroque strategies: The new organisation of Rome under Sixtus V, the production of Versailles under Louis XIV and the invention of St. Petersburg
06. The city between Absolutism and Enlightenment: baroque defence-designs, the European colonization of the American continent and the reconstruction of Lisbon
07. Ideology and speculation after the Glorious Revolution: landscapegoardens and urban figurations in England from 1650-1850
08. Between modernization, Grandeur and repression: Embellishment in Paris from 1750-1830
09. The construction of the bourgeois city: Georges-Eugène Haussmann transforms Paris into the capital of the 19th century
10. Architectural insertion and plan for the expansion of the city: From the Berlin of Karl Friedrich Schinkel to James Hobrecht
11. Neoabsolute power, bourgeois self-confidence and Marxian Idealism: The Viennese Ringstrasse and Ildefonso Cerdas Ensanche for Barcelona

**Lecture notes**  
The lectures are accompanied by a script (two semesters of the bachelor studies), that can be purchased at the chair for the history of urban design (HIL D 75.2) at the price of CHF 30.-. The script serves as an auxiliary means to the attended lecture compiling the most important illustrations showed and the names and dates of the buildings and its builders along with a short introductory note.

**Literature**  
Hänni, Peter, Planungs-, Bau- und besonderes Umweltschutzrecht, 5.A., Bern 2008

**Prerequisites / notice**  
Recommended literature to consult is listed within the script.
### 701-0703-00L Environmental Ethics

- **W 2 credits**  
- **2V**  
- **M. Huppenbauer**

**Abstract**  
The lecture begins with an introduction to applied ethics in general. The main focus is on environmental ethics. Students learn to handle important concepts and positions of environmental ethics. They achieve a deeper understanding of these concepts and positions in applying them to ecological problems and discussing them in case studies.

**Objective**  
On completion of this lecture course you will have acquired the ability to identify and process general and environmental ethical problems. You will be capable of recognising and analysing environmental ethical problems and of working towards a solution. You will have acquired a fundamental knowledge of standpoints and arguments to be found within the field of environmental ethics and you will have practised these in small case studies.

**Content**  
- Introduction to general and applied ethics.  
- Overview and discussion of ethical theories relevant to the environment.  
- Familiarisation with various basic standpoints within environmental ethics.  
- Cross-section topics, such as sustainability, intergenerational justice, protection of species, etc.  
- Practising of newly acquired knowledge in case studies (protection of species, climate change, etc.)

**Lecture notes**  
Summaries of the individual sessions will be distributed, including the most important theories and keywords; reading list.

**Literature**  
- Andrew Light/Holmes Rolston III, Environmental Ethics. An Anthology, 2003  
- John O'Neill et al., Environmental Values, 2008  
- Klaus Peter Rippe, Ethik im ausserhumanen Bereich, Paderborn (mentis) 2008

**Prerequisites / notice**  
The course can be not taken by Master students of the D-ARCH, who have already completed it within the Bachelor programme.

### 851-0549-00L WebClass Introductory Course History of Technology

- **W 3 credits**  
- **2V**  
- **D. Gugerli**

**Abstract**  
WebClass Introductory Course History of Technology is an introductory course to the history of technology. The students are challenged to discover how technological innovations take place within complex economical, political and cultural contexts. They get introduced into basic theories and practices of the field.

**Objective**  
Students are introduced into how technological innovations take place within complex economical, political and cultural contexts. They get to know basic theories and practices of the field.

**Content**  

**Lecture notes**  

**Literature**  
https://www.tg.ethz.ch/de/programme/

**Prerequisites / notice**  

**Further information**  
Weitere Informationen unter https://www.tg.ethz.ch/de/programme/

### 860-0006-00L Statistical Data Analysis

- **W 3 credits**  
- **3G**  
- **M. Höglinger, I. Günther, K. Hartgen**

**Abstract**  
This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with statistical software such as Stata.

**Objective**  
Students  
- have a sound understanding of linear and logit regression  
- know some basics about regression models for multinomial, ordered, or censored response variables, as well as for count data  
- know strategies to test causal hypotheses using regression analysis with experimental and quasi-experimental methods  
- are able to formulate and implement a regression model for a particular research question and a particular type of data  
- are able to critically interpret results of a regression model, in particular, regarding causal inference  

**Content**  
The topics covered in the first part of the course are linear and logit regression analysis. Extensions to regression models for ordered, multinomial or censored response variables, as well as for count data will be addressed briefly. The second part of the course focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, propensity score matching, and randomized controlled trials.

The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs. Students will be enabled to critically read and assess published empirical social science studies.

Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructor. These data sets will cover topics at the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of one fourth. Students are assisted in solving the assignments during the exercises session. Support is provided for the analysis software Stata, but students are free to choose R, SPSS or any other software to solve the assignments.
### Central Questions in Bioethics

**Abstract**
Bioethics deals with the evaluation and regulation of technology based interventions into life. What are valid principles guiding bioethical decision, principles like "Protect the dignity of the living being!" or "Respect a person's self-determination"? Besides answering such questions, the social, scientific and political processes linked with biotechnologies should be taken into account.

**Objective**

**Literature**
1. Dieter Sturma/Bert Heinrichs (Hg.), Handbuch Bioethik, Stuttgart: Metzler 2015.

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### Philosophy of Biology

**Abstract**
The philosophy of biology deals with concepts and problems that occur specifically while dealing with living entities. Accordingly, it covers the historical as well as systematic aspects of concepts like gene or species, or theories explaining diversity or stability, competitive or cooperative action. Another important topic is the role of technology while affording biological objects.

**Objective**
The overarching objective of this seminar is to get an impression of the specificity of biological problems and to develop an appropriate philosophical sensitivity. Accordingly, philosophical traditions in biology will be discussed, just as the application of the history of concepts in the context of biology. The seminar reader will consist of contributions of biologists as well as philosophers of biology. Besides the basic concepts in biology such as gene, species, evolution, or diversity, we will be also reflecting on the relationship between technology, experimenting, and biological objects. Depending on the interests of the seminar participants, the examples to be discussed may be chosen from systems biology, molecular or synthetic biology, ecology or else.

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### Research Ethics

**Abstract**
This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.

**Objective**
The main goal of this course is to enhance the student's ability to:
- recognize and identify ethical issues and conflicts,
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.
I. Ethics & the Process of Ethical Inquiry

Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)

Integrity in Research & Research Misconduct
- What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 Rs (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks;
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access;
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.
Abstract

Manifolds and individuation are concepts which allow to reconsider notorious problems such as the relationship between general and particular, substance and modi, physical processes and persons. They may incorporate heterogeneous elements as needed to overcome traditional categories and classifications, and also describe processes leading to the existence of things.

Objective

The students should become familiar with some conceptual possibilities to recognise and deal with structures across the usual division of subjects. The problem areas are discussed on the basis of texts of various mathematicians and philosophers, with a wide range of applications such as psychology and life sciences.

D-CHAB

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<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>851-0125-51L</td>
<td>Man and Machine</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>M. Hampe, D. A. Strassberg</td>
</tr>
<tr>
<td>Abstract</td>
<td>The lecture gives an overview about the different Man-Machine-Relations since the 16th century. Different modells of machines will be important here: the clockwork, the steam engine and the computer.</td>
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<tr>
<td>Objective</td>
<td>On the one hand models of machines had a heuristical value in research on man, e.g. in Harvey's discovery of blood circulation in the 17th century or in brain research in the 20th century. On the other hand these modells were always criticised, sometimes polemically, because they are supposedly not adequate for man. Students should learn about the connections between the history of anthropology and technology and be able at the end of the course to evaluate the critical philosophical arguments that are connected with the metaphor of the machine.</td>
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</table>

851-0125-52L | Central Questions in Bioethics | W    | 3    | 2S    | L. Wingert |
| Abstract   | Bioethics deals with the evaluation and regulation of technology based interventions into life. What are valid principles guiding bioethical decision, principles like "Protect the dignity of the living being!", or "Respect a person's self-determination"? Besides answering such questions, the social, scientific and political processes linked with biotechnologies should be taken into account. Dürfen Embryonen unter dem Aspekt selektiert werden, ob sie als Rettungsgeschwister geeignet sind, deren Zellgewebe einem schon geborenen anderen Kind durch Implantation das Leben retten kann? Soll die Forschung an Pilzen erlaubt sein, die das menschliche Gedächtnis teilweise auslöschen und damit zum Beispiel traumatische Erlebnisse beseitigen können? Spricht wirklich mehr gegen Hirndoping als gegen Kaffeekonsum? Darf es Patente auf menschliche Stammzellen geben? Das sind Fragen der Bioethik. Der Kurs hat das Ziel, einige der wichtigsten bioethischen Fragen zu erforschen. Es sollen normative Prinzipien identifiziert werden, die oft faktisch bioethischen Entscheidungen zu Grunde liegen. Und es sollen überzeugende Prinzipien ermittelt werden. Zugleich sollen die Teilnehmer Kenntnisse erwerben über die Entwicklungen in zeitgenössischen Gesellschaften westlichen Typs (mit individuellen Grundrechten, kapitalistischer Marktwirtschaft und systematische wissenschaftlicher Forschung), die mit der Dynamik von Biotechniken zusammenhängen. |

Literature

1. Dieter Sturma/Bert Heinrichs (Hg.), Handbuch Bioethik, Stuttgart: Metzler 2015.

851-0145-04L | History and Philosophy of Pharmacy | W    | 3    | 2S    | S. Baier |
|Abstract    | The course provides an insight into selected topics and questions of the history and philosophy of pharmacy by reading and discussing both modern and historical texts. |

851-0738-03L | Protecting Inventions in Chemistry | W    | 2    | 2V    | C. Soltmann |
|Abstract    | The lecture gives students of chemistry-related degree programs an overview of the options to protect inventions and the underlying investments in research and development. The lecture aims to put the participants in a position to be able to use this know-how in the workplace. |
Objective

Research and development play an important role in chemistry-related technology sectors, such as inorganic chemistry, pharmacy or food chemistry.

Investments in the development of new substances and active component in these sectors are traditionally secured by patents because publicly known inventions, generally chemical substances, may easily be reproduced by others.

In the last years, the know-how about intellectual property has become increasingly important for chemists and engineers. Both in the production process and in the distribution sector, chemists and engineers are increasingly concerned with questions related to patenting inventions and the use of patent information. As more than three-quarters of all publicly available technical information is reportedly available only in patents, it is more and more important for researchers and engineers to be capable of extracting relevant information from the flood of patents.

Patents are not only a measure to protect investments and inventions in chemistry-related sectors but also an important source of information about competitors and potential cooperation partners, about the development of markets and the risks of infringing others' patents. Accordingly, the know-how about patents and patent information has also become a key qualification on the strategic level in companies and in the area of research.

The seminar is customised to the needs of chemists and students of related degree programs. Participants will become familiar with practice-relevant aspects of intellectual property with the emphasis being placed on patents. Participants will be able to use the acquired knowledge in the protection and commercialisation of their own inventions.

The topics covered will include:
- The importance of innovation in industrialised countries and high-tech sectors
- The protection of inventions and the safeguarding of commercial implementation - the role and importance of intellectual property
- Patents as a source of technical and business information
- Practical aspects of intellectual property for day-to-day research work, for the formation of start-ups and at the workplace.
- Special aspects of protecting inventions in chemistry-related sectors, including polymorphs and inventions in the field of nanotechnology.

The seminar contains practical exercises on the use and search of patent information in chemistry-related sectors. Basic know-how on how to read and evaluate patent documents, as well as how to use publicly available patent databases in order to obtain the required patent information will also be provided.

Prerequisites / notice

The lecture is coordinated in particular to the needs of the following degree programs: Agricultural science, biotechnology, chemical engineering, chemistry, food science, pharmaceutical sciences.

For engineering and physics students, the lecture 'The Role of Intellectual Property in daily routine: A Practical Introduction' will be offered, which is coordinated to the needs of students in these degree programs.

851-0180-00L  Research Ethics  W 2 credits  2G  G. Achermann

Abstract

This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.

Objective

The main goal of this course is to enhance the student's ability to:
- recognize and identify ethical issues and conflicts,
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.
I. Ethics & the Process of Ethical Inquiry
---------------------------------------
Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
- Professional codes of conduct: functions and limitations

Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
- The plurality of ethical theories and its consequences;
- The concept of dignity

Moral reasoning I: Arguments
- Why arguments? What is a good argument? The structure of (moral) arguments;
- Deductive and inductive arguments; Validity and soundness;
- Assessing moral arguments

Moral reasoning II: Decision-making
- How (not) to approach ethical issues...; Is there a correct method for answering moral questions?
- Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
- Is there a right answer?

II. Research Ethics / Responsible Conduct of Research (RCR)
----------------------------------------------------------
Integrity in Research & Research Misconduct
- What is “integrity” in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
- The confidant of ETH Zurich

Data Management
- Data collection and recordkeeping; Analysis and selection of data;
- Ownership of data; retention and sharing of data;
- Falsification and fabrication of data

Research involving animals
- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 R's (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
- Clinical trials;
- Biobanks
- Ethics Committees / Institutional Review Boards (IRB)

Authorship & Peer review
- Criteria for authorship;
- Plagiarism;
- Challenges to openness and freedom in scientific publication;
- Open access
- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.

Literature
Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RCRintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.

860-0006-00L Statistical Data Analysis W 3 credits 3G M. Höglinger, I. Günther, K. Harttgen

Number of participants limited to 20.

Abstract
This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with statistical software such as Stata.
Introduction to general and applied ethics.
The topics covered in the first part of the course are linear and logit regression analysis. Extensions to regression models for ordered, multinominal or censored response variables, as well as for count data will be addressed briefly. The second part of the course focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, propensity score matching, and randomized controlled trials.

The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs. Students will be enabled to critically read and assess published empirical social science studies. Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover topics at the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of one fourth. Students are assisted in solving the assignments during the exercises session. Support is provided for the analysis software Stata, but students are free to choose R, SPSS or any other software to solve the assignments.

<table>
<thead>
<tr>
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<tr>
<td>701-0703-00L</td>
<td>Environmental Ethics</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>M. Huppenbauer</td>
</tr>
</tbody>
</table>

The lecture begins with an introduction to applied ethics in general. The main focus is on environmental ethics. Students learn to handle important concepts and positions of environmental ethics. They achieve a deeper understanding of these concepts and positions in applying them to ecological problems and discussing them in case studies.

On completion of this lecture course you will have acquired the ability to identify and process general and environmental ethical problems. You will be capable of recognising and analysing environmental ethical problems and of working towards a solution. You will have acquired a fundamental knowledge of standpoints and arguments to be found within the field of environmental ethics and will have practised these in small case studies.

- Introduction to general and applied ethics.
- Overview and discussion of ethical theories relevant to the environment.
- Familiarisation with various basic standpoints within environmental ethics.
- Cross-sectorial topics, such as sustainability, intergenerational justice, protection of species, etc.
- Practising of newly acquired knowledge in case studies (protection of species, climate change, etc.)

Summaries of the individual sessions will be distributed, including the most important theories and keywords; reading list. In the part of the course serving as an introduction to general and applied ethics, we shall be using the following textbook: Barbara Bleisch/Markus Huppenbauer: Ethische Entscheidungsfindung, Ein Handbuch für die Praxis, Zürich 2010 (to be published Autumn 2010).

- Andrew Light/Holmes Rolston III, Environmental Ethics. An Anthology, 2003
- John O'Neill et al., Environmental Values, 2008
- Klaus Peter Rippe, Ethik im ausserhumanen Bereich, Paderborn (mentis) 2008

Generel introductions:
- Barbara Bleisch/Markus Huppenbauer: Ethische Entscheidungsfindung, Ein Handbuch für die Praxis, Zürich 2014, 2. Auflage
- Marcus Diwiel et. al (Hrsg.), Handbuch Ethik, 2. Auflage, Stuttgart (Metzler Verlag), 2006
- Johann S. Ach et. al (Hrsg.), Grundtext Ethik 1. Grundlagen, Paderborn (mentis) 2008

The procedure for accumulating CP will be explained at the start of term.

I expect participants to be motivated and contribute to discussions, keeping the course interesting and lively.

Number of participants limited to 20.

This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with statistical software such as Stata.

Students are able to critically interpret results of a regression model, in particular, regarding causal inference.

The topics covered in the first part of the course are linear and logit regression analysis. Extensions to regression models for ordered, multinominal or censored response variables, as well as for count data will be addressed briefly. The second part of the course focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, propensity score matching, and randomized controlled trials.

The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs. Students will be enabled to critically read and assess published empirical social science studies. Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover topics at the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of one fourth. Students are assisted in solving the assignments during the exercises session. Support is provided for the analysis software Stata, but students are free to choose R, SPSS or any other software to solve the assignments.

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<tr>
<td>860-0006-00L</td>
<td>Statistical Data Analysis</td>
<td>W</td>
<td>3 credits</td>
<td>3G</td>
<td>M. Höglinger, I. Günther, K. Harttgen</td>
</tr>
</tbody>
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This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with statistical software such as Stata.

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Abstract
Bioethics deals with the evaluation and regulation of technology based interventions into life. What are valid principles guiding bioethical decision, principles like “Protect the dignity of the living being!” or “Respect a person’s self-determination!”? Besides answering such questions, the social, scientific and political processes linked with biotechnologies should be taken into account.

Objective

The seminar deals with hot topics of the history of technology since the 1960s. Sharing of computertime, software and data will be discussed as a crucial offer and problem of late modernity.

Literature
1. Dieter Sturma/Bert Heinrichs (Hg.), Handbuch Bioethik, Stuttgart: Metzler 2015.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Instructor</th>
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<tr>
<td>851-0157-56L</td>
<td>Avantgarde-Life: Utopia of the 'New Man' Between Science and Technology</td>
<td>3</td>
<td>W</td>
<td>M. Wulz</td>
</tr>
<tr>
<td>851-0549-12L</td>
<td>Sharing. The History of an Attractive Technology</td>
<td>3</td>
<td>W</td>
<td>D. Gugeri</td>
</tr>
<tr>
<td>363-1027-00L</td>
<td>Introduction to Health Economics and Policy</td>
<td>3</td>
<td>W</td>
<td>W. Mimra</td>
</tr>
<tr>
<td>851-0180-00L</td>
<td>Research Ethics</td>
<td>2</td>
<td>W</td>
<td>G. Achermann</td>
</tr>
</tbody>
</table>

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Objective

The main goal of this course is to enhance the student's ability to:
- recognize and identify ethical issues and conflicts,
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.

Content

I. Ethics & The Process of Ethical Inquiry

Introduction in Ethics and Research Ethics
- What is ethics? What ethics is not...;
- Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
- The ethics movement in the biological and health sciences;
- What is research ethics and why is it important?
- Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
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Ethical approaches in the conduct of research (Normative Ethics)
- Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties), consequentialist theories, other theories);
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Integrity in Research & Research Misconduct
- What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
- Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
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- Falsification and fabrication of data

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- The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
- The 3 Rs (replacement, reduction, refinement);
- Ethical assessment of conflicting issues in animal experimentation;
- The dignity of animals in the Swiss constitution;

Research involving human subjects
- History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
- Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
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- Peer review

Social responsibility
- What is social responsibility? Social responsibility: whose obligation?
- Public advocacy by researchers

Lecture notes

Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.
The course wants to develop the students' ability to critically read and assess historic texts. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with statistical software such as Stata.

Objective

Students

- have a sound understanding of linear and logit regression
- know some basics about regression models for multinomial, ordered, or censored response variables, as well as for count data
- know strategies to test causal hypotheses using regression analysis with experimental and quasi-experimental methods
- are able to formulate and implement a regression model for a particular research question and a particular type of data
- are able to critically interpret results of a regression model, in particular, regarding causal inference

Content

The topics covered in the first part of the course are linear and logit regression analysis. Extensions to regression models for ordered, multinomial or censored response variables, as well as for count data will be addressed briefly. The second part of the course focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, propensity score matching, and randomized controlled trials.

The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs. Students will be enabled to critically read and assess published empirical social science studies.

Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover topics at the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of one fourth. Students are assisted in solving the assignments during the exercises session. Support is provided for the analysis software Stata, but students are free to choose R, SPSS or any other software to solve the assignments.

560-0006-00L Statistical Data Analysis

W 3 credits 3G M. Höglinger, I. Günther, K. Harttgen

Number of participants limited to 20.

Abstract

This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with statistical software such as Stata.

Objective

Students

- have a sound understanding of linear and logit regression
- know some basics about regression models for multinomial, ordered, or censored response variables, as well as for count data
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Content

The topics covered in the first part of the course are linear and logit regression analysis. Extensions to regression models for ordered, multinomial or censored response variables, as well as for count data will be addressed briefly. The second part of the course focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, propensity score matching, and randomized controlled trials.

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Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover topics at the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of one fourth. Students are assisted in solving the assignments during the exercises session. Support is provided for the analysis software Stata, but students are free to choose R, SPSS or any other software to solve the assignments.

850-0549-12L Sharing. The History of an Attractive Technology

W 3 credits 2S D. Gugerli

Number of participants limited to 20.

Abstract

This seminar introduces theory and methods in human-computer interaction and usability. Cognitive Science provides a theoretical framework for designing user interfaces as well as a range of methods for assessing usability (user testing, cognitive walkthrough, GOMS). The seminar will provide an opportunity to experience some of the methods in applied group projects.

Objective

This seminar will introduce key topics, theories and methodology in human-computer interaction (HCI) and usability. Presentations will cover basics of human-computer interaction and selected topics like mobile interaction, adaptive systems, human error and attention. A focus of the seminar will be on getting to know evaluation techniques in HCI. Students form work groups that first familiarize themselves with a select usability evaluation method (e.g. user testing, GOMS, task analysis, heuristic evaluation, questionnaires or Cognitive Walkthrough). They will then apply the methods to a human-computer interaction setting (e.g. an existing software or hardware interface) and present the method as well as their procedure and results to the plenary. Active participation is vital for the success of the seminar, and students are expected to contribute to presentations of foundational themes, methods and results of their chosen group project. In order to obtain course credit a written essay/report will be required (details to be specified in the introductory session of the course).

450-0548-12L Human-Computer Interaction: Cognition and Usability

W 3 credits 2S C. Hölscher, I. Barisic, S. Ognjanovic

Number of participants limited to 20.

Abstract

This seminar introduces theory and methods in human-computer interaction and usability. Cognitive Science provides a theoretical framework for designing user interfaces as well as a range of methods for assessing usability (user testing, cognitive walkthrough, GOMS). The seminar will provide an opportunity to experience some of the methods in applied group projects.

Objective

This seminar will introduce key topics, theories and methodology in human-computer interaction (HCI) and usability. Presentations will cover basics of human-computer interaction and selected topics like mobile interaction, adaptive systems, human error and attention. A focus of the seminar will be on getting to know evaluation techniques in HCI. Students form work groups that first familiarize themselves with a select usability evaluation method (e.g. user testing, GOMS, task analysis, heuristic evaluation, questionnaires or Cognitive Walkthrough). They will then apply the methods to a human-computer interaction setting (e.g. an existing software or hardware interface) and present the method as well as their procedure and results to the plenary. Active participation is vital for the success of the seminar, and students are expected to contribute to presentations of foundational themes, methods and results of their chosen group project. In order to obtain course credit a written essay/report will be required (details to be specified in the introductory session of the course).

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 602 of 1434
At the heart of the discourse is the handling of digital goods and intellectual property in society. Digitization and the Internet allow handling of these resources on a global scale. How do various interest groups influence the methods of production, distribution, and use of digital resources? Current models focusing on intellectual property rights are often criticized for not adequately addressing these new realities.

M. M. Dapp

Slides and other material (both usually in English) will be made available on a weekly basis as the lecture proceeds.

Technical reality: Within minutes you can make perfect copies of high-value digital goods of knowledge or culture (as text, audio, video, images, software) and distribute them around the globe -- for free. "Digitization plus Internet" allows for the first time in humankind's history the (theoretically) free access and global exchange of knowledge at minimal cost. A tremendous opportunity for societal development, in north and south. «Cool, so what's the problem?»

The problem is, that this reality poses a fundamental threat to today's business model of the knowledge and culture industries (starting from the music label and Hollywood, via publishers, up to software vendors). Powerful commercial interests are at stake as "knowledge" (the fourth factor of production) will become even more important in the 21st century. Accordingly, «piracy» and «file-sharing» are attacked with all means. At the core lies the question about the design of property in digital assets. For that, we apply a concept of "intellectual property", which is several hundred years old and does not address digital reality in an adequate manner, sometimes leading to absurd situations. Its original goal seems to get forgotten: to help society develop by spreading knowledge as much as possible.

Using the PC becomes the new cultural technique of the 21st century. In contrast to "reading, writing and arithmetics", this new cultural technique cannot exist in isolation, but depends on a hard- and software infrastructure. This dependency extends to the provider of the infrastructure, which can define technical rules, which can take away or restrict the user's freedom. Even advanced users may have difficulties in recognizing these, often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible consequences we need to understand and investigate, because they decide about access, distribution and usage of digital knowledge.

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Comparable to the environmentalist movement of the 60s and 70s, a growing political movement for «Free Software» exists today, with «GNU/Linux» as its most popular symbol. The movement fights against treating software code as private property but as a central cultural good available to all without private interests. Based on the success of the Free Software movement, new initiatives extend the concepts to other domains (e.g. scientific knowledge, music).

As a «teaser» to the lecture, you are invited to read the essay «ETH Zurich - A Pioneer in Digital Sustainability!». It can be downloaded from www.essays2030.ethz.ch.

More on teach.digisus.info starting from September. Stay tuned.

Lecture notes

Slides and other material (both usually in English) will be made available on a weekly basis as the lecture proceeds.
### 851-0585-04L Lecture with Computer Exercises: Modelling and Simulating Social Systems with MATLAB

<table>
<thead>
<tr>
<th>Type</th>
<th>Credits</th>
<th>Week(s)</th>
<th>Prerequisites / notice</th>
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<tbody>
<tr>
<td>Lecture</td>
<td>3</td>
<td>2S</td>
<td>D. Helbing, S. Baliani, O. Woolley</td>
</tr>
</tbody>
</table>

**Number of participants limited to 70.**

**Particularly suitable for students of D-MAVT, D-INFK, D-ITET, D-MTEC, D-PHYS.**

**Abstract**

This course introduces first the basic functionalities and features of the mathematical software package MATLAB, such as the simple operations with matrices and vectors, differential equations, statistical tools, the graphical representation of data in various forms, and video animations of spatio-temporal data. With this knowledge, students are expected to implement themselves in MATLAB, models of various social processes and systems, including agent-based models, e.g. models of interactive decision making, group dynamics, human crowds, or game-theoretical models.

**Content**

Part of this course will consist of supervised programming exercises in a computer pool. Credit points are finally earned for the implementation of a mathematical model from the sociological literature in MATLAB and the documentation in a seminar thesis.

**Lecture notes**

The lecture slides will be presented on the course web page after each lecture.

**Literature**

2. MATLAB kompakt, Wolfgang Schweitzer, (Oldenburg, 2006)

**Prerequisites / notice**

Further literature, in particular regarding computer models in the social sciences, will be provided in the course.

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### 851-0585-41L From Computational Social Science to Global Systems Science

<table>
<thead>
<tr>
<th>Type</th>
<th>Credits</th>
<th>Week(s)</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td>3</td>
<td>2S</td>
<td>D. Helbing</td>
</tr>
</tbody>
</table>

**Number of participants limited to 100.**

**Particularly suitable for students of D-MAVT, D-INFK, D-MTEC, D-PHYS.**

**Abstract**

The seminar aims at three-fold integration: (1) bringing modeling and computer simulation of techno-socio-economic processes and phenomena together with related empirical, experimental, and data-driven work. (2) combining perspectives of different scientific disciplines (e.g. sociology, computer science, physics, complexity science, engineering), (3) bridging between fundamental and applied work.

**Objective**

Participants of the seminar should understand how tightly connected systems lead to networked risks, and why this can imply systems we do not understand and cannot control well, thereby causing systemic risks and extreme events.

They should also able to explain how systemic instabilities can be understood by changing the perspective from a component-oriented to an interaction- and network-oriented view, and what fundamental implications this has for the proper design and management of complex dynamical systems.

**Content**

Computational Social Science and Global Systems Science serve to better understand the emerging digital society with its close co-evolution of information and communication technology (ICT) and society. They make current theories of crises and disasters applicable to the solution of global-scale problems, taking a data-based approach that builds on a serious collaboration between the natural, engineering, and social sciences, i.e. an interdisciplinary integration of knowledge.

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### 851-0549-00L WebClass Introductory Course History of Technology

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<thead>
<tr>
<th>Type</th>
<th>Credits</th>
<th>Week(s)</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td>3</td>
<td>2V</td>
<td>D. Gugerli</td>
</tr>
</tbody>
</table>

**Number of participants limited to 100.**

**Particularly suitable for students of D-BAUG, D-INFK, D-ITET, D-MATL, D-MAVT.**

**Abstract**

WebClass Introductory Course History of Technology is an introductory course to the history of technology. The students are challenged to discover how technological innovations take place within complex economical, political and cultural contexts. They get introduced into basic theories and practices of the field.

**Objective**

Students are introduced into how technological innovations take place within complex economical, political and cultural contexts. They get to know basic theories and practices of the field.

**Content**


**Lecture notes**


**Literature**

https://www.tg.ethz.ch/de/programme/851-0549-00L

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### 860-0006-00L Statistical Data Analysis

<table>
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<tr>
<th>Type</th>
<th>Credits</th>
<th>Week(s)</th>
<th>Prerequisites / notice</th>
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<tbody>
<tr>
<td>Lecture</td>
<td>3</td>
<td>3G</td>
<td>M. Höglinger, I. Günther, K. Hartggen</td>
</tr>
</tbody>
</table>

**Number of participants limited to 20.**

**Abstract**

For administrative and didactic reasons (high level of interaction and credit group assignments on current hot topics), the number of participants is limited to 45.

Of course, any interested person is invited to attend the lecture without doing the group assignment. The website is actively used for the lecture.

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*Data: 06.02.2019 13:00  Autumn Semester 2015  Page 604 of 1434*
This course introduces students to key statistical methods for analyzing social science data with a special emphasis on causal inference. Students learn to choose appropriate analysis strategies for particular research questions and to perform statistical analyses with statistical software such as Stata.

**Objective**

- Students have a sound understanding of linear and logit regression
- Know some basics about regression models for multinomial, ordered, or censored response variables, as well as for count data
- Know strategies to test causal hypotheses using regression analysis with experimental and quasi-experimental methods
- Are able to formulate and implement a regression model for a particular research question and a particular type of data
- Are able to critically interpret results of a regression model, in particular, regarding causal inference

**Content**

The topics covered in the first part of the course are linear and logit regression. Extensions to regression models for ordered, multinomial or censored response variables, as well as for count data will be addressed briefly. The second part of the course focuses on causal inference and introduces methods such as panel data analysis, difference-in-difference methods, instrumental variable estimation, propensity score matching, and randomized controlled trials.

The course shows how the various methods differ in terms of the required identifying assumptions to infer causality as well as the data needs. Students will be enabled to critically read and assess published empirical social science studies.

Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. These data sets will cover topics at the interface of policy, technology and society. Solving the assignments contributes to the final grade with a weight of about 40%.

Support is provided for the analysis software Stata, but students are free to choose R, SPSS or any other software to solve the assignments.

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**D-ITET**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>851-0591-00L</td>
<td>Digital Sustainability in the Knowledge Society</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>M. M. Dapp</td>
</tr>
</tbody>
</table>

**Abstract**

How various interests influence the methods of production, distribution, and use of digital resources? Current models focusing on strong intellectual property rights are contrasted with open models like, e.g., Open Source/Content/Access. The course discusses consequences from different models and introduces «digital sustainability» as an alternative vision for society.

**Objective**

At the heart of the discourse is the handling of digital goods and intellectual property in society. Digitization and the Internet allow handling knowledge in a way, which directly contrasts with the traditional understanding of "intellectual property" and the industries based on it. Starting from economic and legal basics, we compare proprietary and "free" models. Sustainable development as a concept is transferred to digital goods, taking into account the particular nature of digital stuff.

After the lecture, you should (hopefully) be able to:

- characterize the nature of digital goods vs. physical goods
- critique the basic concepts of copyright and patent rights
- explain the political/legal and economic differences between proprietary and open approaches to the production and use of digital goods
- use an example, explain the meaning of digital sustainability and argue why it is relevant for a knowledge society
- transfer the ideas of the free/open source software model to other digital goods (e.g., open content, open access)

**Content**

Technical reality: Within minutes you can make perfect copies of high-value digital goods of knowledge or culture (as text, audio, video, image or software) and distribute them around the globe — for free. «Digitization plus Internet» allows for the first time in humankind's history the (theoretically) free access and global exchange of knowledge at minimal cost. A tremendous opportunity for societal development, in north and south. «Cool, so what's the problem?»

The problem is, that this reality poses a fundamental threat to today's business model of the knowledge and culture industries (starting from the music label and Hollywood, via publishers, up to software vendors). Powerful commercial interests are at stake as «knowledge» (the fourth factor of production) will become ever more important in the 21st century. Accordingly, «piracy» and «file-sharing» are attacked with all means. At the core lies the question about the design of property in digital assets. For that, we apply a concept of «intellectual property», which is several hundred years old and does not address digital reality in an adequate manner, sometimes leading to absurd situations. Its original goal seems to get forgotten: to help society develop by spreading knowledge as much as possible.

Using the PC becomes the new cultural technique of the 21st century. In contrast to «reading, writing and arithmetic», this new cultural technique cannot exist in isolation, but depends on a hard- and software infrastructure. This dependency extends to the provider of the infrastructure, who can define technical rules, which can take away or restrict the user's freedom. Even advanced users may have difficulties in recognizing these, often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible consequences we need to understand and investigate, because they decide about access, distribution and usage of digital knowledge.

Comparative to the environmentalist movement of the 60s and 70s, a growing political movement for «Free Software» exists today, with «GNU/Linux» as its most popular symbol. The movement fights against treating software code as private property but as a central cultural good available to all without private interests. Based on the success of the Free Software movement, new initiatives extend the concepts to other domains (e.g. scientific knowledge, music)...

As a «teaser» to the lecture, you are invited to read the essay «ETH Zurich - A Pioneer in Digital Sustainability».

More on teach.digisus.info starting from September. Stay tuned.

**Lecture notes**

Slides and other material (both usually in English) will be made available on a weekly basis as the lecture proceeds.

**Literature**

Content of the following books is covered (PDFs freely available online):


Other recommended books are:

1. (general) Chris DiBona et al., Open Sources: Voices from the Open Source Revolution, O'Reilly, 1999.

**Prerequisites / notice**

For administrative and didactic reasons (high level of interaction and credit group assignments on current hot topics), the number of participants is limited to 45.

Of course, any interested person is invited to attend the lecture without doing the group assignment. The website is actively used for the lectures.

851-0125-41L Introduction Into Philosophy of Technology

**Abstract**

Since antiquity philosophy reflects about and evaluates technology. The technical developments in the 19th and 20th century have led to an autonomous philosophy of technology, which has become important also for other philosophical disciplines (e.g. in Heidegger's philosophy).

**Objective**

The course gives an overview on the main schools in the philosophy of technology. Students should learn to analyse and evaluate different philosophies of technology (compensation, objectification, externalisation). For credit point a critical protokoll is to be written.

851-0549-12L Sharing. The History of an Attractive Technology

**Abstract**

Particularly suitable for students D-ARCH, D-BAUG, D-

851-0591-00L Digital Sustainability in the Knowledge Society

Particularly suitable for students of D-INFK, D-ITET, D-MATL, D-MAVT, D-MTEC, D-USYS

W 2 credits 2V M. M. Dapp

W 2 credits 2V
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>ECTS</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0306-05L</td>
<td>Literature and Technology - Simulations, Prototypes, Machines</td>
<td>3</td>
<td>2S</td>
<td>The course deals with the basic legal framework for doing e-business as well as using information technology. It discusses a variety of legal concepts and rules to be taken into account in practice, be it when designing and planning new media business models, be it when implementing online projects and undertaking information technology activities. Students are familiar with different relations between literature and technology. They can verbalise and analyse central contentions.</td>
</tr>
<tr>
<td>851-0727-02L</td>
<td>E-Business-Law</td>
<td>2</td>
<td>2V</td>
<td>The seminar deals with hot topics of the history of technology since the 1960s. Sharing of computertime, software and data will be discussed as a crucial offer and problem of late modernity. Students are familiar with different relations between literature and technology. They can verbalise and analyse central contentions.</td>
</tr>
<tr>
<td>851-0252-01L</td>
<td>Human-Computer Interaction: Cognition and Usability</td>
<td>3</td>
<td>2S</td>
<td>This seminar introduces theory and methods in human-computer interaction and usability. Cognitive Science provides a theoretical framework for designing user interfaces as well as a range of methods for assessing usability (user testing, Cognitive Walkthrough, GOMS). The seminar will provide an opportunity to experience some of the methods in applied group projects. Students are expected to contribute to presentations of foundational themes, methods and results of their chosen group project. In order to obtain course credit a written essay / report will be required (details to be specified in the introductory session of the course).</td>
</tr>
</tbody>
</table>

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 606 of 1434
851-0585-04L Lecture with Computer Exercises: Modelling and Simulating Social Systems with MATLAB
Number of participants limited to 70.

Content
This course introduces first the basic functionalities and features of the mathematical software package MATLAB, such as the simple operations with matrices and vectors, differential equations, statistical tools, the graphical representation of data in various forms, and video animations of spatio-temporal data. With this knowledge, students are expected to implement themselves in MATLAB, models of various social processes and systems, including agent-based models, e.g. models of interactive decision making, group dynamics, human crowds, or game-theoretical models.

Lecture notes
The lecture slides will be presented on the course web page after each lecture.

Literature

Further literature, in particular regarding computer models in the social sciences, will be provided in the course.

Prerequisites / notice
The number of participants is limited to the size of the available computer teaching room. The MATLAB code related to the seminar thesis should be well enough documented for further use by others and must be handed over to the Chair of Sociology, in particular of Modeling and Simulation, for further free and unrestricted use.

851-0585-41L From Computational Social Science to Global Systems Science
Particularly suitable for students of D-MAVT, D-ITET, D-MTEC, D-PHYS

Abstract
The seminar aims at three-fold integration: (1) bringing modeling and computer simulation of techno-socio-economic processes and phenomena together with related empirical, experimental, and data-driven work, (2) combining perspectives of different scientific disciplines (e.g. sociology, computer science, physics, complexity science, engineering), (3) bridging between fundamental and applied work.

Objective
Participating in the seminar should understand how tightly connected systems lead to networked risks, and why this can imply systems we do not understand and cannot control well, thereby causing systemic risks and extreme events.

Computational Social Science and Global Systems Science serve to better understand the emerging digital society with its close co-evolution of information and communication technology (ICT) and society. They make current theories of crises and disasters applicable to the solution of global-scale problems, taking a data-based approach that builds on a serious collaboration between the natural, engineering, and social sciences, i.e. an interdisciplinary integration of knowledge.

851-0549-00L WebClass Introductory Course History of Technology
Particularly suitable for students of D-BAUG, D-MAVT, D-MATL, D-ITET

Abstract
WebClass Introductory Course History of Technology is an introductory course to the history of technology. The students are challenged to discover how technological innovations take place within complex economical, political and cultural contexts. They get introduced into basic theories and practices of the field.

Objective
Students are introduced into how technological innovations take place within complex economical, political and cultural contexts. They get to know basic theories and practices of the field.

Content
WebClass Einführungskurs Technikgeschichte is a web-based introduction to the history of technology. The students will be introduced to the history of technology and learn how technological innovations take place within complex economical, political and cultural contexts. They will be challenged to discover how technological innovations take place within complex economical, political and cultural contexts.

Lecture notes

Literature
https://www.tg.ethz.ch/de/programme/

851-0735-10L Business Law
Particularly suitable for students of D-ITET

Abstract
The students shall obtain a basic knowledge about business law. They shall be able to recognize and evaluate issues in the area of business law and suggest possible solutions.

Objective
The students shall obtain the following competence:
- They shall obtain a working knowledge on the legal aspects involved in setting up and managing an enterprise.
- They shall be acquainted with corporate functions as contracting, negotiation, claims management and dispute resolution.
- They shall be familiar with the issues of corporate compliance, i.e. the system to ascertain that all legal and ethical rules are observed.
- They shall be able to contribute to the legal management of the company and to deal with legal issues.
- They shall have an understanding of the law as a part of the corporate strategy and as a valuable resource of the company.

Lecture notes
A comprehensive script will be made available online on the moodle platform.

851-0594-00L International Environmental Politics
Particularly suitable for students of D-ITET, D-USYS

Abstract
This course focuses on the conditions under which cooperation in international environmental politics emerges and the conditions under which such cooperation and the respective public policies are effective and/or efficient.
The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a social sciences viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems.

This course deals with how and why international cooperation in environmental politics emerges, and under what circumstances such cooperation is effective and efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental politics are discussed: the management of international water resources, the problem of unsafe nuclear power plants in eastern Europe, political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

The course is open to all ETH students. Participation does not require previous coursework in the social sciences. After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 4 ECTS credit points. The workload is around 120 hours (meetings, reading assignments, preparation of test).

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory (http://www.rektorat.ethz.ch/students/admission/auditors/specialstudents_uzh/index_EN; see menu on left side of that webpage for students from other universities).

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The workload for this course is approx. 120 hours (all inclusive).

851-0738-01L The Role of Intellectual Property in Daily Routine: A W 2 credits 2V 2 credits C. Soltmann

Practical Introduction
Particularly suitable for students of D-BAUG, D-ITET, D-MAVT

Abstract
The lecture gives engineering students an overview of the basic aspects of intellectual property. The lecture aims to make participants aware of the various methods of protection and to put them in a position to be able to use this knowledge in the workplace.

Objective
In recent years, knowledge about intellectual property has become increasingly important for engineers. In both production and distribution as well as in research and development, engineers are increasingly being confronted with questions concerning the patenting of inventions and the utilisation of patent information. With up to 80% of publicly-available technical information being stored in patents only, it is of great importance for engineers to know the basics of the patent system and to be in a position to be able to extract relevant information from the flood of patent information available. This relates to daily work in industry as well as in research, where protecting inventions has gained in importance.

Patents are also an important source of information - from competitors and potential cooperation partners to the development of markets and the risk of coming into conflict with third party IP rights. Respectively, a knowledge of patents has also become a key qualification at a company's strategic level.

The seminar is customised to the needs of engineers. Participants will become familiar with practice-relevant aspects of intellectual property with the emphasis being placed on patents. Participants will be able to use the acquired knowledge in the protection and commercialisation of their own inventions.

The topics covered will include:
- The importance of innovation in industrialised countries and high-tech sectors
- The protection of inventions and the safeguarding of commercial implementation - the role and importance of intellectual property
- Patents as a source of technical and business information
- Practical aspects of intellectual property for day-to-day research work, for the formation of start-ups and at the workplace.

The seminar contains practical exercises on the use and research of patent information. Basic knowledge on how to read and evaluate patent documents, as well as how to use publicly available patent databases in order to obtain the required patent information will also be provided.

Prerequisites / notice
The lecture is coordinated in particular to the needs of the following degree programs: Agricultural science, architecture, civil engineering, geomatic engineering and planning, interdisciplinary sciences, materials science, mathematics, mechanical engineering, physics.

For students of chemistry-related degree programs, the lecture 'Protecting inventions in chemistry' will be offered, which is coordinated to the needs of students in these degree programs.

851-0609-05L The Economics of Climate Change W 3 credits 2V

Does not take place this semester.
Particularly suitable for students of D-ITET, D-MATL, D-MAVT, D-USYS

Abstract
Climate change is one of the most pressing issues that governments and the global community have to face. This course outlines the problem of climate change and discusses the economic solutions (both domestic and international) to this problem.

Objective
This course has a number of objectives: (i) To outline the problem of climate change (ii) to discuss and compare the theoretical economic solutions to combating climate change (iii) to present existing climate change mitigation actions in an economic context and (iv) to outline possible future climate policy issues.

Content
Economics of pollution, Optimal level of greenhouse gases, International Environmental Agreements, Tradable pollution permit markets, : Carbon Taxes, Technological innovation and R&D, The optimal approach to control Climate change, The future of Climate change policy

Literature
Required reading:
Perman et al. (2003), Natural Resource and Environmental Economics, Pearson Addison Wesley. Also, Journal articles will be cited

Prerequisites / notice
Prerequisites: The course relies heavily on the concepts and techniques used in basic game theory. Therefore prior knowledge is recommended.
851-0252-02L Introduction to Cognitive Science

- **Number of participants limited to 70.**
- **Particularly suitable for students of D-ITET**

**Abstract**
The lectures provide an overview of the foundations of cognitive science and investigate processes of human cognition, especially perception, learning, memory and reasoning. This includes a comparison of cognitive processes in humans and technical systems, especially with respect to knowledge acquisition, knowledge representation and usage in information processing tasks.

**Objective**
Cognitive Science views human cognition as information processing and provides an inter-disciplinary integration of approaches from cognitive psychology, informatics (e.g., artificial intelligence), neuroscience and anthropology among others. The lectures provide an overview of basic mechanisms of human information processing and various application domains. A focus will be on matters of knowledge acquisition, representation and usage in humans and machines. Models of human perception, reasoning, memory and learning are presented and students will learn about experimental methods of investigating and understanding human cognitive processes and representation structures.

851-0738-00L Intellectual Property: Introduction

- **Particularly suitable for students of D-ITET, D-MAVT, D-MATL**

**Abstract**
The course provides an introduction to Swiss and European intellectual property law (trademarks, copyright, patent and design rights). Aspects of competition law are treated institutionally and are relevant for the protection of intellectual creations and source designations. The legal principles are developed based on current cases.

**Objective**
The aim of this course is to enable students at ETH Zurich to recognize which rights may protect their creations, and which rights may be infringed as a result of their activities. Students should learn to assess the risks and opportunities of intellectual property rights in the development and marketing of new products. To put them in this position, they need to know the prerequisites and scope of protection afforded by the various intellectual property rights as well as the practical difficulties involved in the enforcement of intellectual property rights. This knowledge is imparted based on current rulings and cases.

Another goal is to enable the students to participate in the current debate over the goals and desirability of protecting intellectual creations, particularly in the areas of copyright (keywords: fair use, Creative Commons, Copyleft) and patent law (software patents, patent trolls, patent thickets).

851-0585-15L Complexity and Global Systems Science

- **Particularly suitable for students of D-ITET**

**Abstract**
This course discusses complex techno-socio-economic systems, their counter-intuitive behaviors, and how their theoretical understanding empowers us to solve long-standing problems that are currently bothering the world.

**Objective**
Participants should learn to get an overview of the state of the art in the field, to present it in a well understandable way to an interdisciplinary scientific audience, to develop models for open problems, to analyze them, and to defend their results in response to critical questions. In essence, participants should improve their scientific skills and learn to think scientifically about complex dynamical systems.

**Content**
This course starts with a discussion of the typical and often counter-intuitive features of complex dynamical systems such as self-organization, emergence, (sudden) phase transitions at “ tipping points”, multi-stability, systemic instability, deterministic chaos, and turbulence. It then discusses phenomena in networked systems such as feedback, side and cascade effects, and the problem of radical uncertainty. The course progresses by demonstrating the relevance of these properties for understanding societal and, at times, global-scale problems such as traffic jams, crowd disasters, breakdowns of cooperation, crime, conflict, social unrests, political revolutions, bubbles and crashes in financial markets, epidemic spreading, and/or “tragedies of the commons” such as environmental exploitation, overfishing, or climate change. Based on this understanding, the course points to possible ways of mitigating techno-socio-economic-environmental problems, and what data science may contribute to their solution.

**Prerequisites / notice**
Mathematical skills can be helpful.

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### D-MATH

#### Number	Title	Type	ECTS	Hours	Lecturers

**851-0300-94L Combinatorics: History of a Method Between Mathematics and Literature**

- **Particularly suitable for students of D-MATH**

**Abstract**
Combinatorics is a procedure shared by various disciplines. In mathematics it concerns the calculation of quanta and probabilities, in philosophy the creation of encyclopedic knowledge, in mysticism the achievement of ecstatic experience, in literature, finally, experimental writing. This course investigates these different forms of combinatorics.

**Objective**
- comparative understanding of combinatorics as a transcultural and transdisciplinary procedure to generate knowledge
- cultural and epistemic history of combinatorics since the medieval ages
- combinatorics in theology, mysticism and occultism
- combinatorics in philosophy and the natural sciences
- combinatorics in literature and literary theory

**Content**
Kombinatorik, die Verknüpfung von Elementen, tritt als ein Verfahren in unterschiedlichen Disziplinen und Bereichen des Wissens auf: In der Mathematik, wo man sie zuerst vermutet, ermöglicht sie die Berechnung von Anzahlen und Wahrscheinlichkeiten, in philosophie die creation of encyclopedic knowledge, in mysticism the achievement of ecstatic experience, in literature, finally, experimental writing. This course investigates these different forms of combinatorics.

**851-0148-02L Manifolds and Individuation in Mathematics and Philosophy**

- **Number of participants limited to 40.**
- **Particularly suitable for students of D-BIOL, D-MATH, D-PHYS**

**Abstract**
Manifolds and individuation are concepts which allow to reconsider notorious problems such as the relationship between general and particular substance and modi, physical processes and persons. They may incorporate heterogeneous elements as needed to overcome traditional categories and classifications, and also describe processes leading to the existence of things.

**Objective**
The students should become familiar with some conceptual possibilities to recognise and deal with structures across the usual division of subjects. The problem areas are discussed on the basis of texts of various mathematicians and philosophers, with a wide range of applications such as psychology and life sciences.

**851-0144-07L The Infinite in Philosophy and in the Exact Sciences**

- **Logic, Mathematics, Physics**
- **Particularly suitable for students of D-MATH, D-PHYS**

**Prerequisites**
- **Mathematical skills**

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Participants are expected to study the compulsory texts provided at the beginning of the semester via the online platform Moodle.

3 credits

2V

This course provides an overview of the development of the international system and the central security challenges since the end of the Cold War. The focus of this course will be on security issues of the post 9/11 era: new risks, arcs of crises, security strategies and core actors will be presented during the course.

Objective
To get acquainted with different types of infiniteness; to study what is intriguing or problematic about the infinite; to inquire whether these different types of infiniteness have (important) features in common.

Content
On the one hand, the topic of the infinite will be dealt with historically by discussing philosophical texts, by e.g., Kant, Bolzano and Cantor.

On the other hand, the topic will be treated from a (non-historical) scientific point of view: the point of view of logic, mathematics, and physics.

Scientific interdisciplinary thinking.

Abstract

853-0060-00L

Current Issues in Security Policy

W

3 credits

2V

A. Wenger, O. Thranert

Abstract
This course provides an overview of the development of the international system and the central security challenges since the end of the Cold War. The focus of this course will be on security issues of the post 9/11 era: new risks, arcs of crises, security strategies and core actors will be presented during the course.

Objective
Participants should gain a solid understanding of current issues in international security policy as well as of the central academic debates.

Prerequisites
Participants should have a solid understanding of the basics of international relations.

Content
The aim of the course is to provide the participants with an overview of international security politics in a globalized world. After dealing with the major changes of the international security environment as compared to the cold war era, we will concentrate on some of the key challenges (international terrorism, proliferation of weapons of mass destruction etc.). The third part of the lecture focuses on security strategies pursued by the 'Western' world.

Lecture notes
A reading list will be distributed at the beginning of the spring semester.

851-0549-00L

WebClass Introductory Course History of Technology

W

3 credits

2V

D. Gugerli

Number of participants limited to 100.

Abstract
WebClass Introductory Course History of Technology is an introductory course to the history of technology. The students are challenged to discover how technological innovations take place within complex economical, political and cultural contexts. They get introduced to basic theories and practices of the field.

Objective
Students are introduced into how technological innovations take place within complex economical, political and cultural contexts. They get to know basic theories and practices of the field.

Content

Lecture notes

Prerequisites
Onlinekurs kombiniert mit zwei obligatorischen Präsenzveranstaltungen.

Literature
https://www.tg.ethz.ch/de/programme/

853-0060-00L

Current Issues in Security Policy

W

3 credits

2V

A. Wenger, O. Thranert

Abstract
This course provides an overview of the development of the international system and the central security challenges since the end of the Cold War. The focus of this course will be on security issues of the post 9/11 era: new risks, arcs of crises, security strategies and core actors will be presented during the course.

Objective
Participants should gain a solid understanding of current issues in international security policy as well as of the central academic debates.

Prerequisites
Participants are expected to study the compulsory texts provided at the beginning of the semester via the online platform Moodle.

Content
The aim of the course is to provide the participants with an overview of international security politics in a globalized world. After dealing with the major changes of the international security environment as compared to the cold war era, we will concentrate on some of the key challenges (international terrorism, proliferation of weapons of mass destruction etc.). The third part of the lecture focuses on security strategies pursued by the 'Western' world.

Lecture notes
A reading list will be distributed at the beginning of the spring semester.
3 credits
Central Questions in Bioethics
Particularly suitable for students of D-BIOL, D-CHAB, D-HEST, D-MAVT, D-MATL

Objective
- to critically consider the concepts of science and knowledge
- to understand how advances in technology and science are historically rooted in European imperial expansion and are connected to global social inequalities in the postcolonial world.
- to understand the historical plurality of forms of knowledge in different parts of the world as well as entanglements between different forms of knowledge
- to systematically reconstruct and reproduce complex arguments (reading-competences)
- to understand, compare and analyse differing approaches to the history of science.
- to enable students to form an educated opinion and participate in discussions on the global history of science and knowledge

Literature

1. Dieter Sturma/Bert Heinrichs (Hg.), Handbuch Bioethik, Stuttgart: Metzler 2015.

3 credits
Introduction to the Philosophy of Physics
Particularly suitable for students of D-MAVT, D-MATL

Objective
Students should be able to name and critically evaluate different topics and approaches in the philosophy of physics.

3 credits
Literature and Technology - Simulations, Prototypes, Machines
Particularly suitable for students of D-ITET, D-MAVT, D-MATL

Objective
Students are familiar with different relations between literature and technology. They can verbalise and analyse central contentions.

Content
Im Seminar lesen wir unter anderem Texte von E.T.A. Hoffmann, Franz Kafka, Georg Kaiser und Max Frisch.

3 credits
Sharing, The History of an Attractive Technology
Particularly suitable for students D-ARCH, D-BAUG, D-HEST, D-INFK, D-ITET, D-MAVT, D-MATL

Objective
The course wants to develop the students ability to critically read and asses historic texts.

Lecture notes
A detailed program and course materials will be made available during the semester on www.tg.ethz.ch.
Technical reality: Within minutes you can make perfect copies of high-value digital goods of knowledge or culture (as text, audio, video,
Climate change is one of the most pressing issues that governments and the global community have to face. This course outlines the
Slides and other material (both usually in English) will be made available on a weekly basis as the lecture proceeds.
Content of the following books is covered (PDFs freely available online):

- Data Manipulation, Deception and Fabrication in the
  A. Diekmann
  Digital Sustainability in the Knowledge Society
  This course has a number of objectives: (i) To outline the problem of climate change (ii) to discuss and compare the theoretical economic
  solutions to combating climate change (iii) to present existing climate change mitigation actions in an economic context and (iv) to outline possible future climate policy issues.

- 2V
  M. M. Dapp

At the heart of the discourse is the handling of digital goods and intellectual property in society. Digitization and the Internet allow handling
- 2V
  A. Diekmann

Problem is, that this reality poses a fundamental threat to today's business model of the knowledge and culture industries (starting from
- 2V
  A. Diekmann

How do various interest groups influence the methods of production, distribution, and use of digital resources? Current models focusing on

- 2V
  A. Diekmann

- 2V
  A. Diekmann

At the core lies the question about the design of property in digital assets. For that, we apply a concept of «intellectual property»,
- 2V
  A. Diekmann

In a competitive environment, we may have difficulties in recognizing these, often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible
- 2V
  A. Diekmann

Of course, any interested person is invited to attend the lecture without doing the group assignment. The website is actively used for the
- 2V
  A. Diekmann

Other recommended books are:
- 2V
  A. Diekmann

More on teach.digisus.info starting from September. Stay tuned.

Lecture notes
- 2V
  A. Diekmann

Content of the following books is covered (PDFs freely available online):
- 2V
  A. Diekmann

- 2V
  A. Diekmann

- 2V
  A. Diekmann

- 2V
  A. Diekmann

The Economics of Climate Change
Don't take place this semester.
Particularly suitable for students of D-ITET, D-MATL, D-MAVT, D-MTEC, D-USYS

Climate change is one of the most pressing issues that governments and the global community have to face. This course outlines the
Objective
- 2V
  A. Diekmann

This course has a number of objectives: (i) To outline the problem of climate change (ii) to discuss and compare the theoretical economic
- 2V
  A. Diekmann

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### Introduction to Law

**Objective**
Students who have attended or will attend the lecture "Introduction to Law for Civil Engineering and Architecture" or "Introduction to Law" (851-0708-00) cannot register for this course unit.

**Abstract**
This class introduces students into basic features of the legal system. Fundamental issues of constitutional law, administrative law, private law and the law of the EU are covered.

**Objective**
Students are able to identify basic structures of the legal system. They understand selected topics of public and private law and are able to apply the fundamentals in more advanced law classes.

**Content**
Basic concepts of law, sources of law.

**Private law:** Contract law (particularly contract for work and services), tort law, property law.

**Public law:** Human rights, administrative law, procurement law, procedural law.

**Lecture notes**
Jaap Hage, Bram Akkermans (Eds.), Introduction to Law, Cham 2014 (Online Resource ETH Library)

**Literature**
Further documents will be available online (see https://moodle-app2.let.ethz.ch/course/view.php?id=1596).

**Required reading:**
- Intellectual Property: Introduction
  - Intellectual Property: Introduction
  - Intellectual Property: Introduction

**Recommended reading:**
- Practising of newly acquired knowledge in case studies (protection of species, climate change, etc.)
- Cross-section topics, such as sustainability, intergenerational justice, protection of species, etc.
  - Overview and discussion of ethical theories relevant to the environment.
  - A fundamental knowledge of standpoints and argumentations to be found within the field of environmental ethics and will have practised these in small case studies.
  - Important concepts and positions of environmental ethics. They achieve a deeper understanding of these concepts and positions in applying them to ecological problems and discussing them in case studies.

**Lecture notes**
Summaries of the individual sessions will be distributed, including the most important theories and keywords; reading list.

**Literature**
- General introductions:

### Intellectual Property: Introduction

**Objective**
The course provides an introduction to Swiss and European intellectual property law (trademarks, copyright, patent and design rights).

**Abstract**
Aspects of competition law are treated insofar as they are relevant for the protection of intellectual creations and source designations. The legal principles are developed based on current cases.

**Objective**
The aim of this course is to enable students at ETH Zurich to recognize which rights may protect their creations, and which rights may be infringed as a result of their activities. Students should learn to assess the risks and opportunities of intellectual property rights in the development and marketing of new products. To put them in this position, they need to know the prerequisites and scope of protection afforded by the various intellectual property rights as well as the practical difficulties involved in the enforcement of intellectual property rights. This knowledge is imparted based on current rulings and cases.

**Required reading:**
- Intellectual Property: An Introduction
  - Intellectual Property: Introduction

**Recommended reading:**

**Lecture notes**
Further documents will be available online (see https://moodle-app2.let.ethz.ch/course/view.php?id=1596).

**Literature**
- Practising of newly acquired knowledge in case studies (protection of species, climate change, etc.)
- Cross-section topics, such as sustainability, intergenerational justice, protection of species, etc.
  - Overview and discussion of ethical theories relevant to the environment.

### Environmental Ethics

**Objective**
The lecture begins with an introduction to applied ethics in general. The main focus is on environmental ethics. Students learn to handle important concepts and positions of environmental ethics. They achieve a deeper understanding of these concepts and positions in applying them to ecological problems and discussing them in case studies.

**Abstract**
On completion of this lecture you will have acquired the ability to identify and process general and environmental ethical problems. You will be capable of recognizing and analysing environmental ethical problems and of working towards a solution. You will have acquired a fundamental knowledge of standpoints and argumentations to be found within the field of environmental ethics and will have practised these in small case studies.

**Objective**
Content - Introduction to general and applied ethics.
- Overview and discussion of ethical theories relevant to the environment.
- Familiarisation with various basic standpoints within environmental ethics.
- Cross-section topics, such as sustainability, intergenerational justice, protection of species, etc.
- Practising of newly acquired knowledge in case studies (protection of species, climate change, etc.)

**Lecture notes**
Summaries of the individual sessions will be distributed, including the most important theories and keywords; reading list.

**Literature**
- General introductions:
  - Andrew Light/Holmes Rolston III, Environmental Ethics. An Anthology, 2003
  - John O'Neill et al., Environmental Values, 2008
  - Klaus Peter Rippe, Ethik im ausserhumanen Bereich, Paderborn (mentis) 2008

### Environmental and Science Communication

**Objective**
The course gives an introductory overview in research questions, theoretical perspectives and empirical results of science communication and environmental communication. They will be illustrated by concrete examples and via lectures from external guests.

**Abstract**
Objectives: Learning to understand structures and processes of environmental and science communication, becoming more sensitive for problems of science and public relations, getting an insight into public debates about environmental issues.

**Methods**
- Case studies, invitation of media practitioners and experts, discussions, lectures on key theoretical concepts of communication.
- Topics: Concrete communication instruments like media conferences, theoretical perspectives of public relations, basic principles and examples of information campaigns, environment and science as media topics, functions and structures of science communication, relations between science, media and politics.
Environmental History - Introduction and Overview
A. Wenger
2V 3 credits
The lecture treats the social intercourse with risks of technical systems. The notion of risk and the perception of risk are discussed by case
B. Nowack
I. Introduction
Literature and powerpoint presentations will be provided on the OLAT platform.
D. Speich Chassé
Our society faces a serious ecological crisis. Of what historical dimension is this crisis? How have human societies already in earlier times
Copies of slides and selected documents will be distributed

<table>
<thead>
<tr>
<th>Content</th>
<th>I. Introduction</th>
<th>2 credits</th>
<th>2V</th>
<th>D. Speich Chassé</th>
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<tbody>
<tr>
<td>Abstract</td>
<td>Environmental History - Introduction and Overview</td>
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<tr>
<td>Objective</td>
<td>Number of participants limited to 100.</td>
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<tr>
<td>Literature</td>
<td>Our society faces a serious ecological crisis. Of what historical dimension is this crisis? How have human societies already in earlier times changed their environment, and, consequently, perhaps also ours? What were the main ecological challenges for societies and how did they change over time? And how did societies adapt to changing environmental conditions?</td>
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<tr>
<td>Lecture notes</td>
<td>Introduction into environmental history; survey of long-term development of human-nature-interrelations; discussion of selected problems. Improved ability to assess current problems from a historical perspective and to critically interrogate one’s own standpoint.</td>
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<tr>
<td>Literature</td>
<td>Course material is provided on OLAT.</td>
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<td>Notice</td>
<td>Voraussetzungen: Die Vorlesung hat einführenden Charakter.</td>
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<tr>
<td>Permission</td>
<td>Students are asked to write an exam during the second last session (11.12.2015).</td>
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Social Intercourse with Current Environmental Risks
B. Nowack, C. M. Som-Koller
1 credit
1V

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<tr>
<th>Content</th>
<th>Social Intercourse with Current Environmental Risks</th>
<th>1 credit</th>
<th>1V</th>
<th>B. Nowack, C. M. Som-Koller</th>
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<tbody>
<tr>
<td>Abstract</td>
<td>The lecture treats the social intercourse with risks of technical systems. The notion of risk and the perception of risk are discussed by case studies (e.g. nanotechnology) and socio-political instruments for decision-making are presented. Methods are presented that can be applied to deal with environmental risks and how they can be used for sustainable innovation.</td>
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<td>Objective</td>
<td>- Getting acquainted to the extended risk concept</td>
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<td>- Evaluation of the risks caused by technology within the societal context</td>
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<td>- Knowledge about the mode science and society handle current environmental risks (examples gene- and nanotechnology)</td>
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<td>- Knowledge about handling risks (e.g. precautionary principle, protection goal, damage definition, ethics)</td>
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<td>Content</td>
<td>Knowledge about possibilities for sustainable innovation</td>
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<td>- Risks and technical systems (risk categories, risk perception, risk management)</td>
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<td>- Illustration with case studies (nanotechnology)</td>
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<td>- Implementation (politics, science, media, etc.)</td>
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<td>- Decision making (technology assessment, cost/benefit analysis etc.)</td>
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<td>- The role of the media</td>
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<td>- prospects for future developments</td>
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<td>Lecture notes</td>
<td>Copies of slides and selected documents will be distributed</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The lecture is held biweekly (for 2 hours). The dates are 21.9., 28.9 (attention, out of schedule) ; 19.10, 2.11, 16.11, 30.11, 14.12</td>
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World Politics Since 1945: The History of International Relations (Without Exercises)
A. Wenger
3 credits

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<tr>
<th>Content</th>
<th>World Politics Since 1945: The History of International Relations (Without Exercises)</th>
<th>3 credits</th>
<th>2V</th>
<th>A. Wenger</th>
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<td>Permission</td>
<td>Students are asked to write an exam during the second last session (11.12.2015).</td>
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Data: 06.02.2019 13:00 Autumn Semester 2015 Page 614 of 1434
This lecture series provides students with an overview of the development of international relations since the end of World War II. The first part of the series deals with the development of and changes in Cold War Security policy structures. The second part deals with the period after the transformation of 1989/91; the focus here is on current issues in international security policy.

By the end of the semester, participants of the lecture should have a solid knowledge on the history and theoretical foundations of International Relations since the end of the Second World War. 

Prerequisites / notice
The lecture is being supported by a virtual classroom. If you have any questions, please contact Lukas Meyer, lukas.meyer@sipo.gess.ethz.ch.

D-MTEC

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>851-0101-46L</td>
<td>Introduction in the History of Economic Thought</td>
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<td></td>
<td>Does not take place this semester.</td>
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<td>Particularly suitable for students of D-MTEC.</td>
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<td>Abstract</td>
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<td>The course offers a historical introduction to modern economic thought. It looks at texts of 'classical economics' as well as 'neo-classical', 20th century texts. In addition, the course addresses some modern contributions in the history of economics - in particular extra-European economic potential - and their potential for the enrichment of mainstream economic thought.</td>
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<td>he course is conceptualized as an introduction to the history of economic thought. It acquaints students with the basic tenets of the 'classical economics' through historical accounts of the work of 'worldly philosophers' as well as primary reading of authors such as Adam Smith, David Ricardo and Karl Marx. Further, the course introduces students to 'neo-classical economics' of the 20th century, again looking at authors of particular significance in the furnishment of economic debates such as John Maynard Keynes, Milton Friedman and Friedrich Hayek. The course, however, takes also a closer look at authors whose work is usually situated beyond conventional economic thought, such as Karl Polanyi. Additionally, the course devotes also time to some extra-European economic thought - drain theory, world system and dependency theory, etc. - and its implications/applications in the history of the 20th century. Finally, a particular attention will be paid to some important contributions in the extra-European history of economics and to specific notions such as 'commodity chains', 'divergences' and 'modernization'. Combining these various items, the course aims not simply at introducing students to the 'evolution' of economic thought, but more broadly to ongoing academic debates, political and ideological tensions as well as to critical interventions. The ambition of the course is to inspire through a historical approach and to enrich the 'understanding' of economic theory with a questioning of its underlying structures and tenets and, ultimately, to advance critical thinking among students of modern economics.</td>
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<td>851-0591-00L</td>
<td>Digital Sustainability in the Knowledge Society</td>
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<td>M. M. Dapp</td>
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<td>Particularly suitable for students of D-INFK, D-ITET, D-MATL, D-MAVT, D-MTEC, D-USYS</td>
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<td>Abstract</td>
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<td>How do various interest groups influence the methods of production, distribution, and use of digital resources? Current models focusing on strong intellectual property rights are contrasted with open models, e.g., Open Source (Content/Access). The course discusses consequences from different models and introduces «digital sustainability» as an alternative vision for society.</td>
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<td>At the heart of the discourse is the handling of digital goods and intellectual property in society. Digitization and the Internet allow handling knowledge in a way, which directly contrasts with the traditional understanding of &quot;intellectual property&quot; and the industries based on it. Starting from economic and legal basics, we compare proprietary and open/free models. Sustainable development as a concept is transferred to digital goods, taking into account the particular nature of digital stuff. After the lecture, you should (hopefully) be able to - characterize the nature of digital goods vs. physical goods - critique the basic concepts of copyright and patent rights - explain the political/legal and economic differences between proprietary and open approaches to the production and use of digital goods.</td>
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<td>Content</td>
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<td>Technical reality: Within minutes you can make perfect copies of high-value digital goods of knowledge or culture (as text, audio, video, image or software) and distribute them around the globe -- for free. «Digitization plus Internet» allows for the first time in humankind's history the (theoretically) free access and global exchange of knowledge at minimal cost. A tremendous opportunity for societal development, in north and south. «Cool, so what's the problem?»</td>
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<td>The problem is, that this reality poses a fundamental threat to today's business model of the knowledge and culture industries (starting from the music label and Hollywood, via publishers, up to software vendors). Powerful commercial interests are at stake as «knowledge» (the fourth factor of production) will become even more important in the 21st century. Accordingly, «piracy» and «file-sharing» are attacked with all means. At the core lies the question about the design of property in digital assets. For that, we apply a concept of «intellectual property», which is several hundred years old and does not address digital reality in an adequate manner, sometimes leading to absurd situations. Its original goal seems to get forgotten: to help society develop by spreading knowledge as much as possible. Using the PC becomes the new cultural technique of the 21st century. In contrast to «reading, writing and arithmetic», this new cultural technique cannot exist in isolation, but depends on a hard- and software infrastructure. This dependency extends to the provider of the infrastructure, who can define technical rules, which can take away or restrict the user's freedom. Even advanced users may have difficulties in recognizing these, often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible infrastructure, who can define technical rules, which can take away or restrict the user's freedom. Even advanced users may have difficulties in recognizing these, often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible</td>
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<td>Slides and other material (both usually in English) will be made available on a weekly basis as the lecture proceeds.</td>
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<td>Literature</td>
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<td>Other recommended books are:</td>
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<td>1 (general) Chris DiBona et al., Open Sources. Voices from the Open Source Revolution, O'Reilly, 1999.</td>
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The lecture slides will be presented on the course web page after each lecture.

2S
M. Wulz
A. Cabello Llamas
Avantgarde-Life: Utopia of the 'New Man' Between Design Thinking: Human-Centred Solutions to Real From Computational Social Science to Global
At the beginning of the 20th century, the artistic and social avantgarde movements developed visions of a 'New Man' with new modes of perception and within new forms of social life. The seminar deals with the scientific, technological, artistic, pedagogical, and political designs for a new living.

The seminar deals with the designs for a new living in the artistic and social avantgarde movements at the beginning of the 20th century. It focuses on the correlation of the contemporary scientific and technological developments and the conceptions of a 'New Man'. The discipline of psychotechnics together with scientific and technological designs of living and working environments formulated visions of new and enhanced ways of human living and perception. In the seminar, we will examine the utopian visions of life in the avantgarde movements. Touching upon the fields of the life sciences, economics, management, progressive education, architecture, and art we will reflect the diverse relations between science, technology, and human living.

2S
5 credits
This course introduces first the basic functionalities and features of the mathematical software package MATLAB, such as the simple operations with matrices and vectors, differential equations, statistical tools, the graphical representation of data in various forms, and video animations of spatio-temporal data. With this knowledge, students are expected to implement themselves in MATLAB, models of various social processes and systems, including agent-based models, e.g. models of interactive decision making, group dynamics, human crowds, or game-theoretical models.

Part of this course will consist of supervised programming exercises in a computer pool. Credit points are finally earned for the implementation of a mathematical model from the sociological literature in MATLAB and the documentation in a seminar thesis.

Lecture notes
The lecture slides will be presented on the course web page after each lecture.

Literature

Further literature, in particular regarding computer models in the social sciences, will be provided in the course.

Prerequisites / notice
The number of participants is limited to 70.

851-0585-41L From Computational Social Science to Global Systems Science
Particularly suitable for students of D-INFK, D-ITET, D-MTEC, D-PHYS.

Abstract
Participants of the seminar should understand how tightly connected systems lead to networked risks, and why this can imply systems we do not understand and cannot control well, thereby causing systemic risks and extreme events.

Objective
Computational Social Science and Global Systems Science serve to better understand the emerging digital society with its close co-evolution of information and communication technology (ICT) and society. They make current theories of crises and disasters applicable to the solution of global-scale problems, taking a data-based approach that builds on a serious collaboration between the natural, engineering, and social sciences, i.e. an interdisciplinary integration of knowledge.

363-1065-00L Design Thinking: Human-Centred Solutions to Real World Challenges
Due to didactic reasons, the number of participants is limited to 30.

All interested students are invited to apply for this course by sending a one-page motivation letter until 07.09.2015 to Florian Rittiner (rittiner@ethz.ch).

Additionally please enroll via mystudies. Places will be assigned after the first lecture on the basis of your motivation letter and commitment for the class.

Abstract
The purpose of this course is to engage students in a multidisciplinary collaboration to tackle real world problems. Following a design thinking approach, students will work in multidisciplinary teams to solve a set of design challenges that are organized as a one-week, a three-week, and a six-week project. The final project will be in collaboration with an external project partner.

Objective
During the course, students will learn about different design thinking methods and tools. This will enable them to:
- Generate deep insights through the systematic observation and interaction of key stakeholders.
- Engage in collaborative ideation with a multidisciplinary (student) team.
- Rapidly prototype and iteratively test ideas and concepts by using various materials and techniques.

363-1050-00L Conference of Disarmament: Simulation of Negotiations

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 616 of 1434
The simulation project is intended for Master's or Doctoral students of the Global Studies Institute (GSI) of the University of Geneva, of the ETH and for interested students of the Geneva Centre for Security Policy (GCSP). The simulation will be in French and English and is conducted by Prof. Calmy-Rey, former President of Switzerland.

In the lectures, students will be provided with basic information on disarmament issues and on the functioning of the Conference on Disarmament as well as on negotiation techniques in general. Students will take the role of negotiators in the simulation (including the heads of the delegations), of keeper of the minutes or of observers and analysts.

Students will co-develop their mandates for the negotiation and be assisted by experts that are specialized in international negotiations as well as in the topic of disarmament. The negotiation tables will be chaired by former diplomats. Representatives of diplomatic missions in Geneva will play the role of the "Capitals" to which the heads of delegations will have to give account of the ongoing negotiations.

More details on the program, timetable, reading lists and performance assessment will be published here: https://chamilo.unige.ch/home/courses/M165/?id_session=0

The simulation will take place on the 26 and 27 November 2015 at the University of Geneva.

Languages: English and French

Dates/Time/Location (GE = University of Geneva)

22 Sept. | ETH HG D 22 | 10:15-12:00 | Introduction
28 Sept. | GE Uni Mail Salle 1170 | 10:15-12:00 | Introduction to Negotiation Techniques (Dr. Vitalji Butenko and Dr. Sibylle Zürcher, ETH)
6 Oct. | ETH HG D 16.2 | 10:15-12:00 | Distribution of the roles, composition of the negotiation tables, preparation of mandates for the HA (humanitarian approach)
13 Oct. | ETH HG D 22 | 10:15-12:00 | Preparation of the mandates for the FMCT (Fissile Material Cut-off Treaty)
20 Oct. | GE Uni Mail Salle 1170 | 10:15-12:00 | No session; Students deepen and summarize their mandates on one page (A4)
27 Oct. | GE Uni Mail Salle 1170 | 10:15-12:00 | Discussion of the mandates I (FMCT)
10 Nov. | GE Uni Mail Salle 1170 | 10:15-12:00 | Discussion of the mandates II (HA)
17 Nov. | GE Uni Mail Salle 1170 | 10:15-12:00 | Preparation Meeting
26 & 27 Nov. | GE Salles 407 et 408 | 10:00-18:00 | Simulation at Uni Dufour
1 Dec. | GE Uni Mail Salle 1170 | 10:15-12:00 | Discussion of the results

Note:
The participation in the simulation on 26. and 27. November in Geneva is necessary.
The two hours lectures on the 22. September, 6. and 13. October have to be attended in Zürich via conference call (ETH HG D 16.2). The other lectures during the semester can be attended via Skype.

To get the 3 ECTS, students have to participate at the 2 days simulation in Geneva, attend the 3 mandatory lecture parts via conference call an Zürich and write a report of 5 pages at the end of the course.

(Technical note for registration: At this stage all registered students are on the waiting list)
Literature about technology transposes models, products and procedures of scientific progress into the logic of poetry. This literature converts not only technology into fiction, but it also creates new cultural and social contextualisations, which reveal alternative readings of configurations of knowledge.

Objective

Students are familiar with different relations between literature and technology. They can verbalise and analyse central contentions.

Content

Im Seminar lesen wir unter anderem Texte von E. T. A. Hoffmann, Franz Kafka, Georg Kaiser und Max Frisch.

851-0738-01L The Role of Intellectual Property in Daily Routine: A Practical Introduction

Objective

The lecture gives engineering students an overview of the basic aspects of intellectual property. The lecture aims to make participants aware of the various methods of protection and to put them in a position to be able to use this knowledge in the workplace.

Abstract

In recent years, knowledge about intellectual property has become increasingly important for engineers. In both production and distribution as well as in research and development, engineers are increasingly being confronted with questions concerning the patenting of inventions and the utilisation of patent information. With up to 80% of publicly-available technical information being stored in patents only, it is of great importance for engineers to know the basics of the patent system and to be in a position to be able to extract relevant information from the flood of patent information available. This relates to daily work in industry as well as in research, where protecting inventions has gained in importance.

Prerequisites / notice

Patents are also an important source of information - from competitors and potential cooperation partners to the development of markets and the risk of coming into conflict with third party IP rights. Respectively, a knowledge of patents has also become a key qualification at a company's strategic level.

The seminar is customised to the needs of engineers. Participants will become familiar with practice-relevant aspects of intellectual property with the emphasis being placed on patents. Participants will be able to use the acquired knowledge in the protection and commercialisation of their own inventions.

The topics covered will include:
- The importance of innovation in industrialised countries and high-tech sectors
- The protection of inventions and the safeguarding of commercial implementation - the role and importance of intellectual property
- Patents as a source of technical and business information
- Practical aspects of intellectual property for day-to-day research work, for the formation of start-ups and at the workplace.

The seminar contains practical exercises on the use and research of patent information. Basic knowledge on how to read and evaluate patent documents, as well as how to use publicly available patent databases in order to obtain the required patent information will also be provided.

For students of chemistry-related degree programs, the lecture ‘Protecting inventions in chemistry’ will be offered, which is coordinated to the needs of students in these degree programs.

851-0125-41L Introduction Into Philosophy of Technology

Objective

The course gives an overview on the main schools in the philosophy of technology. Students should learn to analyse and evaluate different philosophies of technology (compensation, objectification, externalisation). For credit point a critical protokoll is to be written.

Abstract

Since antiquity philosophy reflects about and evaluates technology. The technical developments in the 19th and 20th century have led to a autonomous philosophy of technology, which had become important also for other philosophical disciplines (e.g. in Heidegger's philosophy).

Prerequisites / notice

Particularly suitable for students of D-BAUG, D-ITET, D-MATL, D-MAVT

851-0549-12L Sharing. The History of an Attractive Technology

Objective

The seminar deals with hot topics of the history of technology since the 1960s. Sharing of computertime, software and data will be discussed as a crucial offer and problem of late modernity.

Abstract

The course gives an overview on the main schools in the philosophy of technology. Students should learn to analyse and evaluate different philosophies of technology (compensation, objectification, externalisation). For credit point a critical protokoll is to be written.

Prerequisites / notice

The course wants to develop the students ability to critically read and asses historic texts.

Lecture notes

A detailed program and course materials will be made available during the semester on www.tg.ethz.ch.

851-0549-00L WebClass Introductory Course History of Technology

Objective

WebClass Introductory Course History of Technology is an introductory course to the history of technology. The students are challenged to discover how technological innovations take place within complex economical, political and cultural contexts. They get introduced into basic theories and practices of the field.

Abstract

WebClass Introductory Course History of Technology is an introductory course to the history of technology. The students are challenged to discover how technological innovations take place within complex economical, political and cultural contexts. They get introduced into basic theories and practices of the field.

Content


Lecture notes


Literature

https://www.tg.ethz.ch/de/programme/
Prerequisites / notice
Aktive Teilnahme und erfolgreiches Bearbeiten von Onlineaufgaben wird vorausgesetzt.
Versetäpte Anmeldungen können nicht berücksichtigt werden.
Weitere Informationen unter https://www.tg.ethz.ch/de/programme/

851-0585-41L
From Computational Social Science to Global Systems Science
Particularly suitable for students of D-INFK, D-ITET, D-MAVT, D-MTEC, D-PHYS
Abstract
The seminar aims at three-fold integration: (1) bringing modeling and computer simulation of techno-socio-economic processes and phenomena together with related empirical, experimental, and data-driven work, (2) combining perspectives of different scientific disciplines (e.g. sociology, computer science, physics, complexity science, engineering), (3) bridging between fundamental and applied work.
Objective
Participants of the seminar should understand how tightly connected systems lead to networked risks, and why this can imply systems we do not understand and cannot control well, thereby causing systemic risks and extreme events.

Computational Social Science and Global Systems Science serve to better understand the emerging digital society with its close co-evolution of information and communication technology (ICT) and society. They make current theories of crises and disasters applicable to the solution of global-scale problems, taking a data-based approach that builds on a serious collaboration between the natural, engineering, and social sciences, i.e. an interdisciplinary integration of knowledge.

851-0585-04L
Lecture with Computer Exercises: Modelling and Simulating Social Systems with MATLAB
Particularly suitable for students of D-MAVT, D-INFK, D-ITET, D-MTEC, D-PHYS
Number of participants limited to 70.
Abstract
This course introduces first the basic functionalities and features of the mathematical software package MATLAB, such as the simple operations with matrices and vectors, differential equations, statistical tools, the graphical representation of data in various forms, and video animations of spatio-temporal data. With this knowledge, students are expected to implement themselves in MATLAB, models of various social processes and systems, including agent-based models, e.g. models of interactive decision making, group dynamics, human crowds, or game-theoretical models.
Objective
Part of this course will consist of supervised programming exercises in a computer pool. Credit points are finally earned for the implementation of a mathematical model from the sociological literature in MATLAB and the documentation in a seminar thesis.
Lecture notes
The lecture slides will be presented on the course web page after each lecture.
Literature
Further literature, in particular regarding computer models in the social sciences, will be provided in the course.
Prerequisites / notice
The number of participants is limited to the size of the available computer teaching room. The MATLAB code related to the seminar thesis should be well enough documented for further use by others and must be handed over to the Chair of Sociology, in particular of Modeling and Simulation, for further free and unrestricted use.

851-0125-52L
Central Questions in Bioethics
Particularly suitable for students of D-BIOL, D-CHAB, D-HEST, D-MAVT
Abstract
Bioethics deals with the evaluation and regulation of technology based interventions into life. What are valid principles guiding bioethical decision, principles like "Protect the dignity of the living being!", or "Respect a person's self-determination"? Besides answering such questions, the social, scientific and political processes linked with biotechnologies should be taken into account.
Objective
Literature
1. Dieter Sturma/Bert Heinrichs (Hg.), Handbuch Bioethik, Stuttgart: Metzler 2015.

851-0144-01L
Introduction to the Philosophy of Physics
Particularly suitable for students of D-MAVT, D-MATL
Abstract
This course introduces the fundamental concepts of classical mechanics, quantum mechanics, thermodynamics, and statistical mechanics in a way that is accessible to students with a background in mathematics and physics. It aims to provide a solid foundation for further studies in the philosophy of science and technology.
Objective
By the end of the course, students should be able to:
- Understand the basic principles and concepts of classical mechanics, quantum mechanics, thermodynamics, and statistical mechanics.
- Analyze and discuss the philosophical implications of these theories in the context of scientific realism, instrumentalism, and constructivism.
- Critically evaluate arguments for and against the dual-aspect theory of light.
- Understand the role of mathematical models in the philosophy of physics.

851-0117-51L
Simulation, Social Science, and Engineering
Particularly suitable for students of D-MATL, D-MAVT, D-SUP
Abstract
This course provides an introduction to the methodology of simulation, focusing on the application of simulation models to problems in social science and engineering. Students will learn how to build and analyze simulation models, and how to interpret and communicate their results. The course will also cover the ethical and social implications of simulation. Topics include: simulation basics, simulation modeling, simulation software, and simulation-based decision making.
Objective
By the end of the course, students should be able to:
- Understand the basic concepts and techniques of simulation.
- Build and analyze simulation models, and interpret and communicate their results.
- Understand the ethical and social implications of simulation.
- Design and implement simulation experiments using a variety of simulation tools and software.
- Analyze and interpret simulation results using statistical methods.
- Critically evaluate simulation studies in the context of social science and engineering.

851-0126-51L
Introduction to Social System Simulation
Particularly suitable for students of D-MATL, D-MAVT
Abstract
This course provides an introduction to the use of computer simulations to model social systems. Students will learn how to build and analyze simulation models, and how to interpret and communicate their results. The course will also cover the ethical and social implications of simulation. Topics include: simulation basics, simulation modeling, simulation software, and simulation-based decision making.
Objective
By the end of the course, students should be able to:
- Understand the basic concepts and techniques of simulation.
- Build and analyze simulation models, and interpret and communicate their results.
- Understand the ethical and social implications of simulation.
- Design and implement simulation experiments using a variety of simulation tools and software.
- Analyze and interpret simulation results using statistical methods.
- Critically evaluate simulation studies in the context of social science and engineering.
Abstract
This is an introductory course in different areas and positions in the philosophy of physics. It falls into different parts, including one on the concepts of space and time and one on the reality of structures in physics.

Objective
Students should be able to name and critically evaluate different topics and approaches and in the philosophy of physics.

851-0591-00L
Digital Sustainability in the Knowledge Society
W 2 credits 2V M. Dapp
Particularly suitable for students of D-INFK, D-ITET, D-MATL, D-MAV, D-MTEC, D-USYS

Abstract
How do various interest groups influence the methods of production, distribution, and use of digital resources? Current models focusing on strong intellectual property rights are contrasted with open models like, e.g. Open Source/Peer Access. The course discusses consequences from different models and introduces «digital sustainability» as an alternative vision for society.

Objective
At the heart of the discourse is the handling of digital goods and intellectual property in society. Digitization and the Internet allow handling knowledge in a way, which directly contrasts with the traditional understanding of "intellectual property" and the industries based on it. Starting from economic and legal basics, we compare proprietary and open"free" models. Sustainable development as a concept is transferred to digital goods, taking into account the particular nature of digital stuff.

After the lecture, you should (hopefully) be able to:
- characterize the nature of digital goods vs. physical goods
- critique the basic concepts of copyright and patent rights
- explain the political/legal and economic differences between proprietary and open approaches to the production and use of digital goods
- using an example, explain the meaning of digital sustainability and argue why it is relevant for a knowledge society
- transfer the ideas of the free/open source software model to other digital goods (e.g., open content, open access)

Content
Technical reality: Within minutes you can make perfect copies of high-value digital goods of knowledge or culture (as text, audio, video, image or software) and distribute them around the globe -- for free. «Digitization plus Internet» allows for the first time in humankind's history the (theoretically) free access and global exchange of knowledge at minimal cost. A tremendous opportunity for societal development, in north and south. «Cool, so what's the problem?»

The problem is, that this reality poses a fundamental threat to today's business model of the knowledge and culture industries (starting from the music label and Hollywood, via publishers, up to software vendors). Powerful commercial interests are at stake as «knowledge» (the fourth factor of production) will become ever more important in the 21st century. Accordingly, «piracy» and «file-sharing» are attacked with all means. At the core lies the question about the design of property in digital assets. For that, we apply a concept of «intellectual property», which is several hundred years old and does not address digital reality in an adequate manner, sometimes leading to absurd situations. Its original goal seems to get forgotten: to help society develop by spreading knowledge as much as possible.

Using the PC becomes the new cultural technique of the 21st century. In contrast to «reading, writing and arithmetic», this new cultural technique cannot exist in isolation, but depends on a hard- and software infrastructure. This dependency extends to the provider of the infrastructure, who can define technical rules, which can take away or restrict the user's freedom. Even advanced users may have difficulties in recognizing these hidden, restrictions and in evaluating their societal relevance. But exactly these invisible consequences we need to understand and investigate, because they decide about access, distribution and usage of digital knowledge.

Comparable to the environmentalist movement of the 60s and 70s, a growing political movement for «Free Software» exists today, with «GNU/Linux» as its most popular symbol. The movement fights against treating software code as private property but as a central cultural good available to all without private interests. Based on the success of the Free Software movement, new domains (e.g. scientific knowledge, music)...

As a «teaser» to the lecture, you are invited to read the essay «ETH Zurich - A Pioneer in Digital Sustainability!». It can be downloaded from www.essays2030.ethz.ch.

Prerequisites / notice
For administrative and didactic reasons (high level of interaction and credit group assignments on current hot topics), the number of participants is limited to 45.

Lecture notes
Slides and other material (both usually in English) will be made available on a weekly basis as the lecture proceeds.

Lecture notes
Content of the following books is covered (PDFs freely available online):

Other recommended books are:
1 (general) Chris DiBona et al., Open Sources: Voices from the Open Source Revolution, O'Reilly, 1999.

Other recommended books are:

Relevant laws and regulations:
1 (general) Chris DiBona et al., Open Sources: Voices from the Open Source Revolution, O'Reilly, 1999.

851-0596-00L
Data Manipulation, Deception and Fabrication in the W 2 credits 2V A. Diekmann, J. Jerke
Sciences
Particularly suitable for students of D-MATL, D-MAV

Abstract
This seminar covers the basics of modern scientific research and discusses different types of scientific misconduct. Case studies are introduced and the latest diagnostic methods for uncovering data manipulation presented. Problem solving is discussed.

Objective
(1) To be able to recognize and evaluate scientific misconduct and its causes against the background of the competition-oriented systems of modern scientific research.

(2) To get to know methods for uncovering data manipulation and to be able to critically assess them.

Content

Literature


851-0609-05L
The Economics of Climate Change
W 3 credits 2V J. Jerke

Does not take place this semester.

Particularly suitable for students of D-ITET, D-MATL, D-MAV, D-USYS

Abstract
Climate change is one of the most pressing issues that governments and the global community have to face. This course outlines the problem of climate change and discusses the economic solutions (both domestic and international) to this problem.
Objective: This course has a number of objectives: (i) To outline the problem of climate change (ii) to discuss and compare the theoretical economic solutions to combating climate change (iii) to present existing climate change mitigation actions in an economic context and (iv) to outline possible future climate policy issues.

Content: Economics of pollution, Optimal level of greenhouse gases, International Environmental Agreements, Tradable pollution permit markets. Carbon Taxes, Technological innovation and R&D, The optimal approach to control Climate change, The future of Climate change policy

Literature: Required reading: Pernan et al. (2003), Natural Resource and Environmental Economics, Pearson Addison Wesley. Also, Journal articles will be cited

Prerequisites / notice: Prerequisites: The course relies heavily on the concepts and techniques used in basic game theory. Therefore prior knowledge is recommended

851-0703-00L Introduction to Law W 2 credits 2V O. Streifgnopff

Objective: Particularly suitable for students of D-MAVT, D-MATL

Abstract: This class introduces students into basic features of the legal system. Fundamental issues of constitutional law, administrative law, private law and the law of the EU are covered.

Objective: Students are able to identify basic structures of the legal system. They understand selected topics of public and private law and are able to apply the fundamentals in more advanced law classes.

Content: Basic concepts of law, sources of law. Private law: Contract law (particularly contract for work and services), tort law, property law. Public law: Human rights, administrative law, procurement law, procedural law. Insights into the law of the EU and into criminal law.

Lecture notes: Jaap Hage, Bram Akkermans (Eds.), Introduction to Law, Cham 2014 (Online Resource ETH Library)

Literature: Further documents will be available online (see https://moodle-app2.let.ethz.ch/course/view.php?id=1596).

851-0738-00L Intellectual Property: Introduction W 2 credits 2V M. Schweizer

Objective: Particularly suitable for students of D-ITET, D-MAVT, D-MATL

Abstract: The course provides an introduction to Swiss and European intellectual property law (trademarks, copyright, patent and design rights).

Objective: The aim of this course is to enable students to ETH Zurich to recognize which rights may protect their creations, and which rights may be infringed as a result of their activities. Students should learn to assess the risks and opportunities of intellectual property rights in the development and marketing of new products. To put them in this position, they need to know the prerequisites and scope of protection afforded by the various intellectual property rights as well as the practical difficulties involved in the enforcement of intellectual property rights. This knowledge is imparted based on current rulings and cases.

Another goal is to enable the students to participate in the current debate over the goals and desirability of protecting intellectual creations, particularly in the areas of copyright (keywords: fair use, Creative Commons, Copyleft) and patent law (software patents, patent trolls, patent thickets).

701-0703-00L Environmental Ethics W 2 credits 2V M. Huppenbauer

Objective: The lecture begins with an introduction to applied ethics in general. The main focus is on environmental ethics. Students learn to handle important concepts and positions of environmental ethics. They achieve a deeper understanding of these concepts and positions in applying them to ecological problems and discussing them in case studies.

Content: - Introduction to general and applied ethics. - Overview and discussion of ethical theories relevant to the environment. - Familiarisation with various basic standpoints within environmental ethics. - Cross-section topics, such as sustainability, intergenerational justice, protection of species, etc. - Practising of newly acquired knowledge in case studies (protection of species, climate change, etc.)

Lecture notes: Summaries of the individual sessions will be distributed, including the most important theories and keywords; reading list.

In the part of the course serving as an introduction to general and applied ethics, we shall be using the following textbook: Barbara Bleisch/Markus Huppenbauer: Ethische Entscheidungsfindung. Ein Handbuch für die Praxis, Zürich 2010 (to be published Autumn 2010).

Also, Journal articles will be cited

- Andrew Light/Holmes Rolston III, Environmental Ethics. An Anthology, 2003
- John O’Neill et al., Environmental Values, 2008
- Klaus Peter Rippe, Ethik im ausserhumanen Bereich, Paderborn (mentis) 2008

Generel introductions:
- Marcus Düwell et. al (Hrsg.), Handbuch Ethik, 2. Auflage, Stuttgart (Metzler Verlag), 2006
- Johann S. Ach et. al (Hrsg.), Grundkurs Ethik 1. Grundlagen, Paderborn (mentis) 2008

Prerequisites / notice: The procedure for accumulating CP will be explained at the start of the term.

I expect participants to be motivated and contribute to discussions, keeping the course interesting and lively.

701-0785-00L Environmental and Science Communication W 4 credits 2V M. Schäfer

Objective: Goals: Learning to understand structures and processes of environmental and science communication, becoming more sensitive for problems of science public relations, getting an insight into public debates about environmental issues.

Methods: Case studies, invitation of media practitioners and experts, discussions, lectures on key theoretical concepts of communication.

Topics: Concrete communication instruments like media conferences, theoretical perspectives of public relations, basic principles and examples of information campaigns, invitation and science as media topics, functions and structures of science communication, relations between science, media and politics.
### I. Introduction

Copies of slides and selected documents will be distributed.

### Lecture notes

- **B. Nowack**
  - 1 credit
  - Course material is provided on OLAT.

### Literature


- **Uekötter, Frank (Ed.)** 2010. The turning points of environmental history, Pittsburgh: University of Pittsburgh Press.


### Prerequisites / notice


### Prerequisites / notice

Students are asked to write an exam during the second last session (11.12.2015).

### Prerequisites / notice

The lecture is held biweekly (for 2 hours). The dates are 21.9., 28.9 (attention, out of schedule); 19.10, 2.11, 16.11, 30.11, 14.12.
This lecture series provides students with an overview of the development of international relations since the end of World War II. The first part of the series deals with the development of and changes in Cold War security policy structures. The second part deals with the period after the transformation of 1989/91; the focus here is on current issues in international security policy.

By the end of the semester, participants of the lecture should have a solid knowledge on the history and theoretical foundations of International Relations since the end of the Second World War.

Objective

Content

Prerequisites / notice

The lecture is being supported by a virtual classroom. If you have any questions, please contact Lukas Meyer, lukas.meyer@sso.gess.ethz.ch.

851-0144-07L The Infinite in Philosophy and in the Exact Sciences: Logic, Mathematics, Physics

Number of participants limited to 40.

G. Sommaruga

Abstract

On the other hand, the topic of the infinite will be dealt with historically by discussing philosophical texts, by e.g., Kant, Bolzano and Cantor. On the other hand, the topic will be treated from a (non-historical) scientific point of view: the point of view of logic, mathematics, and physics.

Literature

Compulsory Reading:


Objective

To get acquainted with different types of infinitness; to study what is intriguing or problematic about the infinite; to inquire whether these different types of infinitness have (important) features in common.

851-0585-41L From Computational Social Science to Global Systems Science

Particularly suitable for students of D-INFK, D-ITET, D-MAVT, D-MTEC, D-PHYS

Abstract

The seminar aims at three-fold integration: (1) bringing modeling and computer simulation of techno-socio-economic processes and phenomena together with related empirical, experimental, and data-driven work, (2) combining perspectives of different scientific disciplines (e.g. sociology, computer science, physics, complexity science, engineering), (3) comparing between fundamental and applied work.

Objective

Participants of the seminar should understand how tightly connected systems lead to networked risks, and why this can imply systems we do not understand and cannot control well, thereby causing systemic risks and extreme events.

They should also be able to explain how systemic instabilities can be understood by changing the perspective from a component-oriented to an interaction- and network-oriented view, and what fundamental implications this has for the proper design and management of complex dynamical systems.

Computational Social Science and Global Systems Science serve to better understand the emerging digital society with its close co-evolution of information and communication technology (ICT) and society. They make current theories of crises and disasters applicable to the solution of global-scale problems, taking a data-based approach that builds on a serious collaboration between the natural, engineering, and social sciences, i.e. an interdisciplinary integration of knowledge.

851-0585-04L Lecture with Computer Exercises: Modelling and Simulating Social Systems with MATLAB

Particularly suitable for students of D-MAVT, D-INFK, D-ITET, D-MTEC, D-PHYS.

Abstract

This course introduces first the basic functionalities and features of the mathematical software package MATLAB, such as the simple operations with matrices and vectors, differential equations, statistical tools, the graphical representation of data in various forms, and video animations of spatio-temporal data. With this knowledge, students are expected to implement themselves in MATLAB, models of various social processes and systems, including agent-based models, e.g. models of interactive decision making, group dynamics, human crowds, or game-theoretical models.

Objective

Part of this course will consist of supervised programming exercises in a computer pool. Credit points are finally earned for the implementation of a mathematical model from the sociological literature in MATLAB and the documentation in a seminar thesis.

Literature


Prerequisites / notice

The number of participants is limited to the size of the available computer teaching room. The MATLAB code related to the seminar thesis should be well enough documented for further use by others and must be handed over to the Chair of Sociology, in particular of Modeling and Simulation, for further free and unrestricted use.

851-0146-02L Manifolds and Individuation in Mathematics and Philosophy

Particularly suitable for students of D-BIOL, D-MATH, D-PHYS

Abstract

Manifolds and individuation are concepts which allow to reconsider notorious problems such as the relationship between general and particular, substance and modi, physical processes and persons. They may incorporate heterogeneous elements as needed to overcome traditional categories and classifications, and also describe processes leading to the existence of things.

Objective

The students should become familiar with some conceptual possibilities to recognise and deal with structures across the usual division of subjects. The problem areas are discussed on the basis of texts of various mathematicians and philosophers, with a wide range of applications such as psychology and life sciences.

851-0300-93L Philosophy of Biology

Particularly suitable for students of D-BIOL, D-USYS

Objective

The number of participants is limited to the size of the available computer teaching room. The MATLAB code related to the seminar thesis should be well enough documented for further use by others and must be handed over to the Chair of Sociology, in particular of Modeling and Simulation, for further free and unrestricted use.

851-0144-07L The Infinite in Philosophy and in the Exact Sciences: Logic, Mathematics, Physics

Number of participants limited to 40.

G. Sommaruga

Abstract

On the other hand, the topic of the infinite will be dealt with historically by discussing philosophical texts, by e.g., Kant, Bolzano and Cantor. On the other hand, the topic will be treated from a (non-historical) scientific point of view: the point of view of logic, mathematics, and physics.

Objective

To get acquainted with different types of infinitness; to study what is intriguing or problematic about the infinite; to inquire whether these different types of infinitness have (important) features in common.

851-0585-41L From Computational Social Science to Global Systems Science

Particularly suitable for students of D-INFK, D-ITET, D-MAVT, D-MTEC, D-PHYS

Abstract

The seminar aims at three-fold integration: (1) bringing modeling and computer simulation of techno-socio-economic processes and phenomena together with related empirical, experimental, and data-driven work, (2) combining perspectives of different scientific disciplines (e.g. sociology, computer science, physics, complexity science, engineering), (3) comparing between fundamental and applied work.

Objective

Participants of the seminar should understand how tightly connected systems lead to networked risks, and why this can imply systems we do not understand and cannot control well, thereby causing systemic risks and extreme events.

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Computational Social Science and Global Systems Science serve to better understand the emerging digital society with its close co-evolution of information and communication technology (ICT) and society. They make current theories of crises and disasters applicable to the solution of global-scale problems, taking a data-based approach that builds on a serious collaboration between the natural, engineering, and social sciences, i.e. an interdisciplinary integration of knowledge.

851-0585-04L Lecture with Computer Exercises: Modelling and Simulating Social Systems with MATLAB

Particularly suitable for students of D-MAVT, D-INFK, D-ITET, D-MTEC, D-PHYS.

Abstract

This course introduces first the basic functionalities and features of the mathematical software package MATLAB, such as the simple operations with matrices and vectors, differential equations, statistical tools, the graphical representation of data in various forms, and video animations of spatio-temporal data. With this knowledge, students are expected to implement themselves in MATLAB, models of various social processes and systems, including agent-based models, e.g. models of interactive decision making, group dynamics, human crowds, or game-theoretical models.

Objective

Part of this course will consist of supervised programming exercises in a computer pool. Credit points are finally earned for the implementation of a mathematical model from the sociological literature in MATLAB and the documentation in a seminar thesis.

Literature


Prerequisites / notice

The number of participants is limited to the size of the available computer teaching room. The MATLAB code related to the seminar thesis should be well enough documented for further use by others and must be handed over to the Chair of Sociology, in particular of Modeling and Simulation, for further free and unrestricted use.
851-0591-00L Digital Sustainability in the Knowledge Society

Particularly suitable for students of D-INFK, D-ITET, D-MATL, D-MAVT, D-MTEC, D-USYS

**Abstract**

How do various interest groups influence the methods of production, distribution, and use of digital resources? Current models focusing on strong intellectual property rights are contrasted with open models like, e.g., Open Source/Content/Access. The course discusses consequences from different models and introduces «digital sustainability» as an alternative vision for society.

**Objectives**

At the heart of the discourse is the handling of digital goods and intellectual property in society. Digitization and the Internet allow handling knowledge in a way, which directly contrasts with the traditional understanding of "intellectual property" and the industries based on it. Starting from economic and legal basics, we compare proprietary and open"free" models. Sustainable development as a concept is transferred to digital goods, taking into account the particular nature of digital stuff.

After the lecture, you should (hopefully) be able to:

- characterize the nature of digital goods vs. physical goods
- critique the basic concepts of copyright and patent rights
- explain the political/legal and economic differences between proprietary and open approaches to the production and use of digital goods
- using an example, explain the meaning of digital sustainability and argue why it is relevant for a knowledge society
- transfer the ideas of the free/open source software model to other digital goods (e.g., open content, open access)

**Content**

Technical reality: Within minutes you can make perfect copies of high-value digital goods of knowledge or culture (as text, audio, video, image or software) and distribute them around the globe -- for free. «Digitization plus Internet» allows for the first time in human kind's history the (theoretically) free access and global exchange of knowledge at minimal cost. A tremendous opportunity for societal development, in north and south. «Cool, so what's the problem?»

The problem is, that this reality poses a fundamental threat to today's business model of the knowledge and culture industries (starting from the music label and Hollywood, via publishers, up to software vendors). Powerful commercial interests are at stake as «knowledge» (the fourth factor of production) will become ever more important in the 21st Century. Accordingly, «piracy» and «file-sharing» are attacked with all might. At the core lies the question about the design of property in digital assets. For that, we apply a concept of «intellectual property», which is a several hundred years old and does not address digital reality in an adequate manner, sometimes leading to absurd situations. Its original goal seems to get forgotten: to help society develop by spreading knowledge as much as possible.

Using the PC becomes the new cultural technique of the 21st Century. In contrast to «reading, writing and arithmetics», this new cultural technique cannot exist in isolation, but depends on a hard- and software infrastructure. This dependency extends to the provider of the infrastructure, who can define technical rules, which can take away or restrict the user's freedom. Even advanced users may have difficulties in recognizing these, often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible consequences we need to understand and investigate, because they decide about access, distribution and usage of digital knowledge.

Concomitantly to the environmental and social dimension of the 60's and 70's, a growing political movement of the Free Software movement for «Free Software» exists today, with «GNU/Linux» as its most popular symbol. The movement fights against treating software code as private property but as a central cultural property available to all without private interests. Based on the success of the Free Software movement, new initiatives extend the concepts to other domains (e.g. scientific knowledge, music)...

As a «teaser» to the lecture, you are invited to read the essay «ETH Zurich - A Pioneer in Digital Sustainability!». It can be downloaded from www.essays2030.ethz.ch.

In case of interest, you are invited to attend the lecture without doing the group assignment. The website is actively used for the purpose of communication and information.

**Literature**

1. (general) Chris DiBona et al., Open Sources: Voices from the Open Source Revolution, O'Reilly, 1999.

**Prerequisites / notice**

For administrative and didactic reasons (high level of interaction and credit group assignments on current hot topics), the number of participants is limited to 45.

Of course, any interested person is invited to attend the lecture without doing the group assignment. The website is actively used for the purpose of communication and information.

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851-0594-00L International Environmental Politics

Particularly suitable for students of D-ITET, D-USYS

**Abstract**

This course focuses on the conditions under which cooperation in international environmental politics emerges and the conditions under which such cooperation and the respective public policies are effective and/or efficient.

**Objectives**

The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a social sciences viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems.

**Content**

This course deals with how and why international cooperation in environmental politics emerges, and under what circumstances such cooperation is effective and efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental politics are discussed: the management of international water resources, the problem of unsafe nuclear power plants in eastern Europe, political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

The course is open to all ETH students. Participation does not require previous coursework in the social sciences.

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 4 ECTS credit points. The workload is around 120 hours (meetings, reading assignments, preparation of test).

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory (http://www.rektorat.ethz.ch/students/admission/auditors/specialstudents_uhz/index_EN; see menu on left side of that webpage for students from other universities).

**Lecture notes**

Slides and reading material will be made available at www.ib.ethz.ch (teaching, materials), then menu on the left side of the screen. They are password protected. Use your Uethz username and password to access the material.

**Literature**

See www.ib.ethz.ch (teaching, materials)
The Economics of Climate Change

**Objective**
This course has a number of objectives: (i) To outline the problem of climate change (ii) to discuss and compare the theoretical economic solutions to combating climate change (iii) to present existing climate change mitigation actions in an economic context and (iv) to outline possible future climate policy issues.

**Content**
Economics of pollution, Optimal level of greenhouse gases, International Environmental Agreements, Tradable pollution permit markets, : Carbon Taxes, Technological innovation and R&D, The optimal approach to control Climate change, The future of Climate change policy

**Prerequisites**
Required reading: Perman et al. (2003), Natural Resource and Environmental Economics, Pearson Addison Wesley. Also, Journal articles will be cited

**Prerequisites / notice**
Prerequisites: The course relies heavily on the concepts and techniques used in basic game theory. Therefore prior knowledge is recommended

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<thead>
<tr>
<th>Course Code</th>
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<tr>
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<td>851-0724-00L</td>
<td>Property Law for Geometers: Land Registry and Geoinformation Law</td>
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The workload for this course is approx. 120 hours (all inclusive).
Abstract
Fundamental concepts of Land Register Law and Land Surveying Law (substantive and procedural rules of Land Register Law, the parts and the relevance of the Land Register, process of registration with the Land Register, legal problems of land surveying, reform of the official land surveying).

Objective
Overview of the legal norms of land registry and surveying law.

Content
Basic principles of material and formal land registry law, components of the land register, consequences of the land register, the registration process, legal problems of surveying, the reform of official surveying, liability of the geometer. The lecture unit is carried out within a frame of 8 sessions (2 hours): the first hour of each is given in the form of a lecture, the second in the form of a case-study.

Lecture notes
Abgegebene Unterlagen: Skript in digitaler Form

Literature
- Meinrad Huser, Geo-Informationssysteme, Zürich 2005
- Meinrad Huser, Darstellung von Grenzen zur Sicherung dinglicher Rechte, in ZBR 2013, 238 ff.
- Meinrad Huser, Datenschutz bei Geodaten

Prerequisites / notice
Requirements: Property Law (12-722)

851-0735-11L Environmental Regulation: Law and Policy

Number of participants limited to 15.
Particularly suitable for students of D-USYS

The course is fully booked

Abstract
The aim of this course is to make students with a technical scientific background aware of the legal and political context of environmental politics at the example of specific environmental challenges of global importance. The course gives insights into the relevance of ecological aspects in developing countries. It covers concepts, instruments, processes and actors in environmental politics and in multilateral negotiations.

Objective
The aim of this course is to equip students with a legal and regulatory skill-set that allows them to translate their technical knowledge into a policy brief directed at legally trained regulators. More generally, it aims to inform students with a technical scientific background of the legal and political context of environmental policy. The focus of the course will be on international and European issues and regulatory frameworks - where relevant, the position of Switzerland within these international networks will also be discussed.

Content
Topics covered in lectures:

(1) Environmental Regulation
a. Perspectives
b. Regulatory Challenges of Environment Problems
c. Regulatory Tools
(2) Law: International, European and national laws
a. International law
b. European law
c. National law
(3) Policy: Case studies

Assessment:
(i) Class participation (25%): Students will be expected to contribute to class discussions and prepare short memos on class readings.
(ii) Exam (75%) consisting of three parts:
  a. Policy brief - a maximum of 2 pages (including graphs and tables);
  b. Background document to the policy brief - this document sets out a more detailed and academic overview of the topic (maximum 8 pages including graphs and tables);
  c. Presentation of the policy brief: presentations can use a maximum of 5 slides and can last 7 minutes.

Lecture notes
The course is taught as a small interactive seminar and significant participation is expected from the students. Participation will be capped at 15 in order to maintain the interactive nature of the course. All classes, readings, and assignments, are in English.

Teaching will take place over two weeks in September and October. The exam date will be in December.

Literature
During the second week of the teaching period, students will have individual 30-minute meetings with the lecturer to discuss their project.

An electronic copy of relevant readings will be provided to the students at no cost before the start of the lectures.

Prerequisites / notice
The course is (inter)related to materials discussed in Politikwissenschaft: Grundlagen (851-0577-00 V), Ressourcen- und Umweltökonomie (751-1551-00 V), Umweltrecht: Konzepte und Rechtsgebiete (851-0705-01 V), Rechtlicher Umgang mit natürlichen Ressourcen (701-0743-01 V), Environmental Governance (701-1651-00 G), Policy and Economics of Ecosystem Services (701-1653-00 G), International Environmental Politics: Part I (851-0594-00 V).

701-0727-00L Politics of Environmental Problem Solving in Developing Countries

Abstract
The course focuses on processes and drivers of decision-making on natural resources management issues in developing countries. It gives insights into the relevance of ecological aspects in developing countries. It covers concepts, instruments, processes and actors in environmental politics at the example of specific environmental challenges of global importance.

Objective
After completion of the module, students will be able to:
- Identify and appraise ecological aspects in development cooperation, development policies and developing countries' realities
- Analyze the forces, components and processes, which influence the design, the implementation and the outcome of ecological measures
- Characterize concepts, instruments and drivers of environmental politics and understand, how policies are shaped, both at national level and in multilateral negotiations
- Study changes (improvements) in environmental politics over time as the result of the interaction of processes and actors, including international development organizations
- Analyze politics and design approaches to influence them, looking among others at governance, social organization, legal issues and institutions

Prerequisites / notice
No specific pre-existing legal knowledge is required, however all students must have successfully completed Grundzüge des Rechts (851-0708-00 V) or an equivalent course.

Assessment:
(i) Class participation (25%): Students will be expected to contribute to class discussions and prepare short memos on class readings.
(ii) Exam (75%) consisting of three parts:
  a. Policy brief - a maximum of 2 pages (including graphs and tables);
  b. Background document to the policy brief - this document sets out a more detailed and academic overview of the topic (maximum 8 pages including graphs and tables);
  c. Presentation of the policy brief: presentations can use a maximum of 5 slides and can last 7 minutes.

The course is fully booked particularly suitable for students of D-USYS.

The course is taught as a small interactive seminar and significant participation is expected from the students. Participation will be capped at 15 in order to maintain the interactive nature of the classes. All classes, readings, and assignments, are in English.

Teaching will take place over two weeks in September and October. The exam date will be in December.

Literature
An electronic copy of relevant readings will be provided to the students at no cost before the start of the lectures.

No specific pre-existing legal knowledge is required, however all students must have successfully completed Grundzüge des Rechts (851-0708-00 V) or an equivalent course.

The course is (inter)related to materials discussed in Politikwissenschaft: Grundlagen (851-0577-00 V), Ressourcen- und Umweltökonomie (751-1551-00 V), Umweltrecht: Konzepte und Rechtsgebiete (851-0705-01 V), Rechtlicher Umgang mit natürlichen Ressourcen (701-0743-01 V), Environmental Governance (701-1651-00 G), Policy and Economics of Ecosystem Services (701-1653-00 G), International Environmental Politics: Part I (851-0594-00 V).
Key issues and basic concepts related to environmental politics are introduced. Then the course predominantly builds on case studies, providing information on the context, specifying problems and potentials, describing processes, illustrating the change management, discussing experiences and outcomes, successes and failures. The analysis of the cases elucidates factors for success and pitfalls in terms of processes, key elements and intervention strategies.

Different cases not only deal with different environmental problems, but also focus on different levels and degrees of formality. This ranges from local interventions with resource user groups as key stakeholders, to country level policies, to multi- and international initiatives and conventions. Linkages and interaction of the different system levels are highlighted. Special emphasis is given to natural resources management.

The cases address the following issues:
- Land use and soil fertility enhancement: From degradation to sustainable use
- Common property resource management (forest and pasture): Collective action and property rights, community-based management
- Ecosystem health (integrated pest management, soil and water conservation)
- Payment for environmental services: Successes in natural resources management
- Climate change and agriculture: Adaptation and mitigation possibilities
- Biodiversity Convention: Implications for conservations and access to genetic resources
- Biodiversity as a means for more secure livelihoods: Agroforestry and intercropping
- The Millennium Development Goals: Interactions between poverty and the environment
- Poverty and natural resources management: Poverty reduction strategies, the view of the poor themselves
- Food security: Policies, causes for insecurity, the role of land grabbing
- Biofuels and food security: Did politics misfire?
- Strategy development at global level: IAASTD and World Development Report 2008

The students know the opportunities and restrictions which are given by the law when using natural resources. They have insights into the important concepts and positions of environmental ethics. They achieve a deeper understanding of these concepts and positions in their application to concrete cases. The students are able to formulate typical legal questions, to understand the argumentation of courts and to solve simple legal problems with respect to environmental problems.

The performance assessment will consist of an individual essay to be written by each student based on at least five references in addition to the sources provided in the course. Students can choose from a list of topics. Criteria for assessment will be communicated at the beginning of the course.

Law and Natural Resources

Abstract
This course teaches the possibilities and limits of the law in order to protect natural resources and landscapes against harm and nuisance. The learning concept is based on the co-ordinated implementation of the relevant legislations. The complexity of the legal situation will be discussed by analysing virtual and real law cases focused on spatial projects and planning.

Objective
The students know the opportunities and restrictions which are given by the law when using natural resources. They have insights into the complex environmental legal system and their application in concrete cases. The students are able to formulate typical legal questions, to understand the argumentation of courts and to solve simple legal problems with respect to environmental problems.

Content
- Waldrecht - Natur- und Landschaftsschutzrecht - Wasserrecht - Raumplanungsrecht - Umweltschutzrecht - Verfahrensrecht

Unterrichtssprache: Deutsch

Lecture notes
Den Studierenden werden Unterlagen wie eine Übersicht über den behandelten Stoff auf PP-Folien, typische Gerichtsentscheide, Daten: 06.02.2019 13:00

Literature
Griffel, A.; Raumplanungs- und Baurecht in a nutsell, Dike Verlag, Zürich/St. Gallen 2012
Rausch/Martí/Griffel: Umweltrecht Ein Lehrbuch, Herausgeber: Walter Haller, Schultess Verlag, Zürich 2004

Preparations:
- Cross-section topics, such as sustainability, intergenerational justice, protection of species, etc.
- Familiarisation with various basic standpoints within environmental ethics.
- Overview and discussion of ethical theories relevant to the environment.

Prerequisites:
African Studies, 38(1), 89-120.

Environmental Ethics

Abstract
The lecture begins with an introduction to applied ethics in general. The main focus is on environmental ethics. Students learn to handle important concepts and positions of environmental ethics. They achieve a deeper understanding of these concepts and positions in applying them to ecological problems and discussing them in case studies.

Objective
On completion of this lecture course you will have acquired the ability to identify and process general and environmental ethical problems. You will be capable of recognising and analysing environmental ethical problems and of working towards a solution. You will have acquired a fundamental knowledge of standpoints and arguments to be found within the field of environmental ethics and will have practised these in small case studies.

Content
- Introduction to general and applied ethics.
- Overview and discussion of ethical theories relevant to the environment.
- Familiarisation with various basic standpoints within environmental ethics.
- Cross-section topics, such as sustainability, intergenerational justice, protection of species, etc.
- Practising of newly acquired knowledge in case studies (protection of species, climate change, etc.)

Lecture notes
Summaries of the individual sessions will be distributed, including the most important theoretics and keywords; reading list. In the part of the course serving as an introduction to general and applied ethics, we shall be using the following textbook: Barbara Bleisch/Markus Huppenbauer: Ethische Entscheidungsfindung. Ein Handbuch für die Praxis, Zürich 2010 (to be published Autumn 2010).
Environmental Sociology

I. Introduction

M. Schäfer

The course gives an introductory overview in research questions, theoretical perspectives and empirical results of science communication and environmental communication. They will be illustrated by concrete examples and via lectures from external guests.

Objective

- Tools: Research, Theory, Methods - Communication, Social Science, Natural Science - Media, Public, Public Relations

Content

I. Introduction

- Topics: Environment, Science, Communication, Media - Forms, Functions, Effects of Public and Mass Communication

II. Stakeholders and their Public Relations Efforts

- Public Relations and Science PR: Theoretical Perspectives, Instruments

III. Science and Environmental Issues in the Media

- Forms and Functions of Science Journalism - Problems of Selection, Interpretation, Quality - Media Content Analysis - Online Communication

IV. Uses and Effects of Science and Environmental Communication

- Effects of Media Use - Effects on Knowledge, Risk Perceptions, Environmental Attitudes - Effects on Science itself

Literature

- Andrew Light/Holmes Rolston III, Environmental Ethics. An Anthology, 2003
- John O'Neill et al., Environmental Values, 2008
- Klaus Peter Rippe, Ethik im ausserhumanen Bereich, Paderborn (mentis) 2008

Generel introductions:

- Johann S. Ach et. al (Hrsg.), Grundkurs Ethik 1. Grundlagen, Paderborn (mentis) 2008

The procedure for accumulating CP will be explained at the start of term.

I expect participants to be motivated and contribute to discussions, keeping the course interesting and lively.

Environmental Policy of Switzerland I

W 2 credits 2S H. Bruderer Enzler

Abstract

This introductory class in environmental sociology covers different theoretical approaches but the main focus is on recent empirical research topics such as environmental behavior, environmental concern, social dilemmas, social norms, environmental justice, and risk perception.

Objective

- Basic knowledge of environmental sociology
- Overview on current fields of research in environmental sociology and their relevance for environmental protection
- Basic notion of the structure of empirical research papers in social sciences

Content

The Seminar führt in die Umweltsoziologie ein. Dabei werden verschiedene theoretische Ansätze besprochen (Fokus: Rational Choice). Der Schwerpunkt des Kurses liegt auf aktuellen empirischen Untersuchungen zu Themen wie Umweltverhalten, Umweltbewusstsein, soziale Dilemme, soziale Normen, Umweltgerechtigkeit und Risikowahrnehmung.

The processes of change, overuse or destruction of the natural environment through humans have historically placed high demands on social and political institutions. In the interplay between the environment, society and economy, the environmental policy field encompasses the sum of public measures that have the goal to eliminate, reduce or avoid environmental degradation. The course provides insight into political decision-making processes. The well-grounded examination of complex political conflict situations is an important precondition for the entry into the (environmental policy) workforce or a future research career.

The detailed semester program (syllabus) is made available to the students at the beginning of the semester.

Environmental and Science Communication

W 3 credits 2V E. Lieberherr

Abstract

This course presents the basics of policy analysis and the specific characteristics of Swiss environmental policy. Political instruments, programs and processes as well as their change over time. A key aspect is the distinction between politics and political science and specifically environmental policy.

Objective

- Beyond acquiring basic knowledge about policy analysis, this course teaches students how to analytically address current and concrete questions of environmental policy.
- Through exercises the students learn about political science concepts and frameworks as well as real-life political decision-making processes. The well-grounded examination of complex political conflict situations is an important precondition for the entry into the (environmental policy) workforce or a future research career.

Content

The processes of change, overuse or destruction of the natural environment through humans have historically placed high demands on social and political institutions. In the interplay between the environment, society and economy, the environmental policy field encompasses the sum of public measures that have the goal to eliminate, reduce or avoid environmental degradation. The course provides insight into the development of Swiss environmental policy and systematically presents the basics of environmental policy actors, instruments, programs and processes as well as their change over time. A key aspect is the distinction between politics and political science and specifically environmental policy.

The detailed semester program (syllabus) is made available to the students at the beginning of the semester.
**Lecture notes**

Literature and powerpoint presentations will be provided on the OLAT platform.


Die Vorlesung wendet sich auch an Studierende der Publizistikwissenschaft der Universität Zürich

Prerequisites / notice

Voraussetzungen: Die Vorlesung hat einführenden Charakter.

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<tr>
<th>Code</th>
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<tbody>
<tr>
<td>701-0791-00L</td>
<td>Environmental History - Introduction and Overview</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>D. Speich Chassé</td>
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<td></td>
<td><strong>Abstract</strong></td>
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<td>Our society faces a serious ecological crisis. Of</td>
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<td>what historical dimension is this crisis? How</td>
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<td>have human societies already in earlier times</td>
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<td>changed their environment, and, consequently,</td>
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<td>perhaps also ours? What were the main ecological</td>
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<td>challenges for societies and how did they</td>
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<td>change over time? And how did societies adapt to</td>
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<td>changing environmental conditions?</td>
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<td>Introduction into environmental history; survey</td>
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<td>of long-term development of human-nature-</td>
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<td>interrelations; discussion of selected problems.</td>
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<td>Improved ability to assess current problems</td>
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<td>from a historical perspective and to critically</td>
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<td>interrogate one's own standpoint.</td>
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<td>Course material is provided on OLAT.</td>
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<td><strong>Literature</strong></td>
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<td>McNeill, John R. 2000. Something new under the sun:</td>
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<td>An environmental history of the twentieth-century</td>
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<td>world, New York: Norton.</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td>Winiwarter, Verena und Martin Knoll 2007. Umwelt-</td>
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<td>geschichte: Eine Einführung, Köln: Böhlau.</td>
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<td>Students are asked to write an exam during the</td>
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<td>second last session (11.12.2015).</td>
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<td>701-0985-00L</td>
<td>Social Intercourse with Current Environmental</td>
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<td>B. Nowack, C. M. Som-Koller</td>
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<td>Risks <strong>Abstract</strong></td>
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<td>The lecture treats the social intercourse with</td>
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<td>risks of technical systems. The notion of risk</td>
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<td>and the perception of risk are discussed by case</td>
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<td>studies (e.g. nanotechnology) and socio-political</td>
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<td>instruments for decision-making are presented.</td>
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<td>Methods are presented that can be applied to</td>
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<td>deal with environmental risks and how they can</td>
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<td>be used for sustainable innovation.</td>
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<td><strong>Objective</strong></td>
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<td>- Getting acquainted to the extended risk</td>
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<td>concept - Evaluation of the risks caused</td>
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<td>by technology within the societal context</td>
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<td>- Knowledge about the mode science and society</td>
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<td>handle current environmental risks (examples</td>
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<td>gene- and nanotechnology) - Knowledge about</td>
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<td>handling risks (e.g. precautionary principle,</td>
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<td>protection goal, damage definition, ethics)</td>
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<td>Knowledge about possibilities for sustainable</td>
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<td>innovation</td>
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<td><strong>Content</strong></td>
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<td>- Risks and technical systems (risk categories,</td>
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<td>risk perception, risk management) - Illustration</td>
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<td>with case studies (nanotechnology) -</td>
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<td>Implementation (politics, science, media, etc.)</td>
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<td>- Decision making (technology assessment, cost/</td>
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<td>benefit analysis etc.) - The role of the media</td>
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<td>- prospects for future developments</td>
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<td><strong>Lecture notes</strong></td>
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<td>Copies of slides and selected documents will be</td>
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<td>The lecture is held biweekly (for 2 hours). The</td>
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<td>dates are 21.9., 28.9 (attention, out of schedule) ;</td>
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<tr>
<td>860-0006-00L</td>
<td>Statistical Data Analysis <strong>Abstract</strong></td>
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<td>This course introduces students to key statistical</td>
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<td>methods for analyzing social science data with</td>
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<td>a special emphasis on causal inference. Students</td>
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<td>learn to choose appropriate analysis strategies</td>
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<td>for particular research questions and to perform</td>
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<td>statistical analyses with statistical software</td>
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<td>such as Stata.</td>
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<td><strong>Objective</strong></td>
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<td>Students - have a sound understanding of linear</td>
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<td>and logit regression - know some basics about</td>
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<td>regression models for multinomial, ordered, or</td>
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<td>censored response variables, as well as for count</td>
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<td>data - know strategies to test causal hypotheses</td>
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<td>using regression analysis with experimental and</td>
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<td>quasi-experimental methods - are able to formulate</td>
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<td>and implement a regression model for a particular</td>
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<td>research question and a particular type of data</td>
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<td>- are able to critically interpret results of a</td>
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<td>regression model, in particular, regarding causal</td>
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<td>inference</td>
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Data: 06.02.2019 13:00  Autumn Semester 2015  Page 629 of 1434
The main objective of this course is to practice and improve the four language skills of participants (listening, speaking, reading and writing). This course is intended for students who have reached level B2. Participants will train their skills so that they may perform clear, fluent and communicative speech.

This course focuses on modern and contemporary literary texts.

French: Literature (B2-C1)

English Language and Literature Part I (C1-C2)

French: Advanced (B2-C1)

Practising French in Context

French: Advanced (B2-C1)

This course for Bachelor and Master students at C1-C2 level is designed to enhance students' perception and understanding of literature written in English. Through the analysis and interpretation of literary texts, students will improve their own textual analysis and language skills.

The main objective of this course is to practice and improve the four language skills of participants (listening, speaking, reading and writing). Students will have to make a presentation in French on a complex subject, interact in a group, defend a point of view and answer to objections.

The main emphasis is on spoken skills, with the aim of enabling students to develop their own voice in expressing their views and developing arguments efficiently. The course also nurtures the ability to understand detailed and implicit meaning in documents concerning aspects of society at large.

The aims of the course are to
- Introduce students to the traditions and conventions of literature written in English
- Help students to develop critical, creative, and personal approaches to analyzing literary works
- Provide students with an opportunity to enhance and practice their argumentation skills in discussions and writing
- Improve they ways in which students organize their ideas and arguments in a sustained, coherent, and logical manner
- Improve students grammatical and lexical repertoire through reading and discussion
- Impart a life-long interest in a wide and diverse range of literature written in English

A variety of texts, such as classic and modern poetry, short fiction, and one short novel, will be explored. Classwork will be interactive, with pair, small group, and plenary discussions, giving all class members the chance to practice speaking freely and sustaining an argumentative line of discourse. Writing tasks will be assigned to produce coherent and well-structured texts. Lexical work will help students to increase their range of vocabulary and allow them to apply freshly acquired vocabulary in speaking and writing.

Materials: Texts will be made available either online (OLAT) or as handouts.

Please be advised that your online-registration at the language centre has to be simultaneous (www.sprachenzentrum.uzh.ch) as otherwise your registration for the course will not be valid.
Participants should have already reached a level of C1 (advanced), as defined in the Council of Europe Global Scale. The course is also open to participants whose level is above C1.

The course aims to train and develop linguistic skills at Mastery level. Special attention is placed on Speaking and Writing.

Participants should already have reached a level of C1 (advanced), as defined in the Council of Europe Global Scale. The course is also open to participants whose level is above C1.

The course aims to train and develop linguistic skills at Mastery level, with a focus on formal and informal lexis, on listening and oral communication skills, increasing fluency, accuracy and complexity of spoken language; writing well-structured descriptive texts and argumentative essays, with the aim to fulfill the language requirements for study at an English speaking university or follow University Master Courses held in English.

Participants will be expected to:
* Attend regularly throughout the semester;
* Participate actively in discussions, group work, and pair work;
* Do at least 2 hours' work per week outside the classroom, including reading and writing;
* Complete written assignments during the semester

Additional requirements for Bachelor and Master students and those who wish to receive ETH/D-GESS credit points will be outlined in the first lesson of the semester.

NB: This is Part I of a two-part course. Part 2 runs in the spring semester. Each part can be taken on its own. However, a separate enrolment is required for each part.

### Prerequisites / notice
- All participants are expected to
  - Attend regularly throughout the semester
  - Participate actively in discussions, group work, and pair work
  - Do at least 2 hours' work a week outside the classroom, including reading and writing
  - Complete written assignments during the semester

### Content
- The course covers: a review of vocabulary building and extension, including the Academic Word List and formulaic language; input on academic reading, writing and listening comprehension; improvement of grammatical accuracy with web-based practice. Special emphasis is placed on individual speaking, argumentative discourse and group discussions, to enhance fluency and confidence. Topics cover globalization, communication, social issues, work and health, the environment.

### Literature
- Course materials will be provided electronically, prior to the lessons. For additional handouts and materials participants will be expected to make a contribution of about CHF 5.00 at the beginning of the course.

### Prerequisites / notice
- Participants will be expected to:
  - Attend regularly throughout the semester;
  - Participate actively in class discussions, group work and pair work;
  - Do at least 2 hours' work per week at home, including reading and writing;
  - Use the electronic tools provided, such as a Wiki and a virtual library on ILIAS, and engage in web-based activities to practise various linguistic skills;

- A language certificate from the Language Center is issued on successful completion of the course; Bachelor and Master students of the ETH will receive D-Gess credits and a mark, awarded electronically at the end of the semester. Details will follow at the beginning of the semester.

The course is only open to students who register on-line via the Sprachenzentrum website (in September 2014, please review the SZ webpage) and who receive on-line confirmation that they have been accepted on this course.
The course aims towards integrating grammar and oral/written communication. We will present new grammar topics and will introduce them into the oral practice.

Content

The most important grammatical topic will be the imperfecto and pluscuamperfecto of subjunctive in subordinate structures. Free and directed discussion will be enhanced. We will read diverse text forms from Spanish and Latin American Authors.

Lecture notes

The teacher will provide the script. A fee of CHF 4.00 for photocopies be collected.

Prerequisites / notice

The certificate and ETCS points are granted to the students who have complied with the following requirements:

* Participation in the weekly lessons (maximum 3 absences)
* A minimum of 2 hours of self study (reading and grammar exercises)
* Presentation of one of the chosen texts
* Passing of a final exam

Important information for ETH students: The enrollment in this course at the Sprachzentrum does not enrol the student automatically for the granting of the D-GESS points. Please inform yourself.

851-0834-17L Spanish: Oral Interaction (B2)  
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachzentrum.uzh.ch).

Abstract

The course is aimed for students and staff having passed level B1.2 and for those who know and correctly use all indicative tenses, as well as the subjunctive in its present and perfect forms. On the other hand, they should be able to make themselves fluently understood in every day conversations and read intermediate level texts.

Objective

The course aims to introduce new grammar topics and we will introduce them into the oral practice.

Content

The certificate and ETCS points are granted to the students who have complied with the following requirements:

* Participation in the weekly lessons (maximum 3 absences)
* A minimum of 2 hours of self study (reading and grammar exercises)
* Presentation of one of the chosen texts
* Passing of a final exam

Material will be distributed by the teacher.

Prerequisites / notice

The certificate and the corresponding ETCS credits are granted to students having completed to the following criteria:

* Active presence (maximum 3 absences allowed)
* An interview to a Spanish-speaking person
* A presentation

The teacher will communicate the students the marking criteria.

Enrollment in this course is done through the Language Center: www.sprachenzentrum.uzh.ch.

851-0846-02L Spanish: Language and Cinema (B2-C1)  
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachzentrum.uzh.ch).

Abstract

We practice several kinds of oral interactions, such as casual and formal conversation, interviews to Spanish-speaking people, debate, negotiation, etc. We discuss about current issues. On the other hand, it is intended for participants to develop a glossary correspondent to his/her area of study and to do a short presentation.

Objective

The course is aimed to introduce specific problematic in a Spanish-speaking region or country through the cinema, taking into account the geopolitical and cultural spectrum of the Spanish language. It also aims the participant to get familiarized with topics, images, customs, vocabulary, conversation and debate.

Content

The chosen films can be seen / borrowed from the Selbstlernzentrum (http://www.sprachenzentrum.uzh.ch/slz/index.php).

Prerequisites / notice

The certificate and ETCS points are granted to the students who have complied with the following requirements:

* Preparation (glossary and thematics) of one of the chosen films
* Entries in the blog and forum of the course

Important information for ETH students: The enrollment in this course at the Sprachzentrum does not enrol the student automatically for the granting of the D-GESS points. Please inform yourself.

851-0826-04L Italian: Language and Literature (B2-C1)  
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachzentrum.uzh.ch).

Abstract

The main activity of the course is the visioning of films in Spanish (Spain and Latin America), giving an emphasis on a specific thematic, vocabulary, conversation and debate.

Objective

The course aims to approach the Italian language through literature. While reading short stories the participants will deepen their linguistic and syntactic competence as well as their understanding of the Italian culture by means of interactive exercises and class discussions.

Content

The certificate and ETCS points are granted to the students who have complied with the following requirements:

* Active presence (maximum 3 absences allowed)
* The visioning of at least 80% of the films
* Preparation (glossary and thematics) of one of the chosen films
* Entries in the blog and forum of the course

Important information for ETH students: The enrollment in this course at the Sprachzentrum does not enrol the student automatically for the granting of the D-GESS points. Please inform yourself.
Greek Basic Course Part III

Challenging everyday situations; discussion of specific topics (eg. describing pictures and photographs, talking about daily chores);

The students should be able to translate a Greek text on a higher level. They should have a sound knowledge of the Homeric Epos and the Platonic philosophy.

Modern Greek Language III (A2.1)

Practice of oral communication and study of basic vocabulary and grammar; focus on noun and adjective structures, personal and possessive pronouns, active verbs (Present Tense) and the use of adverbs. Initiation to web-based activities in Greek and enhancement of interest and activities in Greek language and culture.

851-0885-07L Greek Basic Course Part I W 4 credits 5U F. Egli Utzinger

Abstract
Language course for beginners. We will work with a textbook which contains easy original Greek texts. Basic knowledge of Greek grammar, vocabulary and of some characteristics of the Greek language and culture.

Objective
Basic knowledge of Greek grammar, vocabulary and of some characteristics of the Greek language and culture.

851-0885-08L Greek Basic Course Part III W 4 credits 4U R. Harder

Abstract
In this third semester "Graecum" we consolidate the knowledge of the language. The course focusses on the lecture of a Platonic dialog and of Homer's Odyssey. The course prepares the students for the final exam in January.

Objective
The students should be able to translate a Greek text on a higher level. They should have a sound knowledge of the Homeric Epos and the Platonic philosophy.

851-0885-09L Modern Greek Language I (A1.1) W 2 credits 2U A. Rassidakis Kastrinidis

Abstract
This is the first part of a language course which runs over four semesters, covering levels A1 and A2 of the Global European Framework. Modern Greek Language I is designed for students who have no or very little command of Modern Greek and covers level A1.1.

Objective
Practice of oral communication and study of basic vocabulary and grammar; focus on noun and adjective structures, personal and possessive pronouns, active verbs (Present Tense) and the use of adverbs. Initiation to web-based activities in Greek and enhancement of interest and activities in Greek language and culture.

Content
The course covers the areas work, home and personal interests; everyday situations and conversations in hotel, restaurant and shops; asking for the way and asking for advice; simple text materials, such as poems, songs and comics will support learning activities.

Lecture notes
Keines

Literature
- The course book by D. Dimitra & M. Papacheimona, Ellinika tora 1+1 (Greek now 1+1, including 2 audio-CD), units 1-5, Athens 2002, and workbook one, Tetradio Askiseon 1, have been ordered for the course members and are available at "Bücherladen der Stiftung Zentralstelle der Studentenschaft", Schönberggasse 2.
- Web-based activities to support and enhance classroom teaching will be accessible via Moodle, an electronic platform offered by LET of ETHZ (http://moodle.let.ethz.ch/).
- Additional course materials and handouts will be distributed in class.
- A set of 1400 vocabulary cards for the entire coursebook (Ellinika tora 1+1) is available and can be ordered at the beginning of the semester.

Prerequisites / notice
All course participants are expected to:
- attend regularly and participate actively in class
- do at least 3 hours' work at home
- submit all their written work for correction
- commit themselves to online-activities in the Moodle-LET online-classroom
- pass all semester-tests.

All candidates who fulfill the course requirements will receive a language certificate, issued by the Language Center, awarding 2 ECTS credits.

D-GESS students will receive on-line credit points and marks, in addition to the LC-certificate.

The course is only open to students who register on-line via the Sprachzentrum-website and who receive online confirmation that they have been accepted on this course. Please note the limited online-registration period.


851-0885-10L Modern Greek Language III (A2.1) W 2 credits 2U A. Rassidakis Kastrinidis

Abstract
This is Part III of the Modern Greek language course, running over four semesters. Modern Greek III covers level A2.1 of the Global European Framework and is designed for students who have already attended courses I and II at the Sprachzentrum UNI/ETHZ, or whose language proficiency is equivalent to level A1.2.

Objective
Extensive vocabulary work (approx. 400 new words); reading of elementary texts; additional practice through speaking only Greek in class; improving listening comprehension; writing short essays (about the past and the future, describing events and personal experience).

Content
Challenging everyday situations; discussion of specific topics (eg. describing pictures and photographs, talking about daily chores); elementary listening comprehension practice (dialogues, talking about events, advertisements); reading comprehension (advertisements, cooking recipes, poems); advanced web-based activities in Greek.

Lecture notes
Keines

Literature
- Audio-visual materials and handouts (photocopiers) will be used. Photocopiers will be distributed during the semester.
- Web-based activities can be accessed via Moodle platform, supported by LET of ETHZ (http://moodle.let.ethz.ch/).
This course is a direct continuation of the first part of the Swedish-course. Participants should already have reached level A1.

The course is the first of a two-part Swedish-course, run over two semesters. The aim of the course is to achieve basic language skills in speaking, listening, reading and writing (Level A1). The focus is based on oral skills.


The participants learn to express themselves in a variety of everyday situations. The course provides knowledge on characteristics of Swedish culture and society. Additional material is distributed during the lessons. You will be asked to pay CHF 5.00 to cover the cost of photocopies.

The course is only open to students who registered online via the Language Center website and who received an e-mail confirmation that they have been accepted in this course.

Regular attendance (max 3 absences), active participation in class and a minimum of 3 hours work outside class is expected per week.

Additional material will be distributed during the lessons. You will be asked to pay CHF 5.00 to cover the cost of photocopies.

The course is only open to students who registered online via the Language Center website and who received an e-mail confirmation that they have been accepted in this course.

Regular attendance (max 3 absences), active participation in class and a minimum of 3 hours work outside class is expected per week.

Students of Greek origin please contact Ms. Rassidakis before enrolling in order to check if the course is not too easy for them.

The course is planned as the first part of a two-semester crash course in Polish at level A1.1. The students learn the principles of Polish pronunciation and intonation as well as basic Polish grammar needed to master the course goals.

The students learn to master a set of basic situations in developing communication skills linked with every day life. Special attention will be given to features of academic culture.

The students learn the principles of Polish pronunciation and intonation as well as basic Polish grammar needed to master the course goals.

The use of of the open-source Learning Management System OLAT will be part of the course.
851-0851-00L Russian I (A1.1) ☑
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Abstract
This course is an introduction to Russian language (and culture) for beginners (Level A1.1). The course treats both the Cyrillic alphabet and phonetics and develops a basic vocabulary. In two terms the students acquire a basic knowledge of the most important aspects of Russian grammar.

Registration for the course at sprachenzentrum.uzh.ch is obligatory!

Objective
The course focuses on grammar, vocabulary, oral communication in easy everyday life situation, and cultural differences.

Working forms: Single, pair, and group work, and plenum.

Content
These are the contents of the course: writing and reading the Russian script; welcoming somebody; saying goodbye; presenting oneself; asking for somebody’s name; addressing somebody; apologising; indicating one’s place and country of origin; indicating one’s profession; talking about family; saying how one is; asking for prices; ordering something in a café; talking about activities; numbers 0-400. The course is supported by the learning platform OLAT.

Lecture notes

851-0853-00L Russian III (A2.1) ☑
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Abstract
This course is the sequel to the one-year basic course. Students’ level should come up to the level of the basic course (two terms, with two lessons per week). In case of doubt please contact the teacher prior to the beginning of the term.

Registration for the course at sprachenzentrum.uzh.ch is obligatory!

Objective
The course focuses on speaking, reading comprehension and auditing as well as on cultural competence.

Working forms: Single, pair, and group work, and plenum.

Content
These are the contents of the course: talking about food and meals; indicating quantity; saying that one needs something or has to buy something; making sales talk; naming dishes and cutlery; making invitations; asking for an explanation of an unknown term; uttering congratulations and wishes; describing one’s day; naming activities in the present, the past and the future; talking about one’s way to the working place. The course is supported by the learning platform OLAT.

Lecture notes

851-0855-00L Russian V (A2.2+)
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Abstract
The course Russian V requires a knowledge which should come up to the level of the four preceding courses (four terms, with two lessons per week). This corresponds to the level A2 of the “European Framework”. In case of doubt please contact the teacher prior to the beginning of the term.

Registration for the course at sprachenzentrum.uzh.ch is obligatory!

Objective
The course focuses on speaking, reading comprehension and auditing as well as on cultural competence on a A2.2+ level according to the “European Framework”.

Working forms: Single, pair, and group work, and plenum.

Content
These are the contents of the course: talking about the weather; naming seasons and months; understanding tourist offers; uttering approval, refusal and indifference; making appointments; talking about holiday plans and arrangements; uttering prohibitions; drawing comparisons; talking about learning; indicating year and date; talking about interests; saying what one is busy with; talking about one's biography; saying what one would like to do; making and asking for recommendations; passing on information; saying how to get to a place; making suggestions. The course is supported by the learning platform OLAT.

Lecture notes

851-0861-00L Arabic I (A1.1) ☑
Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Abstract
This course forms the first part (level A1) of a five semesters’ Arabic course. Its aim is to acquire a basic competence on the level of speaking, hearing skills, and also reading and writing of the Arabic script.

Objective
The participants will be able to adequately respond to selected situations of everyday life. Conversations in everyday life and typical situations while travelling will be taught and exercised. Another important focus is the learning of the Arabic script.

Content
Embedded into communicative situations we will work on the following contents: to greet, to present oneself, to talk about oneself (personal identity, occupation, place of living, etc.), simple telephone calls, to ask for information, to book a room. We will pay special attention to cultural aspects.

Literature
Arabisch Intensiv. Grundstufe. Landesspracheninstitut in der Ruhr-Universität Bochum; Buske Verlag (www.buske.de), 2011

851-0861-01L Arabic I (A1.1) ☑
Your course registration is only valid with a simultaneous online registration at the language center

Abstract
This course forms the first part (level A1) of a five semesters’ Arabic course. Its aim is to acquire a basic competence on the level of speaking, hearing skills, and also reading and writing of the Arabic script.

Objective
The participants will be able to adequately respond to selected situations of everyday life. Conversations in everyday life and typical situations while travelling will be taught and exercised. Another important focus is the learning of the Arabic script.

Content
Embedded into communicative situations we will work on the following contents: to greet, to present oneself, to talk about oneself (personal identity, occupation, place of living, etc.), simple telephone calls, to ask for information, to book a room. We will pay special attention to cultural aspects.

Literature
Arabisch Intensiv. Grundstufe. Landesspracheninstitut in der Ruhr-Universität Bochum; Buske Verlag (www.buske.de), 2011

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The goal is to attain level B1 of the CEF orally and in writing. The class is about acquiring competences needed to deal with literary and

All teaching material besides the reader will be distributed in the lessons and downloaded on OLAT.

The course has the following aims: the participants shall acquire an advanced competence in the field of speaking, listening, reading and

Chinese I (A1.1)■

The course is open for students, post-graduate students and staff of both Zurich university and ETH without any knowledge of the Arabic

Arabic Intensiv. Grundstufe. Landesspracheninstitut in der Ruhr-Universität Bochum; Buske Verlag (www.buske.de), 2011

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| Arabic III (A2.1) ■ |

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| Chinese III (A2.1) ■ |

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| Chinese III (A2.1) ■ |

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Q. Hu

1. Heinrich Reinfried "Kompaktlehrgang Japanisch" or Elementary introduction to the Japanese language. Students acquire the basic language skills needed for everyday life communicative interactions.

Wir arbeiten mit folgendem Lehrmittel:

Japanese I (A1.1) (available at the beginning of the course, later by mail to reinfried@asiaintensiv.ch; also available in English: "Concise course in Japanese")

This will be sold at the beginning of the course or can be ordered directly at www.asiaintensiv.ch.

For details see www.sprachenzentrum.uzh.ch.

851-0879-01L

Chinese V (A2.2+)

Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

This course is meant for all students and employees at the University and the ETH Zurich. Members of the course will acquire an advanced linguistic competence meeting the new standards set by Chinese as a Foreign Language (level B1). It is mandatory that the courses from Chinese I-IV have been successfully completed. Others should contact the instructor of the course beforehand.

Building on the results of course Chinese V the students will learn a basic vocabulary of about 600 characters. Until the end of the course they will acquire the capacity not only to read but also to write these characters. The students will be familiarized with the new vocabulary through a number of exercises involving dialogues and short sentences. In addition, the competence in understanding spoken colloquial Chinese will also be trained.

Diejenigen Studierenden, die ihre Sprachstudien weiterführen oder die Standardprüfung für Chinesisch als Fremdsprache (HSK) ablegen wollen, sollen Gelegenheit haben, ihre Lese- und Schreibfähigkeit zu verbessern und sich schrittweise ein umfangreicheres Vokabular anzueignen.

Neben dem Hörverständnis sollen auch die Sprechfähigkeit nach Maßgabe der Modellprüfungen geübt werden. Der Kurs wird mit einem Modul auf OLAT unterstützt. Die Teilnehmerinnen und Teilnehmer werden einige Aufgaben auf OLAT erledigen.

851-0881-00L

Japanese I (A1.1)

Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Elementary introduction to the Japanese language. Students acquire the basic language skills needed for everyday life communicative interactions.

For details see www.sprachenzentrum.uzh.ch.

Lecture notes

Heinrich Reinfried, "Kompaktlehrgang Japanisch" (available at the beginning of the course, later by mail to reinfried@asiaintensiv.ch; also available in English: "Concise course in Japanese")

"Japanese Intensiv", LSI Bochum (Verlag Buske)

851-0881-01L

Japanese I (A1.1)

Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Elementary introduction to the Japanese language. Students acquire a basic vocabulary together with the most frequently used sentence structures, as well as the Hiragana and Katakana syllabaries. Reading and writing training includes use of the computer for Japanese text editing.

Everyday conversation / Reading simple texts written with Hiragana and Katakana syllabaries / Writing simple texts about everyday topics using the Hiragana and Katakana syllabaries on the computer

1. Heinrich Reinfried "Kompaktlehrgang Japanisch" or "Concise Course in Japanese" (English Version)

This will be sold at the beginning of the course or can be ordered directly at www.asiaintensiv.ch.


This will be sold shortly before the beginning of the semester at book shops and the Studentenladen Zentrum (Schönbergasse 2, 8001 Zürich, Tel 044 634 45 23, ladenz@zsuz.uzh.ch).

851-0883-00L

Japanese III (A2.1)

Your course registration is only valid with a simultaneous online registration at the language center (www.sprachenzentrum.uzh.ch).

Training in colloquial Japanese / Reading of common texts in Japanese / Application, consolidation and expansion of the basic vocabulary and sentence structures / Training in hearing

The participants consolidate and broaden the basic knowledge of the modern colloquial language in Japan. One of the focuses is on the acquisition of speech methods for important everyday standard situations. At the same time the grammar knowledge will be repeated and broadened. Higher reading skills will also be strived for by learning approx. 60 new Kanji.
<table>
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<tr>
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<th>Course Title</th>
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<tr>
<td>851-0890-00L</td>
<td>Reading Course Latin: Hannibal ad portas</td>
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**Content**
For details see www.sprachenzentrum.uzh.ch

**Lecture notes**
We will be using this textbook: "Japanisch Intensiv Grundkurs", LSI, Buske Verlag

**Abstract**
The focus of this course is on the reading of challenging original texts from Japanese media and Japanese contemporary literature. The texts are analyzed and discussed in terms of their content and linguistic features.

**Objective**
By reading selected original texts, students learn strategies for reading texts analytically. The aim is that they are able to handle Japanese sources independently, using appropriate tools.

**Abstract**
The general topic of the course is Hannibal. On the basis of didactically prepared texts written by various Latin authors (including Nepos, Livy) this enigmatic figure who stood before the gates of Rome in 215 BC is examined.

**Objective**
Students mostly prepare the texts at home for class discussion. Furthermore, important topics of basic grammar are reviewed (exercises).

**Abstract**
This language course is an introduction to Norwegian (Bokmål) as well as to the country and its culture.

**Objective**
By the end of the course, you will have read some easy Norwegian texts, have written your first own texts, and be able to conduct simple conversations.

**Abstract**
The third part of the Norwegian-course aims at a further development of your active and passive language competence. You will finish the textbook and round it off by an individual assignment on a Norwegian theme.

**Objective**
You will be reading Norwegian literature with ease and discussing various themes both in speech and in writing.

**GESS Compulsory Electives Course - Key for Type**

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<th>Type</th>
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<td>Compulsory</td>
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<td>W</td>
<td>Eligible for credits</td>
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<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<td>Dr</td>
<td>Suitable for doctorate</td>
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<table>
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<th>Key for Hours</th>
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### Educational Science

Course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

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<td>W</td>
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<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Diploma Sport.</td>
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<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<td>This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.</td>
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<td>Objective</td>
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<td></td>
<td>- Get to know cognitively activating instructions in MINT subjects</td>
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<td></td>
<td>- Get information about recent literature on learning and instruction</td>
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<td>Prerequisites / notice</td>
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<td></td>
<td>Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.</td>
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<tr>
<td>851-0242-07L</td>
<td>Human Intelligence</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner,</td>
</tr>
<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Diploma Sport.</td>
<td></td>
<td></td>
<td></td>
<td>B. Rütsche</td>
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<tr>
<td></td>
<td>Number of participants limited to 30.</td>
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<tr>
<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>The focus will be on the book &quot;Intelligenz: Grosse Unterschiede und ihre Folgen&quot; by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.</td>
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<td>Objective</td>
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<tr>
<td></td>
<td>- Understanding of research methods used in the empirical human sciences</td>
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<td></td>
<td>- Getting to know intelligence tests</td>
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<tr>
<td></td>
<td>- Understanding findings relevant for education</td>
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<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche,</td>
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<tr>
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<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Diploma Sport.</td>
<td></td>
<td></td>
<td></td>
<td>E. Stern, E. Ziegler</td>
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<tr>
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<td>Number of participants limited to 30.</td>
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<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<tr>
<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and two further meetings will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.</td>
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<td>Objective</td>
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<tr>
<td></td>
<td>- Understand research methods used in the empirical educational sciences</td>
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<tr>
<td></td>
<td>- Understand and critically examine information from scientific journals and media</td>
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<tr>
<td></td>
<td>- Understand pedagogically relevant findings from the empirical educational sciences</td>
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<tr>
<td>851-0242-09L</td>
<td>Student Research Projects: Practical Research on Learning and Instruction</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>A. Deiglmayr, P. Edelsbrunner,</td>
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<tr>
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<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Diploma Sport.</td>
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<td></td>
<td></td>
<td>S. Hofer, B. Rütsche, L. Schalk,</td>
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<tr>
<td></td>
<td>Number of participants limited to 20.</td>
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<td></td>
<td></td>
<td>E. Stern, E. Ziegler</td>
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<tr>
<td></td>
<td>The successful completion of both course no. 851-0240-00L &quot;Menschliches Lernen (EW 1)&quot; and course no. 851-0238-01L &quot;Untersützung und Diagnose von Wissensverwerbsprozessen (EW 3)&quot; is a necessary prerequisite for this course.</td>
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<td></td>
<td>Abstract</td>
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<td></td>
<td>In teams of two, participants in this seminar conduct their own research project. Each team is advised by one of the researchers serving as lecturers in this course. Basic conceptual and methodological issues are the topic of a series of plenary meetings; however, the major part of the work is done in small-group meetings with the advising researcher, and in self-directed research projects.</td>
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<td>Objective</td>
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<td></td>
<td>The course is targeted at advanced students who have taken an interest in gathering practical research experience in the field of Learning &amp; Instruction. In teams of two, students conduct their own research projects (planning, conducting, analyzing, interpreting, and presenting research); thus, the course requires a high amount of self-directed working. Students are personally advised, and supported in their research project, by one of the researchers serving as lecturers in this course. During the first half the semester, relevant methodological knowledge and skills are practiced during plenary meetings and in students’ independent reading (e.g. generating and testing research questions, designing experiments, and analyzing data in the field of Learning and Instruction)</td>
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<td></td>
<td>Learning goals include:</td>
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<tr>
<td></td>
<td>- Participants can illustrate and explain basic methods and concepts for research in the fields of Learning and Instruction, e.g. with the help of practical examples.</td>
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<td>- Participants can generate testable research questions for a topic relevant in the fields of Learning and Instruction.</td>
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<td></td>
<td>- Participants can design and conduct a study that is relevant for answering their research question.</td>
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<td></td>
<td>- Participants can summarize and evaluate the main results from a study in the field of learning and instruction, with regard to the research question being asked.</td>
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</tbody>
</table>

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**Subject Didactics in Geography**

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 640 of 1434
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<td>651-4239-00L</td>
<td>Geography Didactics Geography I (University of Zurich)</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>B. Vettiger-Gallusser</td>
</tr>
<tr>
<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: 090GG1</td>
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<tr>
<td></td>
<td>Limited number of participants. Please write an email for registration no later than September 1 to: <a href="mailto:barbara.vettiger@ife.uzh.ch">barbara.vettiger@ife.uzh.ch</a></td>
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<tr>
<td></td>
<td>Simultaneous enrolment in Introductory Internship Geography (651-4219-01L), Practice Lessons for Didactics I an II (651-4219-02L) is compulsory.</td>
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<td></td>
<td>Mind the enrolment deadlines at UZH: <a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
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<tr>
<td></td>
<td>Fundamentals (theory and practice) of specialist subject teaching for high-school geography lessons.</td>
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<tr>
<td>651-4241-00L</td>
<td>Examination Didactics ■</td>
<td>O</td>
<td>1</td>
<td>2G</td>
<td>B. Vettiger-Gallusser</td>
</tr>
<tr>
<td></td>
<td>Prerequisites: Successful completion of Geography Didactics of Geography Teaching I, II, III, IV as well as FV I, II, III, Introductory Internship and Internship.</td>
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<td></td>
<td>Simultaneous enrolment in Examination Lessons Geography - course 651-2520-00L is compulsory.</td>
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<tr>
<td></td>
<td>Unterlagen aus der Fachdidaktik Prüfung ist eine 15 minütige mündliche Prüfung. Sie findet am selben Tag wie die praktische Prüfung (2 Prüfungseinheiten plus Kolloquium) statt.</td>
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<tr>
<td>651-4124-00L</td>
<td>Geography Didactics IV: Mentored Project ■</td>
<td>O</td>
<td>2</td>
<td>4A</td>
<td>B. Vettiger-Gallusser, S. Hesske</td>
</tr>
<tr>
<td></td>
<td>Prerequisites: successful participation in Geography Didactics of Geography Teaching I+II+III (651-4239-00L, 651-2500-00L and 651-4119-00L).</td>
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<td></td>
<td>Mentorierte Arbeit mit Bezug zur Fachdidaktik selbständige, theoriegestützte Auseinandersetzung mit konkreter, praxisbezogener Fragestellung zum Geografieunterricht.</td>
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<td></td>
<td>selbständige, mentorierte Arbeit zu einem Thema aus der Fachdidaktik mit direktem Bezug zur Lehrpraxis im Fach Geografie (z.B. zu eigenen Übungslektionen oder Praktikum oder Unterrichtsforschung).</td>
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<tr>
<td></td>
<td>Das Thema wird zu Beginn mit der Mentorin/ dem Mentor festgelegt.</td>
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<td></td>
<td>Frühstens parallel zum Fachdidaktik-Modul III zu belegen (Pflicht für ETH-Studierende)</td>
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<tr>
<td>651-4120-00L</td>
<td>Geography Didactics of Geography Teaching III (University of Zurich)</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>B. Vettiger-Gallusser, University lecturers</td>
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<tr>
<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: 090FDGGS3</td>
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<td></td>
<td>Limited number of participants.</td>
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</tbody>
</table>
Abstract
The Subject Didactics III course unit comprises two blocks: one "Specialisation" block with key subjects from courses I and II and a block on "Information technology in geography teaching" with specific applications. Students learn about the options for using ICT to design their geography teaching and also the integral furtherance of pupils' IT competence. They plan an IT lesson, hold it and then evaluate it.
- identify the opportunities and limits of illustrating their geography teaching with films, models and experiments.
- look into the significance of the subjective theories for learning success and failure and discuss tuition options for a concept change (geographical case studies).

Objective
In Subject Didactics III, students take a more in-depth, application-oriented look at geography. Students
- learn about the options for using ICT to design their geography teaching and also the integral furtherance of pupils’ IT competence. They plan an IT lesson, hold it and then evaluate it.
- identify the opportunities and limits of illustrating their geography teaching with films, models and experiments.
- look into the significance of the subjective theories for learning success and failure and discuss tuition options for a concept change (geographical case studies).

Content
Fachdidaktik III Block "Vertiefung" (1/2 Semester)
- Planung von Unterrichtseinheiten.
Fachdidaktik III Block "ICT im Geografieunterricht" (1/2 Semester)
- Fachspezifische Einsatzmöglichkeiten, Unterrichtshilfen, konkrete Anwendungen und Resultate an Beispielen kritisch reflektieren.

Lernformen
Theoretische Konzepte werden vorgestellt und an typischen Beispielen aus der Praxis illustriert. Beispiele im IT- Bereich werden von Studierenden selbst erarbeitet ("Werkstatt"), präsentiert und diskutiert.

Lecture notes
Unterlagen werden abgegeben.

Literature
Weitere Literaturangaben.

Prerequisites / notice
Fachdidaktik III kann im Frühlingssemester parallel zu Fachdidaktik II besucht werden, aber erst nach Fachdidaktik I.

Professional Training in Geography

Professional Training (First Subject)

Number | Title | Type | ECTS | Hours | Lecturers
---|---|---|---|---|---
651-2519-01L | Introductory Internship (University of Zürich) | O | 1 credit | 2P | B. Vettiger-Gallusser
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
UZH Module Code: 090BPA12
Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Simultaneous enrolment in Introductory Internship Geography (651-4219-01L), Practice Lessons for Didactics I an II (651-4219-02L) and Geography Didactics I (651-4239-00L) is compulsory.

Abstract
The Introductory Internship belongs to the practical expertise education of the teacher training for Upper Secondary Schools and must be completed at the beginning of studies.

Prerequisites / notice
The Introductory Internship can only be completed together with an accredited internship teacher of ETH Zurich (separate list).

651-2519-02L | Practice Lessons for Didactics I an II (University of Zurich) | O | 2 credits | 4P | B. Vettiger-Gallusser
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
UZH Module Code: 090BPU1
Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Simultaneous enrolment in Introductory Internship Geography (651-4219-01L), Practice Lessons for Didactics I an II (651-4219-02L) and Geography Didactics I (651-4239-00L) is compulsory.

Abstract
The practice lessons help students to gain first experiences in teaching and to reflect the courses of the teacher training and didactics. Accurate planning (preliminary discussion, written proposal) is an integral part of this course as well as a wrap-up.

Prerequisites / notice
The Introductory Internship can only be completed together with an accredited internship teacher of ETH Zurich (separate list).

651-2517-00L | Teaching Internship Geography (University of Zürich) | O | 8 credits | 17P | B. Vettiger-Gallusser
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
UZH Module Code: 090BPUP1
Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Prerequisites: Successful completion of Educational Science and Subject Didactics in Geography (FD I, II, III) as well as Spec. Courses in Resp. Subj. w/ Educ. Focus & Further Subj. Didactics (FV I, II, III) plus completion of the introductory internships.
The Teaching Internship takes place after successful completion of the didactics courses (I, II incl. practice lessons). The teaching internship takes in 50 lessons: 30 are taught by the students, and the students sit in on 20 lessons. The teaching internship lasts a maximum of 10 weeks.

### 651-2520-01L Examination Lesson I Geography

**Simultaneous enrolment in “Examination Lesson II Geography” (651-2520-02L) is compulsory.**

<table>
<thead>
<tr>
<th>Objective</th>
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</thead>
<tbody>
<tr>
<td>To develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle</td>
</tr>
</tbody>
</table>

**Content**

- To analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

**Lecture notes**

Dokument: Schriftliche Vorbereitung für Prüfungslektionen.

**Prerequisites / notice**

Bitte bei der Prüfungsanmeldung den schriftlichen Nachweis erbringen, dass die ganze Ausbildung abgeschlossen ist.

### 651-2520-02L Examination Lesson II Geography

**Simultaneous enrolment in “Examination Lesson I Geography” (651-2520-01L) is compulsory.**

<table>
<thead>
<tr>
<th>Objective</th>
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</thead>
<tbody>
<tr>
<td>In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.</td>
</tr>
</tbody>
</table>

**Content**

- To develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle
- To analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

**Lecture notes**

Dokument: Schriftliche Vorbereitung für Prüfungslektionen.

**Prerequisites / notice**

Bitte bei der Prüfungsanmeldung den schriftlichen Nachweis erbringen, dass die ganze Ausbildung abgeschlossen ist.

### 651-4137-00L Professional Exercises (University of Zurich)

**No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.**

**Lecture notes**

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

**Prerequisites / notice**

Only for Geography Teaching Diploma. Simultaneous enrolment in “Teaching Internship Geography” (651-2517-00L) is compulsory.

<table>
<thead>
<tr>
<th>Objective</th>
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<tbody>
<tr>
<td>In the context of their teaching practice, students compile a portfolio in which they analyse and document selected aspects of their teaching practice.</td>
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</table>

**Content**

- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.
- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle
- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

**Lecture notes**

Anleitung für das Unterrichtspraktikum und die unterrichtspraktischen Übungen:

- Anleitung für das Unterrichtspraktikum und die unterrichtspraktischen Übungen:
- Materialien und Literaturlisten für die Praktikumsvorbereitung
- Materialien und Literaturlisten für die Praktikumsvorbereitung

**Literature**


**Prerequisites / notice**


### Professional Training (Two Subjects in One-Step Procedure)

The programme “Teaching Diploma, Two Subjects in One-Step Procedure” will not be offered anymore since Autumn Semester 2010. Therefore new
The Introductory Internship belongs to the practical expertise education of the teacher training for Upper Secondary Schools and must be completed at the beginning of studies.

Abstract
The Introductory Internship can only be completed together with an accredited internship teacher of ETH Zurich (separate list).

Prerequisites / notice

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>651-2519-01L</td>
<td>Introductory Internship (University of Zürich) ■</td>
<td>O</td>
<td>1</td>
<td>2P</td>
<td>B. Vettiger-Gallusser</td>
</tr>
<tr>
<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: 090BPA12</td>
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<tr>
<td></td>
<td>Mind the enrolment deadlines at UZH:</td>
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<tr>
<td></td>
<td><a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
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<tr>
<td></td>
<td>Simultaneous enrolment in Introductory Internship Geography (651-4219-01L), Practice Lessons for Didactics I an II (651-4219-02L) and Geography Didactics I (651-4239-00L) is compulsory.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Abstract</td>
<td>The Introductory Internship belongs to the practical expertise education of the teacher training for Upper Secondary Schools and must be completed at the beginning of studies.</td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>The Introductory Internship can only be completed together with an accredited internship teacher of ETH Zurich (separate list).</td>
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</table>

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-2519-02L</td>
<td>Practice Lessons for Didactics I an II (University of Zürich) ■</td>
<td>O</td>
<td>2</td>
<td>4P</td>
<td>B. Vettiger-Gallusser</td>
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<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: 090BPUE1</td>
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<td>Simultaneous enrolment in Introductory Internship Geography (651-4219-01L), Practice Lessons for Didactics I an II (651-4219-02L) and Geography Didactics I (651-4239-00L) is compulsory.</td>
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<tr>
<td>Abstract</td>
<td>The practice lessons help students to gain first experiences in teaching and to reflect the courses of the teacher training and didactics.</td>
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<tr>
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<td>The Introductory Internship can only be completed together with an accredited internship teacher of ETH Zurich (separate list).</td>
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<td>Abstract</td>
<td>In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.</td>
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<td>Objective</td>
<td>On the basis of a specified topic, the candidate shows that they are in a position</td>
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<td>- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle</td>
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<td></td>
<td>- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.</td>
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<tr>
<td>Prerequisites / notice</td>
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<td>In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.</td>
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<td>651-4239-00L</td>
<td>Geography Didactics Geography I (University of Zürich) ■</td>
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<td>2G</td>
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<td>Limited number of participants. Please write an email for registration no later than September 1 to: <a href="mailto:barbara.vettiger@ife.uzh.ch">barbara.vettiger@ife.uzh.ch</a></td>
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<td>Simultaneous enrolment in Introductory Internship Geography I (651-4219-01L) is compulsory.</td>
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Data: 06.02.2019 13:00  Autumn Semester 2015  Page 644 of 1434
**Teaching Internship Geography**

**Prerequisites: successful participation in Geography Didactics I-III.**

**Abstract**

In the final phase of their training, students have to apply and test the insights, abilities and skills they have acquired. They spend 3-5 weeks in an educational institution, during which time they observe 10 lessons and teach 30 lessons independently.

**Objective**

The course introduces students to the practical side of geography teaching. Participants look into the understanding of this school subject over the course of time and learn:

- how to plan their teaching in the context of the valid curricula, including on an interdisciplinary basis.
- how geographical contents can be implemented in didactic and methodological terms so as to ensure that fundamental competences can be imparted to pupils (knowledge, skills, attitudes), with a view to university studies as well.
- how to foster pupils in such a way that they can think independently in terms of spatial competence and can act in a responsible manner.

**Content**

Thematic Schwerpunkte

- Einführung in die Theorie der Geografiedidaktik.
- Bildungsauftrag der Geografie an Mittelschulen.
- Interesse der Lernenden am Geografieunterricht.
- Unterrichtsgestaltung und -vorbereitung: Sachanalyse, lernzielorientierte Unterrichtsplanung; Didaktische Analyse; Einführung in die Gestaltung von Lernarrangements.
- Mediendidaktik (Arbeiten mit Bildern und Karten).
- Planung einer Unterrichtseinheit (Struktur - Prozess - Verlauf).

Theorethische Konzepte werden präsentiert und an Beispielen diskutiert. Die Studierenden setzen sich mit Methoden aktiv auseinander (z.B. Lernpuzzle, Fallstudie sowie Sozial-und Aktionsformen) und reflektieren dabei ihre eigenen Schülererfahrungen im Fach.

**Literature**


**Prerequisites / notice**

Fachdidaktik I ist gleichzeitig mit dem Einführungspraktikum zu belegen. Sie gilt als Voraussetzung für Fachdidaktik II und III, sowie die FWV II und FWV III. Fachdidaktik II findet nur im Sommersemester statt. Fachdidaktik III kann parallel zur Fachdidaktik II im Sommersemester oder parallel zur FWV III (Ringvorlesung und FD-Seminar) im Herbstsemester belegt werden.


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<tr>
<td>651-4237-01L</td>
<td>Specialised Courses in the Respective Subject with an Educational Focus Geography</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>University lecturers</td>
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</table>

**Abstract**

Current approaches to research which are of relevance to society are presented on the basis of examples and critically examined in respect of their significance for a high-school education in the subject of geography.

**Objective**

Students

- look at the subject knowledge in its full breadth, on the basis of current approaches to research and with the consideration of specific examples, thereby creating a specialised basis on which to critically examine specialist contents for the school subject of geography, as part of a general education, over the course of time.
- see whether and where current topics from the specialist subject (research) can be incorporated in secondary-school tuition.
- familiarise themselves with questions and forms of cognition-oriented, moderately constructive tuition.
- can reflect on geography teaching in an aware and theory-based manner.

Mind the enrolment deadlines at UZH:

http://www.uzh.ch/studies/application/mobilitaet_en.html

It is recommended to attend the lecture series and seminar after Geography Didactics I - III.

**Data:** 06.02.2019 13:00  
**Autumn Semester 2015**  
**Page 645 of 1434**
Content

Vorlesung: In jeweils in sich geschlossenen Vorlesungen beleuchten Dozierende die gesellschaftliche Relevanz ihrer aktuellen Forschungsansätze an konkreten Beispielen aus der Physischen Geografie und den Erdwissenschaften, der Humangeografie sowie der Methodischen Geografie. Sie thematisieren dabei die Bedeutung der Ansätze für die Gesellschaft zur Auseinandersetzung mit räumlichen Fragestellungen und Problemlösungen und diskutieren die aus ihrem Forschungsansatz und den Ergebnissen resultierenden ethischen Fragen. Sie beleuchten damit die Breite des Fachverständnisses und legen das Fundament für die kritische Auseinandersetzung mit den allgemein bildenden Fachinhalten (Kompetenzen, Fachwissen, Einstellungen), die insbesondere in der gymnasialen Ausbildung im Fach Geographie vermittelt werden sollen.

Lecture notes

Zu jeder Vorlesung werden Folien/ Unterlagen abgegeben.

Literature

Wird von den jeweils verantwortlichen Dozierenden zusammengestellt.

Prerequisites / notice


Es wird sehr empfohlen, dieses Modul parallel zum Unterrichtspraktikum zu besuchen.

651-4237-02L

Specialised Courses in the Respective Subject with an O

Educational Focus Geography FVIII

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

UZH Module Code: GEC991

Mind the enrolment deadlines at UZH:

http://www.uzh.ch/studies/application/mobilitaet_en.html

The lecture series and seminar can only be attended after successful completion of Geography Didactics I.

Abstract

Current approaches to research which are of relevance to society are presented on the basis of examples and critically examined in respect of their significance for a high-school education in the subject of geography.

Objective

Students

- look at the subject knowledge in its full breadth, on the basis of current approaches to research and with the consideration of specific examples, thereby creating a specialised basis on which to critically examine specialist contents for the school subject of geography, as part of a general education, over the course of time.
- see whether and where current topics from the specialist subject (research) can be incorporated in secondary-school tuition.
- familiarise themselves with questions and forms of cognition-oriented, moderately constructivist tuition.
- can reflect on geography teaching in an aware and theory-based manner.

Content

Seminar:

- Einführung in den Umgang mit theoretischen Konzepten zur kritischen Reflexion von Unterrichtsinhalten und -methoden hinsichtlich ihrer Ausrichtung.
- Auseinandersetzung mit Wesen und Inhalt der geographischen Allgemeinbildung, ihren Möglichkeiten und Grenzen (z.B. Ressourcen, Lehrpläne) mit direktem Bezug zur Ringvorlesung.
- Berücksichtigung der Wissensgenese sowie ethischer und methodischer Aspekte für die Ausbildung an Maturitätschulen.
- Diskussion von Unterrichtsinhalten und Lernarrangements unter Berücksichtigung der vermittelten Impulse und fachdidaktischer Literatur.

Lernformen:

Die fachwissenschaftlichen Aspekte werden in der Form einer Vorlesung von verschiedenen Dozierenden von der UZH und ETHZ präsentiert.

Im Seminar erfolgt eine kritische Diskussion und Aufarbeitung der exemplarischen Bedeutung der einzelnen Vorlesungsinhalte an Hand von Kurzvorträgen der Studierenden und bestehender Lehr-/ Lernmaterialien. Konkrete Umsetzungsbeispiele mit Bezug zu behandelten Themen der Ringvorlesung für den Unterricht als Seminararbeit (Partnerarbeit) werden erstellt.

Lecture notes

Zu jeder Seminarveranstaltung werden Folien/ Unterlagen abgegeben.

Literature

Wird von den jeweils verantwortlichen Dozierenden zusammengestellt.

Prerequisites / notice


Es wird sehr empfohlen, dieses Modul parallel zum Unterrichtspraktikum zu besuchen.

651-4247-00L

Regional Geography: Lecture and Didactic Concept Arabian Peninsula (University of Zürich)

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

UZH Module Code: GEC781

Mind the enrolment deadlines at UZH:

http://www.uzh.ch/studies/application/mobilitaet_en.html

3 credits

2V

University lecturers

651-4247-40L

Regional Geography: Lecture and Didactic Concept Asia (University of Zürich)

Does not take place this semester.

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

UZH Module Code: GEC786

Mind the enrolment deadlines at UZH:

http://www.uzh.ch/studies/application/mobilitaet_en.html

3 credits

2V

University lecturers

Abstract

Participants conduct a critical examination of regional geography in terms of the understanding of the subject and teaching in schools, and its potential for substantiated tuition is established.

Objective

Regional geography observes delimited partial areas, mapped to different scales, considering thematic and exemplary aspects. Regional geography features in this form on a large number of geography syllabuses. Against this background, the module comprises two parts. A specialist lecture on the subject takes a specific regional example to highlight current, interdisciplinary topics and case studies. The aim here is to compile specialist contextual knowledge about a region. In an accompanying seminar, this contextual knowledge is then put in the correct practical form for teaching in a school, thus ensuring that the teachers are in a position to configure regional geography teaching that has been duly reflected on from the specialist-subject, didactic and pedagogical angle.
### Content
- Vorlesung
  - Übersicht über Themen, die für eine Region typisch sind oder sich in einer Region abspielen (z. B. Arabische Halbinsel, Afrika südlich der Sahara, Asien)
  - Regionale Fallstudien mit interdisziplinärem Charakter
  - Differenzierte Auseinandersetzung mit kulturellen und politischen Fragen und Entwicklungen in einer Region
  - Erarbeiten von bedeutenden fachwissenschaftlichen Debatten zu einer Region

- Seminar
  - Regional-thematische Geografie versus traditionelle Länderkunde
  - Geografisches Orientierungswissen: Stellenwert
  - Werteerziehung und Interdisziplinarität im regionalgeografschen Kontext
  - Didaktische Analyse und Planung regionalgeografischen Unterrichts: Von der Sachanalyse über den Einstieg bis zur Bewertung
  - Methoden und Recherche in der Regionalgeografie

Lernformen
Fachwissenschaftliche Aspekte werden in der Form einer Vorlesung präsentiert. Die Studierenden vertiefen nach jeder Stunde die Inhalte und setzen diese im Hinblick auf die Schulpraxis um. Dabei wird ein elektronisches Lerntagebuch geführt und über eine Lernplattform über die schulpraktische Umsetzung reflektiert. Es werden auch Materialien zusammengestellt.

### Objective
Regional geography observes delimited partial areas, mapped to different scales, considering thematic and exemplary aspects. Regional geography features in this form on a large number of geography syllabuses. Against this background, the module comprises two parts. A specialist lecture on the subject takes a specific regional example to highlight current, interdisciplinary topics and case studies. The aim here is to compile specialist contextual knowledge about a region. In an accompanying seminar, this contextual knowledge is then put in the correct practical form for teaching in a school, thus ensuring that the teachers are in a position to configure regional geography teaching that has been duly reflected on from the specialist-subject, didactic and pedagogical angle.

### Literature
Folien werden zur Verfügung gestellt.
Wird je nach regionalen Fokus zusammengestellt.

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<thead>
<tr>
<th>651-4247-10L</th>
<th>Regional Geography: Lecture and Didactic Concept Japan (University of Zürich)</th>
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<td>Regional geography: Lecture and Didactic Concept Japan (University of Zürich)</td>
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No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

UZH Module Code: GEO784

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

### Abstract
Participants conduct a critical examination of regional geography in terms of the understanding of the subject and teaching in schools, and its potential for substantiated tuition is established.

### Content
- Vorlesung
  - Übersicht über Themen, die für eine Region typisch sind oder sich in einer Region abspielen (z. B. Arabische Halbinsel, Afrika südlich der Sahara, Asien)
  - Regionale Fallstudien mit interdisziplinärem Charakter
  - Differenzierte Auseinandersetzung mit kulturellen und politischen Fragen und Entwicklungen in einer Region
  - Erarbeiten von bedeutenden fachwissenschaftlichen Debatten zu einer Region

- Seminar
  - Regional-thematische Geografie versus traditionelle Länderkunde
  - Geografisches Orientierungswissen: Stellenwert
  - Werteerziehung und Interdisziplinarität im regionalgeografschen Kontext
  - Didaktische Analyse und Planung regionalgeografischen Unterrichts: Von der Sachanalyse über den Einstieg bis zur Bewertung
  - Methoden und Recherche in der Regionalgeografie

Lernformen
Fachwissenschaftliche Aspekte werden in der Form einer Vorlesung präsentiert. Die Studierenden vertiefen nach jeder Stunde die Inhalte und setzen diese im Hinblick auf die Schulpraxis um. Dabei wird ein elektronisches Lerntagebuch geführt und über eine Lernplattform über die schulpraktische Umsetzung reflektiert. Es werden auch Materialien zusammengestellt.

### Lecture notes
Folien werden zur Verfügung gestellt.
Wird je nach regionalen Fokus zusammengestellt.

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No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

UZH Module Code: GEO789

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

### Abstract
Participants conduct a critical examination of regional geography in terms of the understanding of the subject and teaching in schools, and its potential for substantiated tuition is established.

### Objective
Regional geography observes delimited partial areas, mapped to different scales, considering thematic and exemplary aspects. Regional geography features in this form on a large number of geography syllabuses. Against this background, the module comprises two parts. A specialist lecture on the subject takes a specific regional example to highlight current, interdisciplinary topics and case studies. The aim here is to compile specialist contextual knowledge about a region. In an accompanying seminar, this contextual knowledge is then put in the correct practical form for teaching in a school, thus ensuring that the teachers are in a position to configure regional geography teaching that has been duly reflected on from the specialist-subject, didactic and pedagogical angle.
Vorlesung
- Übersicht über Themen, die für eine Region typisch sind oder sich in einer Region abspielen (z. B. Arabische Halbinsel, Afrika südlich der Sahara, Asien)
- Regionale Fallstudien mit interdisziplinärem Charakter
- Differenzierte Auseinandersetzung mit kulturellen und politischen Fragen und Entwicklungen in einer Region
- Erarbeiten von bedeutenden fachwissenschaftlichen Debatten zu einer Region

Seminar
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- Geografisches Orientierungswissen: Stellenwert
- Werteerziehung und Interdisziplinarität im regionalgeografischen Kontext
- Didaktische Analyse und Planung regionalgeografischen Unterrichts: Von der Sachanalyse über den Einstieg bis zur Bewertung
- Methoden und Recherche in der Regionalgeografie

Lernformen
Fachwissenschaftliche Aspekte werden in der Form einer Vorlesung präsentiert. Die Studierenden vertiefen nach jeder Stunde die Inhalte und setzen diese im Hinblick auf die Schulpraxis um. Dabei wird ein elektronisches Lerntagebuch geführt und über eine Lernplattform über die schulpraktische Umsetzung reflektiert. Es werden auch Materialien zusammengestellt.

Lecture notes
Folien werden zur Verfügung gestellt.

Literature
Wird je nach regionalen Fokus zusammengestellt.

Compulsory Elective Courses
Further course offerings from the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

Additional Requirements (ETH-Masterstudents in ERDW and AC)

Part 1

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<td>Human Geography I: One Earth - Many Worlds (University of Zurich)</td>
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<td>Content</td>
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<td>(1) Society and space (2) Society and development (structure and dynamic of population, urbanisation, disparities (3) Society and natural environment (natural resources; food security, sustainability)</td>
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<td>Lecture notes</td>
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<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-2338-00L</td>
<td>Remote Sensing and Geographic Information Science III (University of Zurich)</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>University lecturers</td>
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<tr>
<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: GEO233</td>
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<td>Mind the enrolment deadlines at UZH:</td>
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<td><a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
</tr>
<tr>
<td></td>
<td>Objective</td>
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<tr>
<td></td>
<td>To get an overview about basic research questions and principles of Human Geography</td>
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<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
<td></td>
<td>(1) Society and space (2) Society and development (structure and dynamic of population, urbanisation, disparities (3) Society and natural environment (natural resources; food security, sustainability)</td>
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<td>Lecture notes</td>
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<td>PowerPoint-slides (German)</td>
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Part 2

<table>
<thead>
<tr>
<th>Number</th>
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<tr>
<td>651-4088-03L</td>
<td>Physical Geography III (Geomorphology and Glaciology) (University of Zurich)</td>
<td>W</td>
<td>3</td>
<td>1V+1U</td>
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<td><a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a></td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Das Modul bietet eine kurze Einführung in einige Komponenten und Prozesse des hydrologischen Kreislaufs. Dabei werden einzelne Wasserspeicher (Schnee,- Boden und Grundwasser) und Flüsse zwischen den Speichern (Verdunstung, Niederschlag und Abfluss) betrachtet. Übungen ergänzen die Vorlesung.</td>
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<thead>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>651-2613-00L</td>
<td>Humangeography III (Geographies of Difference) (Universität Zürich)</td>
<td>W</td>
<td>3</td>
<td>1G+2S</td>
<td>University lecturers</td>
</tr>
<tr>
<td></td>
<td>No enrolment to this course at ETH Zurich. Book the</td>
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</tbody>
</table>

Compulsory Elective Courses Teaching Diploma

Further course offerings from the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

Additional Requirements (ETH-Masterstudents in ERDW and AC)
corresponding module directly at UZH.
UZH Module Code: GEO232

Prerequisite: Human Geography II (UZH Module Code: GEO122)

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
Teil GEO232.1:
Das Seminar verfolgt das Ziel, ein tieferes Verständnis für sozialwissenschaftliche Grundlagen der Humangeographie zu gewinnen.
Teil GEO232.2:
In der Vorlesung und den Tutorien werden aktuelle wirtschaftsgeographische Themen behandelt. Demonstriert und erklärt wird insbesondere, wie die Wirtschaft mit Grenzen und Grenzziehungen umgeht.

Objective
- Sie vertiefen ihre theoretischen, empirischen und methodischen Fähigkeiten in folgenden Themenbereichen:
  - Gesellschaft und Raum
  - Gesellschaft und Entwicklung
  - Gesellschaft und natürliche Umwelt/Ressourcen
  - Offenheit und Geschlossenheit in Wirtschaft und Gesellschaft
  - Chancen und Herausforderungen einer globalisierten Weltwirtschaft
- Sie sind in der Lage, Verknüpfungen zwischen grundlegenden sozial- und wirtschaftswissenschaftlichen Theorien und deren Konkretisierung in der Geographie herzustellen.
- Sie können die erwähnten Themen mit ausgewähltem Faktenwissen verknüpfen und diskutieren
- Sie schulen Ihre analytischen und theoretischen Fähigkeiten und können diese in Diskussionen einbringen
- Sie können die Relevanz von weiterführenden wissenschaftlichen Texten diskutieren und mit einem Ausgangstext verknüpfen
- Sie sind in der Lage, eine Diskussion über wissenschaftliche Themen zu strukturieren und - mit einfachen Moderationstechniken - zu moderieren

Prerequisites / notice
Besuch von GEO122.

Geography Teaching Diploma - Key for Type

<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
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<tbody>
<tr>
<td>W+</td>
<td>W</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>W</td>
<td></td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
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Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<td>P</td>
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</table>

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
# Geomatic Engineering and Planning Bachelor

## 1. Semester

### First Year Examinations

<table>
<thead>
<tr>
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<tr>
<td>401-0241-00L</td>
<td>Analysis I</td>
<td>O</td>
<td>7</td>
<td>5V+2U</td>
<td>M. Akveld</td>
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<tr>
<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>Mathematical tools for the engineer</td>
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<tr>
<td></td>
<td>Basic mathematical knowledge for engineers</td>
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<td>Content</td>
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<tr>
<td></td>
<td>Complex numbers.</td>
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<td></td>
<td>Calculus for functions of one variable with applications.</td>
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<tr>
<td></td>
<td>Simple Mathematical models in engineering.</td>
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<tr>
<td></td>
<td>Die Vorlesung folgt weitgehend</td>
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<td></td>
<td>Neben Akveld, M. &amp; Sperb, R.; Analysis I, vdf, auch</td>
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<tr>
<td></td>
<td>- Ch. Blatter, Ingenieur Analysis, gute Referenz für das Kapitel 0 der Vorlesung.</td>
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<tr>
<td></td>
<td>- J. Stewart, Calculus, Early Transcendentals, Thomson Brooks/Cole, 2003 oder neuere Versionen (auch ein sehr gutes Buch, auch für die Ana.II, aber wieder auf Englisch und voluminos)</td>
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<td></td>
<td>- Lothar Papula, Mathematik für Ingenieure und Naturwissenschaftler, Vieweg Verlag</td>
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<tr>
<td>401-0141-00L</td>
<td>Linear Algebra and Numerical Analysis</td>
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<td>5</td>
<td>3V+1U</td>
<td>P. Grohs</td>
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<tr>
<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>Introduction to Linear Algebra and Numerical Analysis with emphasis on both abstract concepts and algorithms.</td>
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<td></td>
<td>To acquire basic knowledge of Linear Algebra and Numerical Methods. Enhanced capability for abstract and algorithmic thinking based on mathematical concepts and models. Ability to select appropriate numerical linear algebra methods, to apply them properly and to implement them efficiently in MATLAB.</td>
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<tr>
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<td>1. Linear systems of equations</td>
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<td>2. Vector and matrix calculus</td>
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<td>3. Subspaces and bases</td>
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<td>4. The Euclidean space Rn</td>
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<td></td>
<td>5. Numerical linear algebra with MATLAB</td>
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<td>6. Linear mappings (optional)</td>
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<td>7. Diagonalization (eigenproblems)</td>
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<td></td>
<td>K. Nipp, D. Stoffer, Lineare Algebra, VdF Hochschulverlag ETH</td>
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<tr>
<td></td>
<td>G. Strang, Lineare Algebra, Springer</td>
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<td>252-0845-00L</td>
<td>Computer Science I</td>
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<td>M. Hirt</td>
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<td>Abstract</td>
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<tr>
<td></td>
<td>The course covers the basic concepts of computer programming.</td>
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<td></td>
<td>Basic understanding of programming concepts. Students will be able to write and read simple programs and to modify existing programs.</td>
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<tr>
<td>101-0031-01L</td>
<td>Systems Engineering</td>
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<td>4</td>
<td>3G</td>
<td>B. T. Adey, C. Richmond</td>
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<td></td>
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<tr>
<td></td>
<td>An introduction to system development, analysis and optimization, and decision making, with focus on linear programming, networks, formal methods and economic analysis.</td>
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<td></td>
<td>Objective</td>
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<tr>
<td></td>
<td>- to gain competency in methods used to plan and analyse systems</td>
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<td></td>
<td>- to gain the ability to formulate, analyse and solve complex problems</td>
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<td>- to gain competency in the methods used for the evaluation of multiple solutions</td>
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<td>- Introduction</td>
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<td>- System development</td>
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<td>- System analysis</td>
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<td>- Networks</td>
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<td>- Decision theory</td>
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<td>- Economic analysis</td>
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<td>- Cost-benefit analysis</td>
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<td>Lecture notes</td>
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<tr>
<td></td>
<td>Script and transparencies as well as additional material via Moodle. The transparencies will be provided via Moodle two days before the respective class.</td>
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<tr>
<td>101-0031-02L</td>
<td>Business Administration</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>J.P. Chardonnens</td>
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<tr>
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<td></td>
</tr>
<tr>
<td></td>
<td>Introduction to business administration</td>
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<td>Objective</td>
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<tr>
<td></td>
<td>Principles of accounting and financial management</td>
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<td>Financial planning and capital budgeting of projects</td>
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<tr>
<td></td>
<td>Prepare and analyze the financial statements of organizations Understand the major costing systems Perform some product calculations Establish budget and determine profitability of investment</td>
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</table>

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 650 of 1434
This lecture presents an introduction to ecology. It includes basic ecological concepts and the most important levels of complexity in ecological research: the individual, the population, the community and the ecosystem level.

The students should learn ecological concepts at these different levels in the context of concrete examples from terrestrial and aquatic systems; corresponding methodological approaches are demonstrated. In a more applied part of the lecture threats to biodiversity and the appropriate management are discussed.

The course will address classical as well as modern physics, and the interplay between basic research and applications. This objective is to teach basic ecological concepts and the different levels of complexity in ecological research, and to familiarize students with methodological and applied aspects of the subject.

The course consists of lectures and exercises in groups. The lectures cover all aspects of the dynamic earth, from the history of the earth, to the formation of rocks, mountains, and oceans, and the degradation processes shaping the uppermost earth's crust.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<tr>
<td>402-0023-01L</td>
<td>Physics</td>
<td>O</td>
<td>7</td>
<td>5V+2U</td>
<td>L. Degiorgi</td>
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</table>

Lecture notes
Unterlagen, Vorlesungsskolien und relevante Literatur sind in der Lehrerdokumentenablage abrufbar. Die Unterlagen für die nächste Vorlesung stehen jeweils spätestens am Freitagmorgen zur Verfügung.

Literature
Generelle Ökologie:

Aquatische Ökologie:
Lampert & Sommer 1999. Limnoökologie. Thieme, 2. Aufl., ca. Fr. 55.-;
Bohle 1995. Limnische Systeme. Springer, ca. Fr. 50.-

Naturschutzbiologie:

3. Semester
Compulsory Courses
Examination Block 1
**Geodetic Metrology II**

**Objective**

The students acquire enhanced knowledge regarding the operating mode, the application and the limitations of modern geodetic standard instruments. They will be able to properly select, test and apply these instruments for geodetic tasks with higher accuracy requirements. They will get acquainted with the typical workflow from the preparation of the field works to the digital or plotted plan. Finally, the students will be introduced to specific geodetic tasks related to construction and civil engineering.

**Content**

- The geometrics workflow
- Propagation of light in the atmosphere
- The modern total station
- Terrestrial Laserscanning
- Digital levels
- Field tests
- Traverses
- Trigonometric leveling
- Precision leveling
- Route planing and transition curves
- Earthworks: Area and cubature

**Lecture notes**

The slides and documents for enhanced study and further reading will be provided online.

**Literature**

- Umweltverträglichkeitsprüfung, vdf, Zürich 1995.

**ECTS**

5 credits

**Lecturers**

A. Wieser, G. Boffi

---

**GIS I**

**Objective**

Acquire basic knowhow about communication with spatial information by using plans and maps, about the most important design rules and production methods for map graphics. Ability to assess existing products with respect to their content-related and design quality. Ability to design proper plans and well designed legends for basic maps.

**Content**

Definitions "map" and "cartography", map types, current tasks and situation of cartography, map history, spatial reference systems, map projections, map conception and workflow planning, map design, analog and digital map production technology, prepress technology, printing technology, topographic maps, map critics.

**Lecture notes**

Will be distributed module by module

**Literature**


**ECTS**

3 credits

**Lecturers**

A. Donaubauer
### Examination Block 3

In place of the German course 851-0703-03L Introduction to Law for Civil Engineering students can take the French course 851-0709-00L Droit civil.

#### Number

<table>
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<tr>
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<th>Title</th>
<th>Type</th>
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<td>Introduction to Law for Civil Engineering</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>G. Hertig</td>
</tr>
<tr>
<td>851-0709-00L</td>
<td>Introduction to Civil Law</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>H. Peter</td>
</tr>
</tbody>
</table>

#### Abstract

This class introduces students to basic features of the legal system. Questions of constitutional and administrative law, contract law, tort law, corporate law, as well as litigation are covered.

#### Objective

Introduction to fundamental questions of public and private law which serves as a foundation for more advanced law classes.

#### Content

1. Public Law

Constitutional law: sources of law, organization of the state, fundamental rights. Administrative law: administrative decisions, organization of the administration, enforcement of administrative decisions, procedural law, basics of police, environmental and zoning law.

2. Private law


#### Literature

- Boillod, J.-P.: Manuel de droit, éd Slatkine, Genève
- Nef, Urs Ch.: Le droit des obligations à l’usage des ingénieurs et des architectes, trad. Bovay, J., éd. Payot, Lausanne

Sont indispensables:
- le Code civil et le Code des obligations;
- Sont conseillés:
  - Nef, Urs Ch.: Le droit des obligations à l’usage des ingénieurs et des architectes, trad. Bovay, J., éd. Payot, Lausanne
  - Boillod, J.-P.: Manuel de droit, éd Slattine, Genève

- Le cours de droit civil porte notamment sur le droit des obligations (droit des contrats et responsabilité civile) et sur les droits réels (propriété, gages et servitudes). De plus, il est donné un bref aperçu du droit de la procédure et de l'exécution forcée.
- Sont conseillés:
  - les cours "Recht I" et "Recht II" en langue allemande et des exercices y relatifs.
  - Les examens peuvent se faire en français ou en italien.
  - Examen au 1er propédeutique; convient pour travail de semestre.

#### Prerequisites / notice

- Le cours de droit civil et le cours de droit public (2e sem.) sont l'équivalent des cours "Recht I" et "Recht II" en langue allemande et des exercices y relatifs.
- Examens peuvent se faire en français ou en italien.
- Examen au 1er propédeutique; convient pour travail de semestre.

### 5. Semester

#### Compulsory Courses 5. Semester

#### Examination Block 4

#### Number

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0126-00L</td>
<td>Geodetic Reference Systems</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>M. Meindl</td>
</tr>
<tr>
<td>103-0184-00L</td>
<td>Higher Geodesy</td>
<td>O</td>
<td>5</td>
<td>4G</td>
<td>M. Rothacher</td>
</tr>
</tbody>
</table>
ECTS
Lecture notes and slides (in German) can be downloaded from the PLUS homepage.

PART 1: Spatial Planning and Special Land Use Management

L. Hurni

General introduction to the development, the life cycle and the characteristics of projects. Introduction to, and experience with, the methods
Thematic map types (focus on quantitative information), analysis of themes and application, base maps, generalisation

PART 2: Methods of Land Re-Allocation

M. Kersting

Getting knowledge in spatial planning and land re-allocation as an interactive process.

PART 3: Agricultural Planning

M. Huhmann, R. Michelon

Agricultural Planning; Getting knowledge in spatial planning and land re-allocation as an interactive process.

Download: http://www.irl.ethz.ch/plus/education

References to technical literature will be included in the course script. An additional list of literature will be given during the course.

Autumn Semester 2015

Course notes will be provided in German. Slides are made available some days before each lecture.

References in the lecture notes

Download: http://www.irl.ethz.ch/plus/education

Lecture notes

Yes

The transparencies will be available for download from the website at least one week before each class.

Copies of all necessary documents will be distributed at appropriate times.

Elective Blocks

Elective Block: GIS, Photogrammetry and Cartography

Number Title Type ECTS Hours Lecturers
103-0455-01L Thematic Cartography W 2 credits 2G L. Hurni

Thematic map types (focus on quantitative information), analysis of themes and application, base maps, generalisation

Knowing of most important thematic map types.

Ability to design adequate thematic maps from statistical data.
Elective Block: Geodesy and Geodetic Metrology

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>103-0125-00L</td>
<td>Geodetic Networks and Parameter Estimation</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>S. Guillaume</td>
</tr>
</tbody>
</table>

Abstract
This course provides knowledge for parameter estimation and data analysis in geodetic networks. The necessary mathematical and statistical methods are explained and applied by means of concrete examples.

Objective
The students are able to plan, pre-analyse and perform analysis of geodetic networks for practical problems. They are able to understand and develop geodetic software.

Content
Refreshment of statistical and probabilistic basics (simulations with random number generators, correlated random noise, empirical density and distribution functions, hypothesis tests), 2D and 3D terrestrial and satellite based observation equations, coordinate transformation ( Helmert, affine), geodetic datum problem (free networks, stochastic networks, semi-automatic), deformation measurements (congruence test, S-transformations)

Prerequisites / notice
Linear algebra, statistic and probability, geoprocessing and parameter estimation, geodetic metrology

Elective Block: Spatial Development and Environmental Planning

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>103-0315-03L</td>
<td>Planning III</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>A. Grêt-Regamey</td>
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</tbody>
</table>

Further information at http://www.karto.ethz.ch
Abstract
Independent development of a basis for decision-making and preparation of specific project documents in the context of practical spatial and environmental problems.

Objective
The students know different GIS-based techniques and methods for analysis of landscape and urban areas as well as GIS-based process models and can implement these for quantifying urban qualities in planning processes.

Content
Current topics from planning practice lead to a practical task in the context of sustainable urban development. A systematic approach of choosing suitable planning and analysis methods is shown and implemented on a concrete project. The results of the GIS-based analysis serve for developing possible solutions. Different alternatives are evaluated with selected indicators and discussed.

Lecture notes
No script. Handouts will be provided.

Prerequisites / notice
GIS-skills would be advantageous.

Elective Block: Transport

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-0647-00L</td>
<td>Introduction to Mathematical Optimization</td>
<td>W</td>
<td>5</td>
<td>2V+1U</td>
<td>R. Zenklusen</td>
</tr>
</tbody>
</table>

Abstract
Introduction to basic techniques and problems of mathematical optimization.

Objective
The goal is to get a good understanding of some of the most important mathematical optimization techniques used to solve linear programs and basic combinatorial optimization problems.

Content
Topics covered in this course include:
- Linear programming (simplex method, duality theory, shadow prices, ...).
- Basic combinatorial optimization problems (spanning trees, network flows, knapsack problem, ...).

Prerequisites / notice
Information about relevant literature will be given in the lecture.


Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-BAUG.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability
see GESS Compulsory Electives: Language Courses ETH/UBH

Electives

The entire course programs of ETH Zurich and the University of Zurich are open to the students to individual selection.

List of Electives Recommended by the Degree Programme

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>252-1425-00L</td>
<td>Geometry: Combinatorics and Algorithms</td>
<td>W+</td>
<td>6</td>
<td>2V+2U+1A</td>
<td>B. Gärtner, M. Hoffmann, E. Welzl</td>
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</table>

Abstract
Geometric structures are useful in many areas, and there is a need to understand their structural properties, and to work with them algorithmically. The lecture addresses theoretical foundations concerning geometric structures. Central objects of interest are triangulations. We study combinatorial (Does a certain object exist?) and algorithmic questions (Can we find a certain object efficiently?)

Objective
The goal is to make students familiar with fundamental concepts, techniques and results in combinatorial and computational geometry, so as to enable them to model, analyze, and solve theoretical and practical problems in the area and in various application domains. In particular, we want to prepare students for conducting independent research, for instance, within the scope of a thesis project.

Content
Planar and geometric graphs, embeddings and their representation (Whitney's Theorem, canonical orderings, DCEL), polygon triangulations and the art gallery theorem, convexity in Rd, planar convex hull algorithms (Jarvis Wrap, Graham Scan, Chan's Algorithm), point set triangulations, Delaunay triangulations (Lawson flips, lifting map, randomized incremental construction), Voronoi diagrams, the Crossing Lemma and incidence bounds, line arrangements (duality, Zone Theorem, ham-sandwich cuts), 3-SUM hardness, counting planar triangulations.

Prerequisites / notice
Prerequisites: The course assumes basic knowledge of discrete mathematics and algorithms, as supplied in the first semesters of Bachelor Studies at ETH.

Literature

Electives ETH Zurich

Outlook: In the following spring semester there is a seminar "Geometry: Combinatorics and Algorithms" that builds on this course. There are ample possibilities for Semester-, Bachelor- and Master Thesis projects in the area.
## Bachelor Thesis

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>103-0006-00L</td>
<td>Bachelor’s Thesis</td>
<td>O</td>
<td>10 credits</td>
<td>20D</td>
<td>Lecturers</td>
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</table>

### Abstract
The Bachelor Programme concludes with the Bachelor Thesis. This project is supervised by a professor. Writing up the Bachelor Thesis encourages students to show independence and to produce structured work.

### Objective
Encourages students to show independence, to produce scientifically structured work and to apply engineering working methods.

### Content
The contents base upon the fundamentals of the Bachelor Programme. Students can choose from different subjects and tasks. The thesis consists of both a written report and an oral presentation.

### Geomatic Engineering and Planning Bachelor - Key for Type

<table>
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<tr>
<th>Key</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
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<td>W+</td>
<td>Eligible for credits and recommended</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
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<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<td>Dr</td>
<td>Suitable for doctorate</td>
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</table>

### Key for Hours

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<th>Key</th>
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<tr>
<td>V</td>
<td>lecture</td>
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<td>G</td>
<td>lecture with exercise</td>
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<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

### ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Geomatic Engineering Master

► Major Courses

★★ Major in Engineering Geodesy and Photogrammetry

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>103-0287-00L</td>
<td>Image Interpretation</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>K. Schindler</td>
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<td><strong>Abstract</strong></td>
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<td></td>
<td>Introduction to interactive, semi-automatic and automatic methods for image interpretation; methodological aspects of computer-assisted remote sensing, including semantic image classification and segmentation; detection and extraction of individual objects; estimation of physical parameters.</td>
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<td>Understanding the tasks, problems, and applications of image interpretation; basic introduction of computational methods for image-based classification and parameter estimation (clustering, classification, regression), with focus on remote sensing.</td>
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<td><strong>Content</strong></td>
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<td>Image (and point-cloud) interpretation tasks: semantic classification (e.g. land-cover mapping), physical parameter estimation (e.g. forest biomass), object extraction (e.g. roads, buildings), visual driver assistance; image coding and features; probabilistic inference, generative and discriminative models; clustering and segmentation; continuous parameter estimation, regression; classification and labeling; atmospheric influences in satellite remote sensing;</td>
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<td></td>
<td>C. Bishop: Pattern Recognition and Machine Learning</td>
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<td></td>
<td>basics of probability theory and statistics; basics of image processing; elementary programming skills (Matlab);</td>
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<tr>
<td>103-0137-00L</td>
<td>Engineering Geodesy</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>A. Wieser, M. Frukacz</td>
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<td><strong>Abstract</strong></td>
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<td></td>
<td>Introduction to Engineering Geodesy: methods, instruments, and applications. The students will be introduced to the methods, instruments, and applications in Engineering Geodesy with a focus on end-to-end quality assessment, sensor and multi-sensor-systems, setting out, and monitoring of engineering objects. They will be able to acquire enhanced knowledge and fundamental competences in high-precision angle, distance and height measurements. They will be introduced to aspects of interdisciplinary work in particular related to construction processes and civil engineering.</td>
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<td>The students will be introduced to the methods, instruments, and applications in Engineering Geodesy with a focus on end-to-end quality assessment, sensor and multi-sensor-systems, setting out, and monitoring of engineering objects. They will be able to acquire enhanced knowledge and fundamental competences in high-precision angle, distance and height measurements. They will be introduced to aspects of interdisciplinary work in particular related to construction processes and civil engineering.</td>
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<td><strong>Content</strong></td>
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<td></td>
<td>- Planning and realizing geodetic networks</td>
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<td>- High precision distance, angle and height measurements</td>
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<td>- Sensors and multi-sensor-systems</td>
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<td>- Calibration and testing</td>
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<td>- Engineering Geodesy in construction above and below ground</td>
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<td></td>
<td>- Tunnel surveying</td>
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<td></td>
<td>- Building Information Modeling (BIM)</td>
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<td>- Defraction monitoring: Models, methods, and applications</td>
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<td></td>
<td><strong>Lecture notes</strong></td>
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<td></td>
<td>The slides and additional documents will be provided in electronic form.</td>
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<td><strong>Literature</strong></td>
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<td><strong>Prerequisites / notice</strong></td>
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<td>Fundamental knowledge in geodetic metrology (applied geodesy), physical geodesy, reference systems, GNSS and parameter estimation is required for this course. This knowledge can for instance been acquired within the appropriate courses of the bachelor studies in Geomatics and Planning.</td>
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<tr>
<td>103-0267-01L</td>
<td>Photogrammetry and 3D Vision Lab</td>
<td>W</td>
<td>3</td>
<td>2P</td>
<td>K. Schindler, J. D. Wegner</td>
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<td><strong>Abstract</strong></td>
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<td></td>
<td>The course deals with selected topics of close-range photogrammetry and geometric computer vision, including wide-baseline image matching and reconstruction, dense surface reconstruction, panorama stitching and image indexing; emphasis is put on practical project work.</td>
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<td><strong>Objective</strong></td>
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<td>The aim of the course is to get to know the methods and practice of close-range photogrammetric reconstruction, and an in-depth understanding of selected topics in modern close-range photogrammetry and computer vision.</td>
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<td><strong>Content</strong></td>
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<td>This course builds in part on the courses &quot;Photogrammetrie&quot;, &quot;Bildverarbeitung&quot; and &quot;Photogrammetrie II&quot; from the Bachelor program. It focusses on the particular challenges of automated close-range photogrammetry.</td>
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<td><strong>Lecture notes</strong></td>
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<td>Recommended textbooks:</td>
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<td></td>
<td>- T. Luhmann. Nahbereichsphotogrammetrie (also available in English)</td>
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<td></td>
<td>- R. Hartley and A. Zisserman. Multi-view geometry in computer vision</td>
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<td>- R. Szeliski. Computer Vision</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td>A recommended prerequisite for taking this course are the Bachelor courses &quot;Photogrammetrie&quot;, &quot;Bildverarbeitung&quot; and &quot;Photogrammetrie II&quot;. If you have not passed them, please contact the main lecturer of the course before enrolling. The course will include both practical work with commercial software, and programming in Matlab.</td>
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<tr>
<td>103-0767-00L</td>
<td>Engineering Geodesy Lab</td>
<td>W</td>
<td>4</td>
<td>3P</td>
<td>A. Wieser, S. Conzett</td>
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<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>Development of concepts and solutions for challenging tasks in Engineering Geodesy using real-world examples</td>
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<td><strong>Objective</strong></td>
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<td>The students learn to develop, assess and realize concepts and solutions for real-world problems in Engineering Geodesy. They advance the knowledge and skills which they have acquired in relation with geodetic metrology, engineering geodesy. They establish links between these subjects. Particular attention is paid to the selection of appropriate measurement and data processing methods, end-to-end quality control, fulfillment of non-technical criteria, and to the documentation of the work.</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
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<td>Actual real-world problems are chosen for this lab depending on the number, background and experience of the students. If possible the problems are chosen in connection with current research projects within the Geosensors and Engineering Geodesy Group. Examples of such problems are:</td>
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<td>- high-precision transfer of coordinates and orientation through a long vertical shaft</td>
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<td>- monitoring of the deformation of an ice-panace</td>
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<td>- development of a 2D-machine-control-and guidance system</td>
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<td></td>
<td>- bridge vibration monitoring</td>
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<td></td>
<td><strong>Lecture notes</strong></td>
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<td></td>
<td>Publications and documents are made available as needed depending on the selected tasks.</td>
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Data: 06.02.2019 13:00  Autumn Semester 2015  Page 658 of 1434
Prerequisites / notice

Successful participation in the lab requires knowledge and experiences conveyed within the related course "Engineering Geodesy". Students who have not already passed that course and who are not participating in that course will only be admitted to the lab after discussion with the instructors.

If the timetable of the participants allows it, the 3-hourly lab units will partially be combined to individual full-time units.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Type</th>
<th>Credits</th>
<th>2 credits</th>
<th>2V</th>
<th>M. Huser</th>
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</thead>
<tbody>
<tr>
<td>103-0787-00L</td>
<td>Project Parameter Estimation</td>
<td>W</td>
<td>3 credits</td>
<td>2P</td>
<td>A. Wieser</td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>Solving engineering problems with modern methods of parameter estimation for network adjustment in a real-world scenario; choosing adequate mathematical models, suitable data-flow and performing software</td>
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<tr>
<td>Objective</td>
<td>Learn to solve engineering problems with modern methods of parameter estimation in a real-world scenario.</td>
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<tr>
<td>Content</td>
<td>Analysis of the given problem, selection of effective mathematical modells, use of appropriate software.</td>
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<tr>
<td>Literature</td>
<td>Handouts for each topic will be provided</td>
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<tr>
<th>Course Code</th>
<th>Title</th>
<th>Type</th>
<th>Credits</th>
<th>2 credits</th>
<th>2P</th>
<th>I. Hajnsek</th>
</tr>
</thead>
<tbody>
<tr>
<td>102-0617-00L</td>
<td>Basics and Principles of Radar Remote Sensing for Environmental Applications</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>L. Hjennke</td>
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</tr>
<tr>
<td>Abstract</td>
<td>The course will provide the basics and principles of Radar Remote Sensing (specifically Synthetic Aperture Radar (SAR)) and its imaging techniques for the use of environmental parameter estimation.</td>
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<tr>
<td>Objective</td>
<td>The course should provide an understanding of SAR techniques and the use of the imaging tools for bio/geophysical parameter estimation. At the end of the course the student has the understanding of:</td>
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<tr>
<td>Content</td>
<td>1. SAR basics and principles, 2. SAR polarimetry, 3. SAR interferometry and 4. environmental parameter estimation from multi-parametric SAR data</td>
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<th>Credits</th>
<th>2 credits</th>
<th>2P</th>
<th>M. Huser</th>
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<tr>
<td>851-0724-00L</td>
<td>Property Law for Geometers: Land Registry and Geoinformation Law</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>D. M. Steudler</td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>Particularly suitable for students of D-ARCH, D-BAUG, D-USYS</td>
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<tr>
<td>Objective</td>
<td>Overview of the legal norms of land registry and surveying law.</td>
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<tr>
<td>Content</td>
<td>Fundamental concepts of Land Register Law and Land Surveying Law (substantive and procedural rules of Land Register Law, the parts and the relevance of the Land Register, process of registration with the Land Register, legal problems of land surveying, reform of the official land surveying).</td>
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<tr>
<td>Literature</td>
<td>Pflichtlektüre: Meinrad Huser, Schweizerisches Vermessungsrecht, unter besonderer Berücksichtigung des Geoinformationsrechts und des Grundbuchrechts, Beiträge aus dem Institut für schweizerisches und internationales Baurecht der Universität Freiburg/Schweiz, Zürich 2014</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Pflichtlektüre: Meinrad Huser, Schweizerisches Vermessungsrecht, unter besonderer Berücksichtigung Des Geoinformationsrechts Und Des Grundbuchrechts, Beiträge Aus Dem Institut Für Schweizerisches Und Internationales Baurecht Der Universität Freiburg/Schweiz, Zürich 2014</td>
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<th>Course Code</th>
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<th>Type</th>
<th>Credits</th>
<th>2 credits</th>
<th>2P</th>
<th>D. M. Steudler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Nature, role and importance of cadastral systems and related concepts such as land administration, land registration and spatial data infrastructures (SDIs).</td>
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<tr>
<td>Objective</td>
<td>The students will get an understanding of the nature, role and importance of cadastral systems and related concepts such as land administration, land registration and spatial data infrastructures (SDIs). The Swiss cadastral system as well as a range of international approaches both in developed and developing countries will be reviewed.</td>
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<th>Credits</th>
<th>2 credits</th>
<th>2P</th>
<th>D. M. Steudler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Nature, role and importance of cadastral systems and related concepts such as land administration, land registration and spatial data infrastructures (SDIs).</td>
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<tr>
<td>Objective</td>
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### Major in Space Geodesy and Navigation

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<tr>
<th>Number</th>
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<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0187-01L</td>
<td>Space Geodesy</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>M. Rothacher</td>
</tr>
<tr>
<td>103-0657-01L</td>
<td>Signal Processing, Modeling, Inversion</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>A. Geiger</td>
</tr>
<tr>
<td>103-0657-00L</td>
<td>Astro Gravity Lab</td>
<td>W</td>
<td>5</td>
<td>4P</td>
<td>S. Guillaume, C. Hollenstein</td>
</tr>
<tr>
<td>103-0787-00L</td>
<td>Project Parameter Estimation</td>
<td>W</td>
<td>3</td>
<td>2P</td>
<td>A. Wieser</td>
</tr>
</tbody>
</table>

**Abstract**
- **Objectives**:
  1. To introduce the fundamental problems of computer vision.
  2. To introduce the main concepts and techniques used to solve those.
  3. To enable participants to make sense of the computer vision literature.

**Content**: Camera models and calibration, invariant features, multiple-view geometry, model fitting, stereo matching, segmentation, 2D shape matching, shape from silhouettes, optical flow, structure from motion, tracking, object recognition, object category recognition.

**Prerequisites / Notice**: It is recommended that students have taken the Visual Computing lecture or a similar course introducing basic image processing concepts before taking this course.

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**Lecture notes**

- **263-5902-00L Computer Vision**: "Computer Vision" by S. Guillaume and M. Pollefeys, L. Van Gool
- **103-0187-01L Space Geodesy**: "Space Geodesy and Satellite Altimetry: Principles, Instrumentation, and Observation Equation" by A. Wieser
- **103-0657-01L Signal Processing, Modeling, Inversion**: "Signal Processing, Modeling, and Inversion of Analytical and Voxel-Type Models" by A. Geiger
- **103-0657-00L Astro Gravity Lab**: "Astro Gravity Lab" by S. Guillaume, C. Hollenstein
- **103-0787-00L Project Parameter Estimation**: "Project Parameter Estimation" by A. Wieser

**Literature**


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**Course Descriptions**

- **Computer Vision**: The students will learn to solve engineering problems with modern methods of parameter estimation in a real-world scenario. They will study the major observation techniques in space geodesy, including GPS, VLBI, Satellite and Lunar Laser Ranging (SLR/LLR), and Satellite Radar Altimetry. They will also learn the basic principles and instruments associated with each technique.

- **Space Geodesy**: The goal of this course is to provide students with a good understanding of computer vision and image analysis techniques. The main concepts and techniques will be studied in detail and practical algorithms and approaches will be discussed and explored through the exercises. Students will learn about the major observation techniques in space geodesy as modern methods applied in Earth system monitoring, including geometry, time scales, and computer vision techniques.

- **Signal Processing, Modeling, Inversion**: The course aims to teach students how to analyse data in view of specific scientific questions and interpretations. They will learn to mathematically formulate engineering and scientific problems. Students will become familiar with the basic methodologies to be able to further study the expert literature.

- **Astro Gravity Lab**: The objective of this course is to provide students with a good understanding of astro-geodetic methods aiming at the determination of the direction of the local plumb line in terms of astronomical latitude and longitude. The students will learn about space geodesy and navigation, including the determination of satellite orbits, ionospheric and tropospheric effects, and atmospheric parameters.

- **Project Parameter Estimation**: The course aims to teach students how to analyse data in view of specific scientific questions and interpretations. They will learn to mathematically formulate engineering and scientific problems. Students will become familiar with the basic methodologies to be able to further study the expert literature.

---

**Notice**

The lectures will be given in English in case of need.
### 102-0617-00L Basics and Principles of Radar Remote Sensing for Environmental Applications

**W 3 credits 2G I. Hajnsek**

**Abstract**
The course will provide the basics and principles of Radar Remote Sensing (specifically Synthetic Aperture Radar (SAR)) and its imaging techniques for the use of environmental parameter estimation.

**Objective**
The course should provide an understanding of SAR techniques and the use of the imaging tools for bio/geophysical parameter estimation. At the end of the course the student has the understanding of:
1. SAR basics and principles,
2. SAR polarimetry,
3. SAR interferometry and
d. environmental parameter estimation from multi-parametric SAR data

**Content**
The course is giving an introduction into SAR techniques, the interpretation of SAR imaging responses and the use of SAR for different environmental applications. The outline of the course is the following:
1. Introduction into SAR basics and principles
2. Introduction into electromagnetic wave theory
3. Introduction into scattering theory and decomposition techniques
4. Introduction into SAR interferometry
5. Introduction into polarimetric SAR interferometry
6. Introduction into bio/geophysical parameter estimation (classification/segmentation, soil moisture estimation, earth quake and volcano monitoring, forest height inversion, wood biomass estimation etc.)

**Lecture notes**
Handouts for each topic will be provided

**Literature**
First readings for the course:

Complete literature listing will be provided during the course.

**Prerequisites / notice**
This course in combination with 102-0627-00-G: Applied Radar Remote Sensing for Environmental Parameter Estimation is providing a profound basis for independent data analysis. It is recommended to take both courses together.

### 103-0687-00L Cadastral Systems

**W 2 credits 2G D. M. Steudler**

**Abstract**
Nature, role and importance of cadastral systems and related concepts such as land administration, land registration and spatial data infrastructures (SDIs).

**Objective**
The students will get an understanding of the nature, role and importance of cadastral systems and related concepts such as land administration, land registration and spatial data infrastructures (SDIs). The Swiss cadastral system as well as a range of international approaches both in developed and developing countries will be reviewed.

**Content**
- Origins and purposes of cadastral systems
- Importance of documentation
- Basic concepts of cadastral systems (real estate, legal basis, conceptual principles, property-ownership, property types)
- Swiss cadastral system:
  - legal basis
  - organization
  - technical elements
  - methods of data acquisition and maintenance
  - profession
  - quality assurance
- Digital revolution, access to data
- Benchmarking and evaluation of cadastral systems
- International trends, developments and initiatives

**Lecture notes**
see: http://www.geo21.ch/ethz/

**Literature**
- Pflichtlektüre: Meinrad Huser, Schweizerisches Vermessungsrecht, unter besonderer Berücksichtigung des Geoinformationsrechts und des Grundbuchrechts, Beiträge aus dem Institut für schweizerisches und internationales Baurecht der Universität Freiburg/Schweiz, Zürich 2014

see also: http://www.geo21.ch/ethz/

### 851-0724-00L Property Law for Geometers: Land Registry and Geoinformation Law

**W 2 credits 2V M. Huser**

**Abstract**
Particularly suitable for students of D-ARCH, D-BAUG, D-USYS

Fundamental concepts of Land Register Law and Land Surveying Law (substantive and procedural rules of Land Register Law, the parts and the relevance of the Land Register, process of registration with the Land Register, legal problems of land surveying, reform of the official land surveying).

**Objective**
Overview of the legal norms of land registry and surveying law.

**Content**
Basic principles of material and formal land registry law, components of the land register, consequences of the land register, the registration process, legal problems of surveying, the reform of official surveying, liability of the geom-eter. The lecture unit is carried out within a frame of 8 sessions (2 hours): the first hour of each is given in the form of a lecture, the second in the form of a case-study.

**Lecture notes**
Abgegebene Unterlagen: Skript in digitaler Form

**Literature**
- Meinrad Huser, Schweizerisches Vermessungsrecht, unter besonderer Berücksichtigung des Geoinformationsrechts und des Grundbuchrechts, Beiträge aus dem Institut für schweizerisches und internationales Baurecht der Universität Freiburg/Schweiz, Zürich 2014
- Meinrad Huser, Geo-Informationsrecht, Rechtlicher Rahmen für Geographische Informationssysteme, Zürich 2005
- Dieter Zobl, Grundbuchrecht, Zürich 1999
- Meinrad Huser, Darstellung von Grenzen zur Sicherung dinglicher Rechte, in ZBGR 2013, 238 ff.
- Meinrad Huser, Datenschutz bei Geodaten

**Prerequisites / notice**
Requirements: Property Law (12-722)

### 651-4016-00L Geophysical Geodesy

**W 3 credits 2G N. Houlié**

**Abstract**
The course is an introduction to the concepts of geodesy applied to the seismic cycle and to the monitoring of ground deformation.
Objective

a) Students are introduced to various geodetic techniques and to their most famous applications in Earth Sciences;
b) Students are able to independently conceptualize 1) the inter seismic strain accumulation for an earthquake and 2) inflation of a spherical reservoir (i.e. magma chamber of a volcano) or 3) water level change within aquifer. c) Students are then introduced to news techniques linking seismology and geodesy.

Content

1. Plate Tectonics before Space Geodesy.
3. The seismic cycle monitoring (Moment release, seismology, Stress transfer)
4. Space geodetic techniques (VBLI, gravity, etc.)
5. Presentation of GPS and Applications 1 (positioning, rigid plate motions)
6. GPS networks in the world. Development of tectonic geodesy and Applications 2 (Practical on inter-seismic deformation)
7. Presentation of InSAR, pSAR, etc. Applications to earthquake. Post-seismic deformation.
8. GPS and deformation related to volcanoes (Practical on Mogi source)
9. GPS. Strain, Stress and Plate motion.
10. InSAR applied to subsidence and small deformation.
11. Trososphere sounding. Accuracies of GPS and InSAR.
12. GPS and geodynamics
13. Future of GPS. Future of InSAR.
14. GPS and normal modes?

Lecture notes

Slides. Script in English is planned. PDF of articles cited.

Geology and Geophysics equivalent to Bachelor program at ETH
Math of Bachelor program at ETH

Prerequisites / notice

Pre-Requisite:
Higher Geodesy Basics; Physical Geodesy and Geodynamics I; Seismotectonics

Literature

See webpage

Prerequisites /
notice

The grading is based on participation, homework sets, and a final oral presentation. There is no final exam.

**Major in GIS and Cartography**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>103-0227-00L</td>
<td>Cartography III</td>
<td>O</td>
<td>5 credits</td>
<td>4G</td>
<td>L. Hurni</td>
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<tr>
<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>Basic methods, technologies, scripting, and systems for interactive web mapping projects and in the internet cartography</td>
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<td>Objective</td>
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<td></td>
<td>Gain knowledge about basic methods, technologies, scripting, and systems for interactive web mapping projects. Assessment of existing products regarding production methods. Definition of useful methods for Web-based map projects.</td>
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<tr>
<td></td>
<td>Content</td>
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<tr>
<td></td>
<td>- Web mapping</td>
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<td>- Web Map Services (WMS)</td>
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<td>- User Interface design</td>
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<td>- Symbolisation</td>
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<td>- Programming</td>
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<td>- Java Script</td>
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<td>- Debugging</td>
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<td>- Map production using GIS data</td>
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<td>- 3D-applications in cartography</td>
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<td>Lecture notes</td>
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<td>Own script and instructions will be distributed.</td>
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<tr>
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<td>Literature</td>
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| 103-0237-00L | GIS III       | O    | 5 credits | 3G    | P. Kiefer, S. Scheider |
|          | Abstract               |      |       |       |                    |
|          | The course deals with advanced topics in GIS; GIS project lifecycle, Managing GIS, Legal issues, GIS assets & constraints; Geospatial Web Services: technical basics, architecture, functions, interoperability, standards, mashups, portals, applications; Geostatistics; Sensor Web Enablement; Human-Computer Interaction; Cognitive Issues in GIS. |
|          | Objective              |      |       |       |                    |
|          | Students will get a detailed overview of advanced GIS topics. They will go through all steps of setting up a Web-GIS application in the labs and perform other practical tasks relating to Sensor Web Enablement, Human-Computer Interaction, Geostatistics, and Web Processing Services. |
|          | Lecture notes          |      |       |       |                    |
|          | no script              |      |       |       |                    |
|          | Literature             |      |       |       |                    |

| 103-0747-00L | Cartography Lab | W    | 6 credits | 13A    | L. Hurni |
|          | Abstract               |      |       |       |                    |
|          | Independent practical work in cartography |
|          | Objective              |      |       |       |                    |
|          | Independent practical work in cartography |
|          | Content                |      |       |       |                    |
|          | Choice of theme upon individual agreement |
|          | Prerequisites / notice |      |       |       |                    |
|          | German or English      |      |       |       |                    |

| 103-0687-00L | Cadastral Systems | W    | 2 credits | 2G    | D. M. Steudler |
|          | Abstract               |      |       |       |                    |
|          | Nature, role and importance of cadastral systems and related concepts such as land administration, land registration and spatial data infrastructures (SDIs). The Swiss cadastral system as well as a range of international approaches both in developed and developing countries will be reviewed. |
|          | Objective              |      |       |       |                    |
|          | The students will get an understanding of the nature, role and importance of cadastral systems and related concepts such as land administration, land registration and spatial data infrastructures (SDIs). The Swiss cadastral system as well as a range of international approaches both in developed and developing countries will be reviewed. |

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Origins and purposes of cadastral systems

Importance of documentation

Basic concepts of cadastral systems (real estate, legal basis, conceptual principles, property-ownership, property types)

Swiss cadastral system:
- legal basis
- organization
- technical elements
- methods of data acquisition and maintenance
- profession
- quality assurance

Digital revolution, access to data

Benchmarking and evaluation of cadastral systems

International trends, developments and initiatives

see: http://www.geo21.ch/ethz/

Learn how to work with (mobile) geoinformation technologies (including application design and programming) and make a contribution to the Zurich Open Data community. A possible topic is given below but students may choose their own topic(s). The only requirement is that all data is freely available and part of the Zurich Open Data.

- Bicycle parking spots
- Bicycle Pump Station
- Routing-Service

See: https://www.stadt-zuerich.ch/portal/de/index/ogd/daten.html

- Know transfer formats and reformat with 1:1 processors
- Know and use interoperability types
- Know and apply appropriate software tools
- UML, EBNF, INTERLIS, ITF, XML, awk, FME
- Know and use communication technologies and OGC Web services
- UML, EBNF, INTERLIS, ITF, XML, awk, FME
- Know and apply appropriate software tools

- Explain object-oriented modelling (with graphic and text)
- Know and use communication technologies and OGC Web services
- UML, EBNF, INTERLIS, ITF, XML, awk, FME
- Know and apply appropriate software tools

Condition for participation: Successful bachelor lecture GIS II


see also: http://www.geo21.ch/ethz/
The lecture consists of several modules. The main focus is on site and project development questions in relation to recycling of industrial wasteland. A semester phase will be discussed, for example the area Sihl- Manegg in Zurich (GreenCity) or the area Alter Pilatusmarkt (Niedfeld) Luzern. For one specific industrial wasteland area the students will develop a vision for a possible redevelopment and a new land-use concept, which will be discussed with experts.

The theory is discussed and illustrated at case studies and exercises. Specific large-scale projects that are currently in the development phase will be discussed, for example the area Sihl- Manegg in Zurich (GreenCity) or the area Alter Pilatusmarkt (Niedfeld) Luzern. For one specific industrial wasteland area the students will develop a vision for a possible redevelopment and a new land-use concept, which will be discussed with experts.

Lecture notes
No script. The documentation, consisting of presentation slides are partly handed out and are provided for download on the PLUS website.

Prerequisites / notice
The contents of the course will be illustrated in the associated lecture 103-0347-01 U (Landscape Planning and Environmental Systems (exercises)). An combination of courses is recommended.

**Major in Planning**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0347-00L</td>
<td>Landscape Planning and Environmental Systems</td>
<td>O</td>
<td>3 credits</td>
<td>2V</td>
<td>A. Grêt-Regamey</td>
</tr>
<tr>
<td></td>
<td>Only for master students, otherwise a special permission by the lecturers is required.</td>
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</tbody>
</table>

**Abstract**
In the course, methods for the identification and measurement of landscape characteristics, as well as measures and implementation of landscape planning are taught. Landscape planning is put into the context of the environmental systems (soil, water, air, climate, flora and fauna) and discussed with regard to socio-political questions of the future.

**Objective**
The aims of this course are:
1. To illustrate the concept of landscape planning, the economic relevance of landscape and nature in the context of the environmental systems (soil, water, air, climate, flora and fauna).
2. To show landscape planning as an integral information system for the coordination of different instruments by illustrating the aims, methods, instruments and their functions in landscape planning.
3. To show the importance of ecosystem services.
4. To point out basic information about nature and landscape: Analysis and assessment of the complex interactions between landscape elements, effects of existing and foreseeable utilization of space (nature goods and services and landscape functions).
5. To identify and measure the characteristics of landscape.
6. Learn how to use the instrument of GIS appropriately in landscape planning.

**Content**
In this course, the following topics are discussed:
- Definition of the concept of landscape
- Landscape change
- Landscape planning
- Methods, instruments and aims of landscape planning (politics)
- Socio-political questions of the future
- Environmental systems, IUCN Red List, ecological connectivity
- Urban landscape services
- Practice of landscape planning
- Use of GIS in landscape planning

**Lecture notes**
No script. The documentation, consisting of presentation slides are partly handed out and are provided for download on the PLUS website.

**Prerequisites / notice**
The contents of the course will be illustrated in the associated lecture 103-0347-01 U (Landscape Planning and Environmental Systems (exercises)). An combination of courses is recommended.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0337-00L</td>
<td>Site and Project Development</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>G. Nuessbaumer</td>
</tr>
</tbody>
</table>

**Abstract**
The main focus of the lecture is on site and project development questions in relation to recycling of industrial wasteland. A semester exercise covers a specific major project and serves as the semester grade (project report and presentation).

**Objective**
Objectives of the lecture are:
1. Get knowledge of comprehensive and multifunctional large-scale projects and their problem areas
2. Get deepened knowledge in selected fields (site analysis, market analysis, project development, cooperative planning, participation processes)
3. Practical orientation, insight into occupational fields
4. Independent acquirement and acquisition of theoretical knowledge

**Content**
The lecture consists of several modules. The main focus is on site and project development questions in relation to recycling of industrial wasteland. Technical presentations, lectured by scientific staff of the division of Planning of Landscape and Urban Systems PLUS as well as well guest referees treat different subjects.

The subjects are:
- Site and market analysis
- Real estate development
- Project development from the perspective of project developers and investors
- Parking and transportation models
- Cooperative planning, participation processes, mediation

The theory is discussed and illustrated at case studies and exercises. Specific large-scale projects that are currently in the development phase will be discussed, for example the area Sihl- Manegg in Zurich (GreenCity) or the area Alter Pilatusmarkt (Niedfeld) Luzern. For one specific industrial wasteland area the students will develop a vision for a possible redevelopment and a new land-use concept, which will be discussed with experts.

**Lecture notes**
- Handouts of the lectures
- Extracts from relevant scientific articles and theory literature
- Exercise material

Download: http://www.irl.ethz.ch/plus/education

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0377-00L</td>
<td>Introduction to the Data Analysis Software R</td>
<td>W</td>
<td>1 credit</td>
<td>1G</td>
<td>A. Grêt-Regamey, M. J. Van Strien</td>
</tr>
</tbody>
</table>

**Abstract**
R is one of the most popular statistical open-source software for data analysis and data modeling. It has proved very useful for a variety of tasks commonly faced by planners, such as data preparation, exploratory analysis, model estimation or graphical display. R is also a programming language providing users with a more flexible and powerful tool for solving more complex problems.

**Objective**
The aim of this course is to provide participants with an introduction to the statistical open-source software R. Students will learn how to read data from files and write data to files, and how these data can be used to plot graphs and maps. Since R is a command-line software, that is, one has to type in text commands at a prompt, rather than just clicking menus and buttons, students will also learn how to write their own functions.

**Content**
Reading data from files
Creating and handling R objects such as matrices, vectors and arrays
Plotting data: histograms, boxplots, scattered plots
Writing data to files
Reading raster and vector data
Writing for- and while-loops
Writing your own functions

**Lecture notes**
Handouts of the lectures and exercises will be distributed
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Type</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0317-00L</td>
<td>Sustainable Spatial Development I</td>
<td>3</td>
<td>O</td>
<td>Only for master students, otherwise a special permission by the lecturer is required.</td>
</tr>
<tr>
<td>103-0417-02L</td>
<td>Theory and Methodology of Spatial Planning</td>
<td>3</td>
<td>O</td>
<td>Only for master students, otherwise a special permission by the lecturer is required.</td>
</tr>
<tr>
<td>101-0427-01L</td>
<td>System and Network Planning</td>
<td>6</td>
<td>W</td>
<td>U. A. Weidmann</td>
</tr>
<tr>
<td>101-0417-00L</td>
<td>Transport Planning Methods</td>
<td>6</td>
<td>W</td>
<td>K. W. Axhausen</td>
</tr>
<tr>
<td>103-0347-01L</td>
<td>Landscape Planning and Environmental Systems</td>
<td>3</td>
<td>W</td>
<td>A. Grêt-Regamey, S. Huber,</td>
</tr>
</tbody>
</table>

**Abstract**

The course will be held in English and no prior knowledge on R is required.

**Objective**

The lectures impart important knowledge for solving spatial relevant conflicts and problems. Case studies will be used to demonstrate the implementation in practice.

**Content**

Tasks of Spatial Planning and development

Issues of local and supra-local interest

Recurring spatial changes, impacts and key figures

Formal and informal instruments and procedures in spatial planning

Spatial Design - Ideas about the future

Reasoning and assessing the situation in spatial planning

Spatial planning as a sequence of decisions and interventions

Process and procedures management

Focus issues - Inner development before external development

Focus issues - Cross-border tasks

Focus Issues - Integrated spatial and infrastructure development

Further information and the documents for the lecture can be found on the homepage of the Chair of Spatial Development.

**Content**

In order to solve problems in spatial planning it is necessary to explore actions and to judge them; finally, one has to argue why a certain option should be preferred to others. Assessments of the situation are the basis for the problems to treat. Specific knowledge, represented in an adequate manner, is required.

**Content**

Assessment of the situation, deciding, language and knowledge are the main parts.

**Content**

The course provides the necessary knowledge to develop models supporting the solution of given planning problems. This is done by dividing the forecasting problem into sub-problems.

The course is composed of a lecture part, providing the theoretical knowledge, and a applied part, in which students develop their own models.

Knowledge of methods and algorithms commonly used in transport planning

Ability to independently develop a transport model able to solve / answer the given problem / questions

Understanding of algorithms and their implementations commonly used in transport planning

The course provides the necessary knowledge to develop models supporting the solution of given planning problems. Examples of such planning problems are the estimation of traffic volumes, prediction of estimated utilization of new public transport lines, and evaluation of effects (e.g. change in emissions of a city) triggered by building new infrastructure and changes to operational regulations.

To cope with the forecasting problem it is first divided into sub-problems. Then, these are solved using various algorithms like iterative proportional fitting, shortest path algorithms and the method of successive averages.

The course is composed of a lecture part, providing the theoretical knowledge, and a applied part, in which students create their own models. This part takes place in form of a tutorial and consists in the development of a computer program. The programming part is closely guided and particularly suitable for students with little programming experience.
The project work is supervised by a professor. Students can choose from different subjects and tasks.

<table>
<thead>
<tr>
<th>Title</th>
<th>Objective</th>
<th>Content</th>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interdisciplinary Project</td>
<td>To show the importance of ecosystem services.</td>
<td>Learn how to use the instrument of GIS appropriately in landscape planning.</td>
<td>Will be named in the lecture.</td>
</tr>
</tbody>
</table>

## Electives

The entire course programs of ETH Zurich and the University of Zurich are open to the students to individual selection.

### List of Electives Recommended by the Degree Programme

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0439-00L</td>
<td>Introduction to Economic Policy - A Case Study Approach with Cost Benefit Analysis in Transport</td>
<td>W</td>
<td>6 credits</td>
<td>4G</td>
<td>K. W. Axhausen, R. Schubert</td>
</tr>
<tr>
<td>101-0449-00L</td>
<td>Management, Marketing, Quality</td>
<td>W</td>
<td>6 credits</td>
<td>4G</td>
<td>U. A. Weidmann</td>
</tr>
</tbody>
</table>

## Electives ETH Zurich

### Course Catalogue of ETH Zurich

### Seminar Work (ONLY for Programme Regulations 2013)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

## Interdisciplinary Project Work (ONLY for Programme Regulations 2013)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0298-02L</td>
<td>Interdisciplinary Project</td>
<td>O</td>
<td>12 credits</td>
<td>24A</td>
<td>Professors</td>
</tr>
</tbody>
</table>
The project can be carried out in German upon mutual agreement between supervisor and student.

## Compulsory Electives in Humanities, Social and Political Sciences

*Recommended GESS compulsory elective courses (Type B) for D-BAUG.*

*see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability*

*see GESS Compulsory Electives: Language Courses ETH/UZH*

## Master Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0009-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>24</td>
<td>47D</td>
<td>Supervisors</td>
</tr>
</tbody>
</table>

**Abstract**

The Master Programme concludes with the Master Thesis, which has to be done in one of the chosen Majors and has to be completed within 16 weeks. The Master Thesis is supervised by a professor and shall attest the student's ability to work independently and to produce scientifically structured work.

**Objective**

To work independently and to produce a scientifically structured work.

**Content**

The topics of the Master Thesis are published by the professors. The Topic can be set also in consultation between the student and the professor.

## Course Units for Additional Admission Requirements

*The courses below are only available for MSc students with additional admission requirements.*

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0115-AAL</td>
<td>Geodetic Metrology II</td>
<td>E-</td>
<td>5</td>
<td>4R</td>
<td>A. Wieser</td>
</tr>
</tbody>
</table>

**Abstract**

Advanced topics in geodetic metrology with focus on instrumental and methodic aspects for applications with higher accuracy demands.

**Objective**

The students acquire enhanced knowledge regarding the operating mode, the application and the limitations of modern geodetic standard instruments. They will be able to properly select, test and apply these instruments for geodetic tasks with higher accuracy requirements. They will get acquainted with the typical workflow from the preparation of the field works to the digital or plotted plan. Finally, the students will be introduced to specific geodetic tasks related to construction and civil engineering.

**Content**

- The geomatics workflow
- Propagation of light in the atmosphere
- The modern total station
- Terrestrial Laser-scanning
- Digital levels
- Field tests
- Traverses
- Trigonometric leveling
- Precision leveling
- Route planning and transition curves
- Earthworks: Area and cubature

**Lecture notes**

Slides and documents for enhanced study and further reading will be provided online.

**Literature**


<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0126-AAL</td>
<td>Geodetic Reference Systems</td>
<td>E-</td>
<td>3</td>
<td>3R</td>
<td>M. Meindl</td>
</tr>
</tbody>
</table>

**Abstract**

Fundamentals and theory of geodetic reference systems and frames. Introduction to current international systems as well as to systems for the Swiss national geodetic survey.

**Objective**

Provision of fundamental knowledge and theory to get familiar with the applications of geodetic reference systems. Special emphasis will be placed on international global systems as well as on the systems of the Swiss national geodetic survey.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0132-AAL</td>
<td>Geodetic Metrology Fundamentals</td>
<td>E-</td>
<td>6</td>
<td>4R</td>
<td>A. Wieser</td>
</tr>
</tbody>
</table>

**Abstract**

Introduction to the most important sensors, operation and calculation methods of Geodetic Metrology

**Objective**

Getting to know the most important sensors, operation and calculation methods of Geodetic Metrology

**Content**

Overview on the different domains of geodetic metrology

Geodetic instruments and sensors

Determination of 3D-coordinates with GNSS, total sttaion and levelling

Calculation methods of geodetic metrology

Survey and staking-out methods

**Lecture notes**

Slides and additional material used in the associated regular course Geodätische Messtechnik GZ (in German) are provided in electronic form.

**Literature**


**Prerequisites / notice**

The field course is part of this lecture. Practical exercises complete the subjects taught during the semester.

If evidence of equivalent practical experience in surveying cannot be provided by the student, participation in the field course during the respective next available period (i.e. 1 week in the beginning of the summer holidays) is required.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0414-AAL</td>
<td>Transport Planning (Transportation I)</td>
<td>E-</td>
<td>3</td>
<td>2R</td>
<td>K. W. Axhausen</td>
</tr>
</tbody>
</table>
Abstract The lecture course discusses the basic concepts, approaches and methods of transport planning in both their theoretical and practical contexts.

Objective The course introduces the basic theories and methods of transport planning.

Content Basic theoretical links between transport, space and economic development; basic terminology; measurement and observation of travel behaviour; methods of the four stage approach; cost-benefit analysis.

The self-study course comprises the following readings:

**Planning I**
- To get to know the interaction between the community and our living space and their resulting conflicts.

**Geodata Analysis**
4R
The basics of photogrammetry, its products and applications: the principle of image-based measurement; digital aerial cameras and related

We suggest the following textbooks for further reading:

**Planning II**
2R
4R
Photogrammetry (slides on the web)


**Literature**


exemplarily applying the knowledge gained from the literature by independently exploring the two city quarters.

- «SIDAIA - Spatial and Infrastructure Development: An Integrated Approach».
- Mikoleit, Anne and Pürckhauer, Moritz: «Urban Code», and
- Alexander, Christopher et al.: «A Pattern Language»,
- Lynch, Kevin: «The Image of the City»,

enabling the student of two Zurich city quarters that involves investigating specific spatially relevant conditions, recognizing regularities and relevant

problems that need to be explored, clarified and solved. The cornerstone of the course is formed by an independent exploration by the

student of two Zurich city quarters.

additional admission requirement.

Enrolment only for MSc students who need this course as additional admission requirement.

The graded semester performance comprises a condensed paper to be written by the student reflecting both the literature read as well as exemplarily applying the knowledge gained from the literature by independently exploring the two city quarters.

- «SIDAIA - Spatial and Infrastructure Development: An Integrated Approach».

Applying image processing algorithms to relevant problems in photogrammetry and remote sensing.

The following topics will be covered in the course:
- Properties of digital images
- Signal processing/Sampling
- Image enhancement
- Image restoration: Spatial domain
- Image restoration: Fourier domain
- Color/Demosaicing
- Image compression
- Feature extraction
- Texture analysis

Our lecture notes will provide a deeper understanding of the topics covered.

Rafael C. Gonzalez, Richard E. Woods
Digital Image Processing
ISBN: 013168728X

Rafael C. Gonzalez, Steven L. Eddins, Richard E. Woods:
Digital Image Processing Using MATLAB
Prentice Hall, 2003
ISBN: 0130085197

The course is accompanied by programming assignments, that need to be completed in order to pass the semester performance.

The course deals with advanced methods in spatial data analysis in theory as well as in practical exercises.

The course is accompanied by programming assignments, that need to be completed in order to pass the semester performance.

The lecture imparts methodological and instrumental fundamentals for spatial planning and will be exemplified by exploring two Zurich city

quarters.

Spatial planning is concerned with the foresighted design of the built and un-built environment. Starting points are spatially relevant problems that need to be explored, clarified and solved. The cornerstone of the course is formed by an independent exploration by the student of two Zurich city quarters that involves investigating specific spatially relevant conditions, recognizing regularities and relevant problems.

The self-study course compromises the following readings:

Chapters of:
- Lynch, Kevin: «The Image of the City»,
- Alexander, Christopher et al.: «A Pattern Language»,
- Mikoleit, Anne und Pürckhauer, Moritz: «Urban Code», and
- «SIDAIA - Spatial and Infrastructure Development: An Integrated Approach».

The graded semester performance comprises a condensed paper to be written by the student reflecting both the literature read as well as exemplarily applying the knowledge gained from the literature by independently exploring the two city quarters.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0435-AAL</td>
<td>Landmanagement</td>
<td>5</td>
<td>G. Nussbaumers</td>
</tr>
<tr>
<td></td>
<td>Enrolment only for MSc students who need this course as additional admission requirement.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>Spatial planning on the Commune level with focus on the special land use management. Land re-allocation as an instrument of spatial planning; specific explanations for land re-allocations in rural regions and in construction zones. Land marketing: the view of investors.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>Getting knowledge in spatial planning and land re-allocation as an interactive process.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>252-0846-AAL</td>
<td>Computer Science II</td>
<td>4</td>
<td>F. O. Friedrich</td>
</tr>
<tr>
<td></td>
<td>Enrolment only for MSc students who need this course as additional admission requirement.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to programming in Java. Procedural foundations of programming and outlook to object oriented programming. Variables, types, assignments, control structures (branch, loop), data structures, algorithms, line graphics, graphical user interface. Writing small programs. Working with a professional programming environment (Eclipse).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>The students will be able to write simple programs and to modify existing programs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content</td>
<td>This course offers an introduction to variables, control structures (branch, loop), algorithms and data structures, as well as an outlook to modularisation and object oriented techniques. In the exercises students train programming skills (in the programming language JAVA). Students can solve the exercises on their own laptop or in the computer labs at ETH. The software used in this course runs on MS Windows, MacOS X and Linux.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literature</td>
<td>cf. content</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>406-0023-AAL</td>
<td>Physics</td>
<td>7</td>
<td>L. Degiorgi</td>
</tr>
<tr>
<td></td>
<td>Enrolment only for MSc students who need this course as additional admission requirement.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>Basic topics in classical as well as modern physics, interplay between basic research and applications.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content</td>
<td>Electrodynamics, Thermodynamics, Quantum physics, Waves and Oscillations, special relativity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literature</td>
<td>cf. content</td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>406-0141-AAL</td>
<td>Linear Algebra and Numerical Analysis</td>
<td>5</td>
<td>P. Grohs</td>
</tr>
<tr>
<td></td>
<td>Enrolment only for MSc students who need this course as additional admission requirement.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to Linear Algebra and Numerical Analysis for Engineers. This reading course is based on chapters from the book &quot;Introduction to Linear Algebra&quot; by Gilbert Strang (SIAM 2009), and <em>A first Course in Numerical Methods</em> by U. Ascher and C. Greif (SIAM, 2011).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>To acquire basic knowledge of Linear Algebra and some aspects of related numerical methods and the ability to apply basic algorithms to simple problems.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content</td>
<td>* Linear systems of equations: Gaussian elimination, row echelon form, theory about existence and uniqueness of solutions (Strang Ch. 2 and 3.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>* Mathematical modelling by linear systems (e.g. networks, trusses) (Strang, parts of Ch. 8)</td>
<td></td>
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<tr>
<td></td>
<td>* Column space, null space and rank of matrices (Strang 3.2, 3.3)</td>
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<td></td>
<td>* linear combinations, linear (in)dependence, bases, dimension theorem for matrices (Strang 3.5, 3.6)</td>
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<td></td>
<td>* inner product, orthogonality, length in Euclidean space (Strang 4.1, 4.2)</td>
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<td></td>
<td>* Least squares solutions and orthogonalization (Gram-Schmidt and QR) (Strang 4.3, 4.4)</td>
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<td></td>
<td>* Linear mappings, matrix representation and change of basis (Strang Ch. 7)</td>
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<td></td>
<td>* Determinants and diagonalization of matrices (eigenvalues and eigenvectors) (Strang 6.1, 6.2, 6.5, 6.6)</td>
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<tr>
<td></td>
<td>* Diagonalization applied to linear differential and difference equations. (Strang 6.3)</td>
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<tr>
<td></td>
<td>* Numerical methods for solving linear systems of equations (Ascher/Greif 5.1, MATLAB Documentation)</td>
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<tr>
<td></td>
<td>* Interpolation with polynomials and splines (Ascher/Greif Ch. 10 and 11)</td>
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<td>7</td>
<td>M. Akveld</td>
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<td>Enrolment only for MSc students who need this course as additional admission requirement.</td>
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<tr>
<td>Abstract</td>
<td>Mathematical tools of an engineer. Mathematics as a tool to solve engineering problems, mathematical formulation of problems in science and engineering. Basic mathematical knowledge of an engineers.</td>
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<td>Objective</td>
<td>Multi variable calculus; gradient, directional derivative, chain rule, Taylor expansion, Lagrange multipliers. Multiple integrals: coordinate transformations, path integrals, integrals over surfaces, divergence theorem, applications in physics. Ordinary differential equations.</td>
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<tr>
<td>Content</td>
<td>Textbooks in English:</td>
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<td></td>
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<tr>
<td></td>
<td>- J. Stewart: Multivariable Calculus, Thomson Brooks/Cole</td>
<td></td>
<td></td>
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<td></td>
<td>- V. I. Smirnov: A course of higher mathematics. Vol. II. Advanced calculus</td>
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<td></td>
<td>- M. Akveld, R. Sperb, Analysis II, vdf</td>
<td></td>
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<tr>
<td></td>
<td>- L. Papula: Mathematik für Ingenieure 2, Vieweg Verlag</td>
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<td>Abstract</td>
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Data: 06.02.2019 13:00 Autumn Semester 2015 Page 670 of 1434
Mathematical tools for the engineer

Mathematics as a tool to solve engineering problems.
Mathematical formulation of technical and scientific problems.

Complex numbers.
Calculus for functions of one variable with applications.
Simple Mathematical models in engineering.


Textbooks in English:

Textbooks in German:
- M. Akveld, R. Sperb: Analysis I, vdf
- M. Akveld, R. Sperb: Analysis II, vdf
- L. Papula: Mathematik für Ingenieure und Naturwissenschaftler, Vieweg Verlag
- L. Papula: Mathematik für Ingenieure 2, Vieweg Verlag

Abstract
Introduction to basic methods and fundamental concepts of statistics and probability theory for non-mathematicians. The concepts are presented on the basis of some descriptive examples. Learning the statistical program R for applying the acquired concepts will be a central theme.

Objective
The objective of this course is to build a solid fundament in probability and statistics. The student should understand some fundamental concepts and be able to apply these concepts to applications in the real world. Furthermore, the student should have a basic knowledge of the statistical programming language "R".

Content
From "Statistics for research" (online)
Ch 1: The Role of Statistics
Ch 2: Populations, Samples, and Probability Distributions
Ch 3: Binomial Distributions
Ch 6: Sampling Distribution of Averages
Ch 7: Normal Distributions
Ch 8: Student’s t Distribution
Ch 9: Distributions of Two Variables

From "Introductory Statistics with R (online)"
Ch 1: Basics
Ch 2: The R Environment
Ch 4: Descriptive statistics and tables
Ch 5: One- and two-sample tests
Ch 6: Regression and correlation

Literature
- "Statistics for research" by S. Dowdy et. al. (3rd edition); Print ISBN: 9780471267355; Online ISBN: 9780471477433; DOI: 10.1002/0471477435
  From within the ETH, this book is freely available online under: http://onlinelibrary.wiley.com/book/10.1002/0471477435
  From within the ETH, this book is freely available online under: http://www.springerlink.com/content/m17578/

Geomatic Engineering Master - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Meaning</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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Key for Hours

<table>
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<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
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ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
History and Philosophy of Knowledge Master

► Basic Courses

► Lectures and Exercises

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>862-0050-00L</td>
<td>History and Philosophy of Knowledge: Goals, Methods and Work Technics</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>N. El Kasser, M. Hampe, F. Hupfer, A. Mohr, M. Stadler, A. Totzke</td>
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</table>

This lecture is important as an Introduction to the Master Programme

Abstract

The lecture series are held by all scientific disciplines involved in the HPK-Master programme and are meant to acquaint the students with the different ambitions, methods and techniques of each discipline. Furthermore, the lectures should serve as a "helpdesk" and "workshop" for all theses written within the M.A. programme.

Objective

The interdisciplinary lecture series are exclusively addressed to the students of the HPK-M.A. programme. They provide an insight into all the disciplines which participate in the M.A. programme and their specific demands, approaches, problems and techniques. Subsequent to the lectures, there will be an opportunity to discuss difficulties occurring within the procedures of thesis-writing. The series should provide and secure a substantial, methodological and formal orientation within the disciplines taught in the M.A.-program.

Prerequisites / notice

Dates: Thursday, 10-12

851-0125-18L  Self-Ownership - Philosophical and Juridical Perspectives

Abstract

Rights in Objects are founded by an inalienable Self-Ownership. These Idea ist central for personal rights. We speak of my body, my genes, my name, my portrait, my ideas oder ways of expression.

Objective

The interdisciplinary lecture series are exclusively addressed to the students of the HPK-M.A. programme. They provide an insight into all the disciplines which participate in the M.A. programme and their specific demands, approaches, problems and techniques. Subsequent to the lectures, there will be an opportunity to discuss difficulties occurring within the procedures of thesis-writing. The series should provide and secure a substantial, methodological and formal orientation within the disciplines taught in the M.A.-program.

Participants will have the opportunity to gain access to unfamiliar texts from the philosophical tradition and to see their relevance today. They experience the consequences of a certain use of concepts und orient themselves in current bioethical, juridical and political discussions.

Content

Texts by Locke, Nozick, Christman, Otsuka, Rasmussen, Schneider, Stirner, Fichte and Forschner. Founding of property right in self-ownership (Locke), renewal of this concept in Nozick and his egalitarian critics. Critique of the concept of self-ownership related to property in one's body. Looking back to the personal self-relatedness that comes up again in Intellectual Property and in modern personal rights.

Literature

Text, Seminarplan und Literaturliste in ILIAS Lehrdokumentenablage.

851-0157-00L  Mind and Brain

Abstract

In the last 2500 years, the mind-brain relationship has been articulated in various ways. In these lectures, I will explore the scientific and philosophical aspects of this relationship in the context of relevant cultural, historical and technological processes, with a focus on the modern neurosciences, but I will also discuss works of art and literature.

Objective

By the end of the lecture, students should be familiar with essential positions in the scientific and philosophical treatment of questions relating the mind to the brain. It should also become clear that some of the most relevant problems in current neurosciences have a long history.

Content

According to a myth, the ancient Greek philosopher Democrit dissected animals, because he was in search of the seat of the soul. Current neuroscientists use neuroimaging techniques like functional magnetic-resonance-tomography in order to localize cognitive and emotional qualities in the brain. Between these two dates lies a history of 2500 years, in which the relationship between the mind and the brain has been defined in various ways. Starting with ancient and medieval theories, the lecture will have its focus on modern theories from the nineteenth century onward. I will discuss essential issues in the history of the neurosciences such as localization theories, the neuron doctrine, reflex theory, theories of emotions, neurocbernetics and the importance of visualizing the brain and its parts, but I will also include works of art and literature.

851-0144-15L  The Beginning of Scientific Enquiry - History and Impact of Presocratic Natural Philosophy

Abstract

Several questions and notions introduced by presocratic natural philosophy are still considered important (albeit in historically altered forms, of course). This applies, e.g., to the notion of the infinite, the process character of nature, and atomism. The present lecture discusses both, the origin of these notions and their persistent relevance for later approaches in philosophy.

Objective

By the end of the lecture the students are able to describe and classify different approaches and notions in presocratic philosophy. Moreover, they are able to critically compare and evaluate them in relation to later approaches in natural philosophy.

851-0549-00L  WebClass Introductory Course History of Technology

Abstract

WebClass Introductory Course History of Technology is an introductory course to the history of technology. The students are challenged to discover how technological innovations take place within complex economical, political and cultural contexts. They get introduced into basic theories and practices of the field.

Objective

Students are introduced into how technological innovations take place within complex economical, political and cultural contexts. They get to know basic theories and practices of the field.

Content


Lecture notes


Literature

https://www.tg.ethz.ch/de/programme/
Parasites have a bad reputation. They settle in with other creatures' bodies, they manipulate and deceive them, they live at the expense of others. Such features are not only of biological but also of social, political, and economic importance. The lecture will track the traces of the parasite through the history of biology and medicine and the fields of political economy and cultural theory.

The course provides insight into the complex and intricate history of the parasite and the various definitions of parasitism. In particular, it will make students aware of the fact that there is no single expert discourse on parasites (such as biology or medicine) which is then transferred to the realm of the social and the political. Instead, it will be considered how and why all these aspects are intertwined when people talk about parasites.

Switzerland in the 20th Century - an Overview. Perspectives from Economic, Social and the History of Technology. Subjects: Switzerland and technology; 1968: students', women's and the environmental movement; wealth and its distribution; Switzerland and Europe

History of science

Philosophy

Philosophy of technology

Science

Technology

Switzerland

Abstract

Objective

Prerequisites / notice


Weitere Informationen unter https://www.tg.ethz.ch/de/programme/
Objective

ETH students get a useful survey of crucial topics and processes in Switzerland in the course of the 20th century which had impacts up to the current day. The perspective is an entangled one combining approaches and methods from the economic and social history as well as the history of technology. For MA GPW students, these insights can enable them to better contextualize other courses within the realm of social sciences, the history of knowledge, technology and philosophy. Although this course connects with the one on the 19th century in the spring semester 2015, it is an independent course and participation requires no previous knowledge about the 19th century.

851-0331-02L  The Factory of the Origins: Myth and Sciences

Abstract

In which language has God pronounced «Fiat Lux»? Which discourses have dealt with the origins of religions, nations, languages and «races»? Renan questions if the «destiny» of peoples has ever been driven by racial «instincts». In his Schwarze Hefte (2014-2015), Heidegger speaks about the «metaphysics» of «race». The «origins factory» can be related both to oneself as well as to the others.

Objective

More informations will follow in the lecture.

Erica Seidler

851-0129-00L  Writing for Others - Science and Public

Abstract

Learning to write texts, that can present topics from the sciences to an interested public (in newspapers, non-specialist journals but also in papers for non-specialists in an academic context); to gain insights into the cultural, historical and philosophical contexts of science and the public.

Objective

Learning to write texts, that can present topics from the sciences to an interested public (in newspapers, non-specialist journals but also in papers for non-specialists in an academic context); to gain insights into the cultural, historical and philosophical contexts of science and the public.

Content

Prerequisites / notice

Voraussetzungen: Die Bereitschaft, sich auf ein Projekt mit experimentellem Charakter einzulassen. GUTE BEHERRSCHUNG DER DEUTSCHEN SPRACHE.

851-0144-01L  Introduction to the Philosophy of Physics

Abstract

Does not take place this semester. Particularity suitable for students of D-MAVT, D-MATL.

Objective

This is an introductory course in different areas and positions in the philosophy of physics. It falls into different parts, including one on the concepts of space and time and one on the reality of structures in physics.

Content

Prerequisites / notice

Die Teilnehmerzahl ist begrenzt. SCHRIFTLICHE ANMELDUNG erforderlich (bis 31. August): uwe.justus.wenzel@nzz.ch

701-0019-00L  Readings in Environmental Thinking

Abstract

This course introduces students to foundational texts that led to the emergence of the environment as a subject of scientific importance, the historical, sociological and philosophical aspects of writing for others.

Objective

Prerequisites / notice

This course provides students with opportunities to read, discuss, evaluate and interpret key texts that have shaped the environmental movement and, more specifically, the environmental sciences. Students will gain familiarity with the foundational texts, but also understand the historical context within which their academic and future professional work is based. More directly, the course will encourage debate and discussion of each text that is studied, from both the original context as well as the modern context. In so doing students will be forced to consider and justify the current societal relevance of their work.

Content

The course will be run as a book reading club. The first session will provide a short introduction as to how to explore a particular text (that is not a scientific paper) to identify the key points for discussion.

Thereafter, in each week a text (typically a chapter from a book or a paper) considered to be seminal or foundational will be assigned by a course lecturer. The lecturer will introduce the selected text with a brief background of the historical and cultural context in which it was written, with some additional biographical information about the author. He/she will also briefly explain the justification for selecting the particular text.

The students will read the text, with two to four students (depending on class size) being assigned to present it at the next session. Presentation of the text requires the students to prepare by, for example:

identifying the key points made within the text
identifying issues of particular personal interest and resonance
considering the impact of the text at the time of publication, and its importance now

evaluating the text from the perspective of our current societal and environmental position

Such preparation would be supported by a mid-week tutorial discussion (about 1 hour) with the assigning lecturer.

These students will then present the text (for about 15 minutes) to the rest of the class during the scheduled class session, with the lecturer facilitating the subsequent class discussion (about 45 minutes). Towards the end of the session the presenting students will summarise the emerging points (5 minutes) and the lecturer will finish with a brief discussion of how valuable and interesting the text was (10 minutes). In the remaining 15 minutes the next text will be presented by the assigning lecturer for the following week.

Literature

The specific texts selected for discussion will vary, but examples include:

Leopold (1949) A Sand County Almanach
Carson (1962) Silent Spring
Jared Diamond (2005) Collapse

Discussions might also encompass films or other forms of media and communication about nature.

862-0096-00L  Theoretical Philosophy Work in Progress Seminar

Abstract

Does not take place this semester. Only for History and Philosophy of Knowledge MSc and D-GESS PhD students.

Number of participants limited to 15.
Abstract
In this course themes from theoretical philosophy are discussed which are of particular interest for current MAPGW students. Primary texts will be read together and the work in progress of the participants (essays, theses) will be presented and discussed.

Objective
This course is aimed at MAPGW students who are particularly interested in theoretical philosophy. The seminar provides an opportunity to discuss and present one's own research. The participants learn to critically evaluate primary texts and improve their skills in presenting and discussing work in progress.

851-0306-05L  Literature and Technology - Simulations, Prototypes, Machines

Abstract
Literature about technology transposes models, products and procedures of scientific progress into the logic of poetry. This literature converts not only technology into fiction, but it also creates new cultural and social contextualisations, which reveal alternative readings of configurations of knowledge.

Objective
Students are familiar with different relations between literature and technology. They can verbalise and analyse central contentions.

Content
Im Seminar lesen wir unter anderem Texte von E.T.A. Hoffmann, Franz Kafka, Georg Kaiser und Max Frisch.

851-0300-94L  Combinatorics: History of a Method Between Mathematics and Literature

Abstract
Combinatorics is a procedure shared by various disciplines. In mathematics it concerns the calculation of quanta and probabilities, in philosophy the creation of encyclopedic knowledge, in mysticism the achievement of ecstatic experience, in literature, finally, experimental writing. This course investigates these different forms of combinatorics.

Objective
- comparative understanding of combinatorics as a transcultural and transdisciplinary procedure to generate knowledge
- cultural and epistemic history of combinatorics since the medieval ages
- combinatorics in theology, mysticism and occultism
- combinatorics in philosophy and the natural sciences
- combinatorics in literature and literary theory

Content
Kombinatorik, die Verknüpfung von Elementen, tritt als ein Verfahren in unterschiedlichen Disziplinen und Bereichen des Wissens auf: In der Mathematik, wo man sie zuerst vermutet, ermöglicht sie die Berechnung von Anzahlen und Wahrscheinlichkeiten. Zugleich spielt die Kombinatorik auch eine grosse Rolle in der Philosophie (als ein Verfahren zur Erzeugung eines enzyklopädischen Wissens), in der Mystik (zur Erlangung ekstatischer Erfahrung) und in der Literatur (als ein experimentelles Schreibverfahren). In dem Seminar werden diese vielfältigen Formen und Funktionen von kombinatorischen Verfahren zwischen mathematischer, philosophischer, mystischer und ästhetischer Anwendung verglichen und analysiert.

851-0144-07L  The Infinite in Philosophy and in the Exact Sciences: Logic, Mathematics, Physics

Abstract
The infinite in philosophy and the exact sciences is a complex and challenging topic. It is studied through a variety of approaches, from a broader cultural historical perspective to a more rigorous mathematical analysis.

Objective
- to get acquainted with different types of infinitness; to study what is intriguing or problematic about the infinite; to inquire whether these different types of infinitness have (important) features in common.

851-0158-01L  Science and Wonder

Abstract
Wonders seem to be perfectly incompatible with science: Superstition and ignorance here, exactness and certitude there. In the seminar we will study this conflictive relation in more detail. Texts will cover a broad historical spectrum ranging from pre-modern cabinets of wonder to the anti-wonder polemics in the 19th century to the current dispute on Intelligent Design.

Objective
- to enable students to form an educated opinion and participate in discussions on the global history of science and knowledge
- to understand, compare and analyse differing approaches to the history of science
- to systematically reconstruct and reproduce complex arguments (reading-competences)
- to understand how advances in technology and science are historically rooted in European imperial expansion and are connected to global social inequalities in the postcolonial world

851-0101-47L  Science in the Twentieth Century: A Global Perspective WEBCLASS

Abstract
This course studies the 20th century history of those forms of knowledge framed specifically as science and technology, from a global perspective. It explores how exchanges and relationships between different parts of the world contributed to what is understood as science and "development". In doing so, it considers how the concept of science is entangled with structures of power and domination.

Objective
- to critically consider the concepts of science and knowledge
- to understand how advances in technology and science are historically rooted in European imperial expansion and are connected to global social inequalities in the postcolonial world
- to understand the historical plurality of forms of knowledge in different parts of the world as well as entanglements between different forms of knowledge
- to systematically reconstruct and reproduce complex arguments (reading-competences)
- to understand, compare and analyse differing approaches to the history of science
- to enable students to form an educated opinion and participate in discussions on the global history of science and knowledge

851-0145-04L  History and Philosophy of Pharmacy

Abstract
The course provides an insight into selected topics and questions of the history and philosophy of pharmacy by reading and discussing both modern and historical texts.

Objective
The course provides an insight into selected topics and questions of the history and philosophy of pharmacy by reading and discussing both modern and historical texts.

851-0309-13L  "Materialmäränen": Thomas Mann's Zauberberg from the Point of View of the History of Knowledge

Abstract
This seminar is dedicated to Thomas Mann's "Zauberberg", the great Bildungsroman and "Zeitroman" (Mann) from the author's middle period. Mann himself feared that the novel might be intellectually overburdened with contexts and concepts. The seminar will attempt to elucidate these contexts from the point of view of the history of ideas and knowledge and will take into account current research.

Objective
- Students familiarize themselves with one of the great novels of the 20th century in the context of a diligent reading accompanied by the lecturer.
- On the basis of the primary text, the seminar establishes several perspectives grounded in cultural history, the history of knowledge and ideas, economic and social history and the history of medicine.
Objective
The seminar deals with the designs for a new living in the artistic and social avantgarde movements at the beginning of the 20th century. It focuses on the correlation of the contemporary scientific and technological developments and the conceptions of a ‘New Man’. The discipline of psychotechnics together with scientific and technological designs of living and working environments formulated visions of new and enhanced ways of human living and perception. In the seminar, we will examine the utopian visions of life in the avantgarde movements. Touching upon the fields of the life sciences, economics, management, progressive education, architecture, and art we will reflect the diverse relations between science, technology, and human living.

Abstract
Based on the contributions published between 1910 and 1932 in “Der Sturm”, the seminar gives an overview on the unique diversity of literary and cultural movements in Berlin between the turn of the century and the Weimar Republic. Despite the reading of literary texts, the lecture focuses on the aesthetic, philosophical and political discourses of the epoch.

Objective
The students will get to know the literature and the art of an epoch during which a specific large town culture emerged in Berlin. The wide range of reading materials deals with the diverse literary movements from the Fin de Siècle until the Neue Sachlichkeit, including Expressionism. Many of the writers and artists presented in the course are bound through their collaboration with the cultural and art journal “Der Sturm”, one of the most important publication organs for the promotion of literary Expressionism that offered a forum to modern art representatives from entire Europe. This journal is absolutely exemplary for the epoch, its trends and breaks and therefore requires a closer look. It should become clear how in a time of extreme social and political tensions resulting in nationalist, imperialist and racist tendencies, a unique form of supranational discussion and exchange emerged that would revolutionize and leave its mark on the art discourse.

Abstract
Wisdom is widely - maybe even universally, at all times and everywhere - regarded as one of the highest virtues. But what constitutes wisdom? And is wisdom compatible with uncertainty? Does a wise person have to be certain or can she be uncertain? These and related questions will be discussed in the seminar to gain an understanding of what wisdom, certainty and uncertainty are.

Objective
1. Analysis and discussion of different interpretations of the virtue "wisdom".
2. Analysis of the role of wisdom and discussion of certainty and uncertainty.
3. Discussion of the questions what constitutes wisdom today and whether wisdom is a goal of the good life.
4. Examination of the relevance of wisdom in practical and theoretical contexts.

Abstract
The philosophy of biology deals with concepts and problems that occur specifically while dealing with living entities. Accordingly, it covers the historical as well as schematic aspects of concepts like gene or species, or theories explaining diversity or stability, competitive or cooperative action. Another important topic is the role of technology while affording biological objects.

Objective
The overarching objective of this seminar is to get an impression of the specificity of biological problems and to develop an appropriate philosophical sensibility. Accordingly, philosophical traditions in biology will be discussed, just as the application of the history of concepts in the context of biology. The seminar reader will consist of contributions of biologists as well as philosophers of biology. Besides the basic concepts in biology such as gene, species, evolution, or diversity, we will be also reflecting on the relationship between technology, experimenting, and biological objects. Depending on the interests of the seminar participants, the examples to be discussed may be chosen from systems biology, molecular or synthetic biology, ecology or else.

Abstract
More often than not, classics are known by hearsay; they are quoted, but not read, or re-discovered and re-read selectively, so we can quote them. That holds true for many ‘classics’ in the history of science, too - texts, that is, which have shaped approaches to, and understandings of, science. The aim of this introductory course is to critically read some of these seminal texts.

Objective
This course is suited for all students with an interest in the history of science and knowledge. Conceived of as an advanced historiographical introduction to the subject, the course is to explore a selection of “classics” in the history of science - some of them well known, others less so. In this course, we shall be as much concerned with the positions and the perspectives on science that were advanced in these various texts as we shall be concerned with the historical circumstances, political meanings and wider cultural contexts of these perspectives.

Abstract
The seminar is dedicated to the texts of scandal author Oskar Panizza. Especially the dogmas and beliefs of the Christian churches caused in this perception the grievances in society. Other the subject regimented categories such as ethnicity and gender are denounced by Panizza and discussed in his writings in many ways.

Objective
- Acquiring cultural scientific aspects and perspectives of literature and literary history: alterity, ethnicity, gender constructions, social differences, religion, etc.
- Critical analysis of recent research positions and research questions
- Training problem oriented circumvention of literature and its social functions in historical contexts
- Developing genre typological and narratological foundations
- Independent balancing and writing of ones own research ideas
681-0301-00L Term Paper History of Technology (HS 2015)  ■  W 5 credits 11A Lecturers

Abstract
Term paper that allows students to explore a topic of their choice in greater depth, applying the fundamental knowledge they have acquired so far.

Objective
Term paper that allows students to explore a topic of their choice in greater depth, applying the fundamental knowledge they have acquired so far.

681-0080-14L Term Paper History of Technology in Late Modernity II  ■  W 5 credits 11A Lecturers

Abstract
History of Technology in Late Modernity II

Objective
Term paper that allows students to explore a topic of their choice in greater depth, applying the fundamental knowledge they have acquired so far.

681-0081-00L Semester Report  ■  O 3 credits 3A Lecturers

Abstract
The report is a critical self-assessment of the students' development during the last semester.

Objective
The report should lead to the competence to judge the relation between curricula design and fostered or prevented learning processes.

681-0088-14L Term Paper in: History of Technology in Late Modernity II  ■  W 5 credits 11A Lecturers

Abstract
History of Technology in Late Modernity II

Objective
Term paper that allows students to explore a topic of their choice in greater depth, applying the fundamental knowledge they have acquired so far.


Abstract
Term paper that allows students to explore a topic of their choice in greater depth, applying the fundamental knowledge they have acquired so far.

Objective
Term paper that allows students to explore a topic of their choice in greater depth, applying the fundamental knowledge they have acquired so far.

681-0093-14L Term Paper in Theoretical Philosophy (HS 2015)  ■  W 5 credits 11A Lecturers

Abstract
This paper is based on the active participation in the actual seminar. It concentrates on one aspect of the seminar's general topic in the history of technology and must develop a sound approach to a well-defined corpus of historic sources.

Objective
Developing a case-specific approach, coping with relevant literature and an enhancing one's competence in the critical evaluation of historic sources are the learning targets of this course.

681-0099-13L Term Paper in Practical Philosophy (HS 2015)  ■  W 5 credits 11A Lecturers

Abstract
This paper is based on the active participation in the actual seminar. It concentrates on one aspect of the seminar's general topic in the history of technology and must develop a sound approach to a well-defined corpus of historic sources.

Objective
Developing a case-specific approach, coping with relevant literature and an enhancing one's competence in the critical evaluation of historic sources are the learning targets of this course.
This paper is based on the active participation in the actual seminar. It concentrates on one aspect of the seminar's general topic in the history of technology and must develop a sound approach to a well-defined corpus of historic sources. Developing a case-specific approach, coping with relevant literature and an enhancing one's competence in the critical evaluation of historic sources are the learning targets of this course.

**Term Paper History of the Modern World (HS 2015)**

- **Number:** 862-0013-13L
- **Type:** W
- **ECTS:** 5 credits
- **Lecturers:** 11A

**Abstract**
This paper is based on the active participation in the actual seminar. It concentrates on one aspect of the seminar's general topic in the history of technology and must develop a sound approach to a well-defined corpus of historic sources.

**Objective**
Developing a case-specific approach, coping with relevant literature and an enhancing one's competence in the critical evaluation of historic sources are the learning targets of this course.

---

### Major Courses

#### Essays

In each subject of the master reading lists are handed out. The books on these lists are the subject of the tutorials one has to attend with the teachers that are named in the Leitfaden. In three subjects essays are to be written about works on these lists.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>862-0021-00L</td>
<td>Essay on Readings in History of Technology (HS)</td>
<td>W</td>
<td>8 credits</td>
<td>17A</td>
<td>Lecturers</td>
</tr>
<tr>
<td>862-0022-00L</td>
<td>Essay on Readings in Science Research (HS)</td>
<td>W</td>
<td>8 credits</td>
<td>17A</td>
<td>Lecturers</td>
</tr>
<tr>
<td>862-0025-00L</td>
<td>Essay on Readings in Theoretical Philosophy (HS)</td>
<td>W</td>
<td>8 credits</td>
<td>17A</td>
<td>Lecturers</td>
</tr>
<tr>
<td>862-0027-00L</td>
<td>Essay on Readings in Practical Philosophy (HS)</td>
<td>W</td>
<td>8 credits</td>
<td>17A</td>
<td>Lecturers</td>
</tr>
<tr>
<td>862-0029-00L</td>
<td>Essay on Readings in Literature and Culture (HS)</td>
<td>W</td>
<td>8 credits</td>
<td>17A</td>
<td>Lecturers</td>
</tr>
<tr>
<td>862-0031-00L</td>
<td>Essay on Readings in the History of the Modern World (HS)</td>
<td>W</td>
<td>8 credits</td>
<td>17A</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

**Abstract**
This essay is the outcome of an individual teaching and learning process during several terms and draws upon representative books and articles in history of technology. It has to consider the state of the art in the field.

**Objective**
Writing this essays intents to become acquainted with methods, tools and concepts relevant for the students master thesis.

---

### Seminars

In the seminars topics from the introductory courses are taught in more detail. Topics for essays are to be arranged with the teachers of the courses.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tbody>
<tr>
<td>862-0041-12L</td>
<td>Advanced Seminar in Science Research (HS 2015)</td>
<td>W</td>
<td>3 credits</td>
<td>6S</td>
<td>Lecturers</td>
</tr>
<tr>
<td>862-0042-12L</td>
<td>Advanced Seminar in Theoretical Philosophy (HS 2015)</td>
<td>W</td>
<td>3 credits</td>
<td>6S</td>
<td>Lecturers</td>
</tr>
<tr>
<td>862-0043-12L</td>
<td>Advanced Seminar in Practical Philosophy (HS 2015)</td>
<td>W</td>
<td>3 credits</td>
<td>6S</td>
<td>Lecturers</td>
</tr>
<tr>
<td>862-0044-12L</td>
<td>Advanced Seminar in Literature and Culture (HS 2015)</td>
<td>W</td>
<td>3 credits</td>
<td>6S</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

**Abstract**
This paper aims at the differentiation of one topic in the current seminar in the history of technology and has to connect its topic with the seminars discussions.

**Objective**
The learning target is the development of a problem oriented differentiation of arguments in the history of technology.
Research Colloquium

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
862-0078-00L | Research Colloquium. Extra-European History and Global History | W | 1 credit | 1K | M. Hagner, P. Sarasin, J. Tanner, K. M. Espahangizi, D. Gugerli

**Abstract**
The forntightly colloquium provides a forum for PhD students and postdoctoral researchers to present and discuss their current work. Half of the slots are reserved for presentations by invited external scholars.

**Objective**
PhD students will have an opportunity to improve their presentation skills and obtain an important chance to receive feedback both from peers and more advanced scholars.

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
862-0075-00L | Master-Colloquium: Research Colloquium for Ph.D. Students and Members of Staff | W | 2 credits | 1K+4A | L. Wingert, M. Hampe

**Abstract**
Personal registration required to Mr. Wingert.

**Objective**
Key problems of research projects will be discussed. Participants will learn to know arguments and ideas dealing with systematic problems in philosophy.

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
862-0088-00L | Research Colloquium Science Studies | W | 1 credit | 1K | M. Hagner

**Abstract**
This colloquium is devoted to the introduction into the theory and practice of scientific work. The schedule can be found on the institute's website - http://www.wiss.ethz.ch/en/teaching/

**Objective**
This colloquium is devoted to the introduction into the theory and practice of scientific work.

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
862-0089-00L | Advanced Colloquium in Literary Studies | W | 1 credit | 1K | A. Kilcher

**Abstract**
The colloquium addresses graduate students. First, it offers participants the opportunity to present their own research projects (work in progress); and, second, it provides a most fruitful space to discuss methodological, theoretical and systematic complex issues.

**Objective**
The colloquium addresses graduate students. First, it offers participants the opportunity to present their own research projects (work in progress); and, second, it provides a most fruitful space to discuss methodological, theoretical and systematic complex issues.

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
851-0551-00L | Colloquium for Master and Ph.D. Students | W | 2 credits | 1K | D. Gugerli

**Objective**
Colloquium for master and doctoral students preparing a thesis in the history of technology.

**Prerequisites / notice**
Goals: to identify, discuss, and resolve methodological problems that emerge while elaborating a master or doctoral thesis.

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---

**Abstract**
The colloquium deals with the general problems, questions and methods of the interdisciplinary research field "The History of Knowledge". Knowledge has become one of the existential conditions of modern societies and it increasingly determines their dynamics. Therefore, it is getting more and more relevant to develop a differentiated analysis of the epistemic, social and cultural constraints of the production, circulation and the decay of knowledge. In addition, the colloquium asks after the cultural and ethical resonances of knowledge not only within science but also in relation to art, literature, technology, everyday life, and so on.

**Prerequisites / notice**
Short notice about program changes are possible and will be communicated through the ZGW newsletter. Please register with www.zgw.ethz.ch/de/newsletter.html

Credit points can be gained by regular attending and by writing an essay. In addition to the five colloquia there will be a deepening seminar on offer (lecturer K. Espahangizi).

Free childcare available.
Philosophical Colloquium (HS 2015)

No fixed schedule. Registrations with Prof. L. Wingert.

Abstract
Ph.D. students, post docs, members of staff, and senior colleagues from other philosophy departments will report on their work in progress. Furthermore, promising new philosophical articles and parts of new philosophical books will be studied.

Objective
Ideas and arguments dealing with systematic problems especially in epistemology, ethics, political philosophy, and the philosophy of mind will be scrutinized and elaborated.

Master Thesis

The work on the master-thesis is supervised by one of the teachers that are allowed to offer tutorials for it, named in the Leitfaden.

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>862-0500-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30</td>
<td>64D</td>
<td>Supervisors</td>
</tr>
</tbody>
</table>

Number

- A student is only permitted to commence the Master thesis if
  a. the Bachelor degree programme has been completed
  b. any additional requirements for admission to the degree programme have been fulfilled
  c. all credits have been acquired in the categories basic courses and major courses and at least 6 credits have been acquired in the category research colloquium

Abstract
The Master's thesis gives a thorough historical, philological or philosophical analysis of a topic related to the experimental or formal sciences or to technology. It incorporates the relevant research literature on this topic as well as first attempts at original research.

Objective
The master thesis gives a thorough historical, philological or philosophical analysis of a topic related to the experimental or formal sciences or to technology. It incorporates the relevant research literature on this topic as well as first attempts at original research.

History and Philosophy of Knowledge Master - Key for Type

| O | Compulsory    | E- | Recommended, not eligible for credits |
| W+| Eligible for credits and recommended | Z | Courses outside the curriculum |
| W | Eligible for credits | Dr | Suitable for doctorate |

Key for Hours

| V | lecture                  | P | practical/laboratory course |
| G | lecture with exercise    | A | independent project |
| U | exercise                 | D | diploma thesis |
| S | seminar                  | R | revision course / private study |
| K | colloquium               |   |                           |

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## First Year Compulsory Subjects

### First Year Examinations

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0185-00L</td>
<td>Fundamentals of Biology IA</td>
<td>O</td>
<td>5</td>
<td>5G</td>
<td>M. Aebi, E. Hafen</td>
</tr>
</tbody>
</table>

**Objective**: The course provides an introduction to the basics of molecular- and cell biology and genetics.

**Abstract**: Introduction to modern biology and to principal biological concepts.

**Content**: The course is divided into several chapters:
1. Basic principles of Evolution.
2. Chemistry of Life: Water; Carbon and molecular diversity; biomolecules
3. The cell: structure; membrane structure and function, cell cycle
4. Metabolism: Respiration; Photosynthesis; Fermentation
5. Inheritance: meiosis and sexual reproduction; Mendelian genetics, chromosomal basis of inheritance, molecular basis of inheritance, from gene to protein, regulation of gene expression; genomes and their evolution

**Lecture notes**

**Literature**
- The text-book “Biology” (Campbell, Reece) (10th edition) is the basis of the course.
- The structure of the course is largely identical with that of the text-book.
- Certain sections of the text-book must be studied by self-instruction.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-1011-00L</td>
<td>General Chemistry (for Biology/Pharmacy/HST)</td>
<td>O</td>
<td>4</td>
<td>4V</td>
<td>W. Uhlig</td>
</tr>
</tbody>
</table>

**Abstract**: The lecture deals with a number of basic chemistry concepts. These include (amongst others) chemical reactions, energy transfer during chemical reactions, properties of ionic and covalent bonds, Lewis structures, properties of solutions, kinetics, thermodynamics, acid-base equilibria, electrochemistry and properties of metal complexes.

**Objective**: The course is designed to provide an understanding of the basic principles and concepts of general and inorganic chemistry.

**Content**: The lecture deals with a number of basic chemistry concepts. These include (amongst others) chemical reactions, energy transfer during chemical reactions, properties of ionic and covalent bonds, Lewis structures, properties of solutions, kinetics, thermodynamics, acid-base equilibria, electrochemistry and properties of metal complexes.

**Literature**

- U. Bernoulli, H. Steiner, *Chemie* (deutsch)
- Housecroft and Constable, *CHEMISTRY* (englisch)
- Oxtoby, Gilis, Nachtrieb, *MODERN CHEMISTRY* (englisch)

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<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-1011-00L</td>
<td>Organic Chemistry I (for students of Biology, Pharmaceutical Sci., and Health Sci. &amp; Tech.)</td>
<td>O</td>
<td>4</td>
<td>4G</td>
<td>C. Thilgen</td>
</tr>
</tbody>
</table>

**Abstract**: Fundamentals of Organic Chemistry; molecular structure. Bonding and functional groups; nomenclature; resonance and aromaticity; stereochemistry; conformation; bond strength; organic acids and bases; basic reaction thermodynamics and kinetics; reactive intermediates: carbanions, carbenium ions and radicals.

**Objective**: Understanding the basic concepts and definitions of organic chemistry. Knowledge of the functional groups and classes of compounds that are important in biological systems. Understanding the relationship between structure and reactivity.


**Lecture notes**

**Literature**

**Supplementary textbooks**:

**Prerequisites / notice**

**401-0291-00L Mathematics I**

**Abstract**: Mathematics I is an introduction to one- and multidimensional calculus and linear algebra emphasizing on applications.

**Objective**: Students understand mathematics as a language for modeling and as a tool for solving practical problems in natural sciences.

Students can analyze models, describe solutions qualitatively or calculate them explicitly if need be. They can solve examples as well as their practical applications manually and using computer algebra systems.
## Eindimensionale diskrete Entwicklungen ##
- linear, exponentiell, begrenzt, logistisch
- Fixpunkte, diskrete Veränderungsraten
- Folgen und Grenzwerte

## Funktionen in einer Variablen ##
- Reproduktion, Fixpunkte,
- Periodizität,
- Stetigkeit

## Differentialrechnung (I) ##
- Veränderungsrate-geschwindigkeit
- Differentialquotient und Ableitungsfunktion
- Anwendungen der Ableitungsfunktion

## Integralrechnung (I) ##
- Stammfunktion
- Integrationstechniken

## Gewöhnliche Differentialgleichungen (I) ##
- Qualitative Beschreibung an Beispielen: Beschränkt, Logistisch, Gompertz
- Stationäre Lösungen
- Lineare DGL 1. Ordnung
- Trennung der Variablen

## Lineare Algebra ##
- Erste Arithmetische Aspekte
- Matrizenrechnung
- Eigenwerte / -vektoren
- Quadratische LGS und Determinante

Lecture notes
In Ergänzung zu den Vorlesungskapiteln der Lehrveranstaltungen fassen wir wichtige Sachverhalte, Formeln und weitere Ausführungen jeweils in einem Vademecum zusammen. Die pdfs finden Sie unter Lernmaterial > Dokumente.

Dabei gilt:
* Die Skripte ersetzen nicht die Vorlesung und/oder die Übungen!
* Ohne den Besuch der Lehrveranstaltungen verlieren die Ausführungen ihren Mehrwert.
* Details entwickeln wir in den Vorlesungen und den Übungen, um die hier bestehenden Lücken zu schliessen.
* Prüfungsrelevant ist, was wir in der Vorlesung und in den Übungen behandeln.

**Th. Wihler**
Mathematik für Naturwissenschaften, 2 Bände: Einführung in die Analysis, Einführung in die Lineare Algebra; Haupt-Verlag Bern, UTB.

**H. H. Storrer**
Einführung in die mathematische Behandlung der Naturwissenschaften I; Birkhäuser. Via ETHZ-Bibliothek: http://link.springer.com/book/10.1007/978-3-0348-8598-0/page/1

**Ch. Blatter**
Lineare Algebra; VDF auch als [pdf](http://www.math.ethz.ch/~blatter/dlp.html)

Prerequisites / notice
## Übungen und Prüfungen ##
+ Die Übungsaufgaben (inkl. Multiple-Choice) sind ein wichtiger Bestandteil der Lehrveranstaltung.
+ Es wird erwartet, dass Sie mindestens 75 % der wöchentlichen Serien bearbeiten und zur Korrektur einreichen.
+ Der Prüfungsstoff ist eine Auswahl von Themen aus Vorlesung und Übungen. Für eine erfolgreiche Prüfung ist die konzentrierte Bearbeitung der Aufgaben unerlässlich.

## Einschreibung in die Übungen ##
Die Einschreibung in die Übungsgruppen erfolgt online. Alle unter http://www.mystudies.ethz.ch/ für die Vorlesung Eingeschriebenen erhalten rechtzeitig per Email einen personalisierten Link zur Einschreibung. Behalten Sie diesen Link.

## Zugang Übungsserien ##
Erfolgt auch online. Alle unter http://www.mystudies.ethz.ch/ für die Vorlesung Eingeschriebenen erhalten rechtzeitig per Email einen 2. personalisierten Link. Behalten Sie auch diesen Link.

252-0852-00L Foundations of Computer Science

O 4 credits 2V+2U J. Hromkovic, H.J. Böckenhauer, M. Dahinden, L. E. Fässler, D. Komm

Abstract
Students learn to apply selected concepts and tools from computer science for working on interdisciplinary projects.

The following topics are covered: modeling and simulations, introduction to programming, visualizing multi-dimensional data, introduction matrices, managing data with lists and tables and with relational databases, universal methods for algorithm design.
Objective
The students learn to
- understand the role of computer science in science,
- to control computer and automate processes of problem solving by programming,
- choose and apply appropriate tools from computer science,
- process and analyze real-world data from their subject of study,
- handle the complexity of real-world data,
- know universal methods for algorithm design.

Content
1. The role of computer science in science
2. Introduction to Programming with Python
3. Modeling and simulations
4. Introduction to Matrices with Matlab
5. Visualizing multidimensional data
6. Data management with lists and tables
7. Data management with a relational database
8. Universal methods for algorithm design

Lecture notes
All materials for the lecture are available at www.gdi.ethz.ch

Prerequisites / notice
This course is based on application-oriented learning. The students spend most of their time working through projects with data from natural science and discussing their results with teaching assistants. To learn the computer science basics there are electronic tutorials available.

376-0003-00L Introduction to Health Sciences and Technology I
ECTS: 4
Credits: 4
Hours: 2V+2U
Title: Introduction to Health Sciences and Technology I
Lecturers: R. Müller

Abstract
Overview on various aspects of health and disease (health models, classification of diseases, prevention and rehabilitation, therapy, epidemiology); introduction to technical aspects (measurement technique, etc.); fundamentals of scientific working (ethics, literature search, study design, data collection, data analysis and data presentation).

Objective
Students should know the terms, models and classification systems used in health and disease; in addition, they should understand the methods of scientific working.

Content
- Health: biomedical model and classification of diseases, salutogenesis and ICF, prevention and rehabilitation, therapy, epidemiology.
- Technology: measurement technology, automatic control engineering.
- Science: ethics, literature search, study design, tests, data analysis, data presentation

First Year Laboratory Courses

Number Title Type ECTS Hours Lecturers
376-0003-01L Demonstration Week Health Sciences and Technology O 1 credit 2P R. Müller, W. Langhans, S. Lorenzetti, R. Riener, M. Ristow, M. E. Schwab, N. Wenderoth, further lecturers

Abstract
Delivery of practical insight into research methods relevant to the field by means of demonstrations and small projects in the areas of Human Movement Science, Health Technologies, Molecular Health Sciences, and Neurosciences.

Second Year Compulsory Subjects

Examination Blocks

Number Title Type ECTS Hours Lecturers

Abstract
The goal of this course is to provide students with a wide general understanding in cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

Objective
The goal of this course is to provide students with a wide general understanding in cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

Content
The focus is animal cells and the development of multicellular organisms with a clear emphasis on the molecular basis of cellular structures and phenomena. The topics include biological membranes, the cytoskeleton, protein sorting, energy metabolism, cell cycle and division, viruses, extracellular matrix, cell signaling, embryonic development and cancer research.

Lecture notes
The lectures are presented in the Powerpoint format. These are available on the WEB for ETH students over the nethz (Moodle). Some lectures are available on the ETH WEB site in a live format (Livestream) at the above WEB site.

Literature

Prerequisites / notice
Some of the lectures are given in the English language. Certain sections of the text-book must be studied by self-instruction.

376-0002-00L Product Design in Medical Engineering O 4 credits 2V+2U S. J. Ferguson

Abstract
This course will provide insight into various aspects of medical device design such as patient needs assessment, product specification, research and technical design, validation, regulatory affairs and clinical evaluation.

Objective
The goal of this lecture series is to enable the students to (i) identify the principal functional requirements for a medical device, (ii) to understand the mechanical properties of natural tissues and synthetic biomaterials, (iii) to apply this information and a basic knowledge of mechanics in the calculation of implant performance, (iv) to develop a plan for the pre-clinical evaluation and regulation of a new device.
Lecture notes
https://moodle-app2.let.ethz.ch/course/view.php?id=180

Examination Block 2

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-0293-00L</td>
<td>Mathematics III</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>E. W. Farkas</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Vertiefung der mehrdimensionalen Analysis mit Schwerpunkt in der Anwendung der partiellen Differentialgleichungen, Vertiefung der Linearen Algebra und Einführung in die Systemanalyse.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>Vertiefung und Ausbau des Stoffes Mathematik I/II für die Anwendung in der Systemanalyse.</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
<td></td>
<td>- Modellbildung</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Lineare Modelle: Vektorräume, Normalformen, Lösungsraum eines Linearen DGL-Systems</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Qualitative Aussagen, Nichtlineare Modelle: Stabilität für eine DGL 1. Ordnung, für allgemeine DGL-Systeme</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Modelle in Raum und Zeit: Partielle DGL, Fourier-Reihe, -Transformation, Laplace-Operator</td>
</tr>
<tr>
<td></td>
<td>Prerequisites / notice</td>
<td></td>
<td></td>
<td></td>
<td>Vorlesungen Mathematik I/II</td>
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</table>

Examination Block 3

<table>
<thead>
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<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-0151-00L</td>
<td>Anatomy I and Physiology I</td>
<td>O</td>
<td>6 credits</td>
<td>4V</td>
<td>M. Ristow, M. Flück, L. Slomianka, C. Spengler, N. Wenderoth, D. P. Wolfer</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Basic knowledge of the anatomy and physiology of tissues, of the embryonal and postnatal development, of the basic terminology of pathology, the neuro-muscular system, the cardiovascular system and the respiratory system.</td>
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<tr>
<td></td>
<td>Objective</td>
<td></td>
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<td></td>
<td>Basic knowledge of human anatomy and physiology and basics of clinical pathophysiology.</td>
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<tr>
<td></td>
<td>Content</td>
<td></td>
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<td></td>
<td>Short overview of human anatomy, physiology and general pathology.</td>
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<tr>
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<td></td>
<td>Anatomy and Physiology I (fall term): Basics of cytology, histology, embryology, general pathology; nervous system, muscles, cardiovascular system, respiratory system</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Anatomy and Physiology II (spring term): digestive system, kidney and urinary tract, endocrine system, skin, thermoregulation, sensory organs, male and female reproductive system, pregnancy and child birth.</td>
</tr>
<tr>
<td></td>
<td>Prerequisites / notice</td>
<td></td>
<td></td>
<td></td>
<td>Voraussetzungen: 1. Jahr, naturwissenschaftlicher Teil</td>
</tr>
</tbody>
</table>

Examination Block 3

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0043-00L</td>
<td>Physics I</td>
<td>O</td>
<td>4 credits</td>
<td>3V+1U</td>
<td>M. R. Meyer</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
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<td>Introduction to the concepts and tools in physics with the help of demonstration experiments: mechanics of point-like and ridged bodies, periodic motion and mechanical waves.</td>
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<tr>
<td></td>
<td>Objective</td>
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<td></td>
<td>The concepts and tools in physics, as well as the methods of an experimental science are taught. The student should learn to identify, communicate and solve physical problems in his/her own field of science.</td>
</tr>
</tbody>
</table>
Advanced knowledge of human anatomy and physiology and of molecular and pathophysiological aspects of different organ systems.

Movement and Sport Biomechanics

To understand the mechanisms governing disease development with a special emphasis on genetic and ageing associated components.

W. Movement- and sports biomechanics deals with the attributes of the human body and their link to mechanics. The course includes topics such as functional anatomy, biomechanics of daily activities (gait, running, etc.) and looks at movement in sport from a mechanical point of view. Furthermore, simple reflections on the loading analysis of joints in various situations are discussed. Additionally, questions covering the statics and dynamics of rigid bodies, and inverse dynamics, relevant biomechanics are investigated.

Third Year Focus Courses

Focus Courses: Human Movement Science and Sport

Number Title Type ECTS Hours Lecturers
376-0007-00L Advanced Anatomy and Physiology I Only for Health Sciences and Technology BSc. O 2 credits 2V K. De Bock, N. Wenderoth, D. P. Wolfer

Objective
Advanced knowledge of anatomy and physiology and of molecular and pathophysiological aspects.

Content
Advanced Anatomy and Physiology I (fall term):
Closer look to the nervous system,
Advanced Anatomy and Physiology II (spring term):
Introduction to Molecular Biology; Closer look to muscles, cardiovascular system, and respiratory system as well as immunology.

Focus Courses: Molecular Health Sciences

Number Title Type ECTS Hours Lecturers
376-0203-00L Movement and Sport Biomechanics W 4 credits 3G B. Taylor, R. List, S. Lorenzetti

Objective
Learning to view the human body as a (bio-) mechanical system. Making the connections between everyday movements and sports activity with injury, discomfort, prevention and rehabilitation.

Content
Students are able to describe the human body as a mechanical system.

Focus Courses: Medical Technology

Number Title Type ECTS Hours Lecturers
376-0021-00L Introduction to Biomedical Engineering I W 4 credits 3G R. Müller, P. Christen, J. G. Snedeker, M. Zenobi-Wong

Abstract
Introduction to biomechanics, biomaterials, tissue engineering, medical imaging as well as the history of biomedical engineering.

Objective
Understanding of physical and technical principles in biomechanics, biomaterials, tissue engineering, medical imaging as well as the history of biomedical engineering. Mathematical description and problem solving. Knowledge of biomedical engineering applications in research and clinical practice.
Content
Tissue and Cellular Biomechanics, Molecular Biomechanics and Biopolymers, Computational Biomechanics, Biomaterials, Tissue Engineering, Radiation and Radiographic Imaging, Diagnostic Ultrasound Imaging, Magnetic Resonance Imaging, Biomedical Optics and Lasers.

Lecture notes
Stored on ILIAS.

Literature

376-1714-00L Biocompatible Materials W 4 credits 3G K. Manura, J. Möller, M. Zenobi-Wong

Abstract
Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

Objective
The class consists of three parts:
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

Content
Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

Lecture notes
Handouts can be accessed online.

Literature
(available online via ETH library)

Handouts provided during the classes and references therein.

227-0385-10L Biomedical Imaging W 6 credits 5G S. Kozerke, U. Moser, K. P. Prüssmann, M. Rudin

Abstract
Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.

Objective
To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

Content
- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

Lecture notes
Lecture notes and handouts

Literature
Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011
Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

Prerequisites / notice
None. Bring something to write and your student ID

Focus Courses: Neurosciences

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>376-1305-00L</td>
<td>Development of the Nervous System</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>E. Stoeckli, further lecturers</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course covers the development of the nervous system (NS) with a focus on neurogenesis and migration, axon growth, synapse formation, mol. &amp; cell. mechanisms, and diseases of the developing NS.</td>
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<tr>
<td>Objective</td>
<td>The aim is to give a deepened insight on the normal development, of the nervous system based on molecular, cellular and biochemical approaches.</td>
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<tr>
<td>Content</td>
<td>The main focus is on the development of the NS: Early development of the NS, cellular processes, nerve fiber growth, building of synapses and neuronal networks.</td>
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<tr>
<td>Lecture notes</td>
<td>Must be downloaded from OLAT: <a href="https://www.olat.uzh.ch/olat/dmz/">https://www.olat.uzh.ch/olat/dmz/</a> 301C344</td>
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<tr>
<td>Literature</td>
<td>The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on OLAT.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Auxiliary tools: None. Bring something to write and your student ID</td>
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<th>ECTS</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>376-1305-01L</td>
<td>Structure, Plasticity and Repair of the Nervous System</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>M. E. Schwab, L. Filli, K. A. Martin, further lecturers</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course covers the structure, plasticity and regeneration of the adult nervous system (NS) with focus on: sensory systems, cognitive functions, learning and memory, molecular and cellular mechanisms, animal models, and diseases of the NS.</td>
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<tr>
<td>Objective</td>
<td>The aim is to give a deepened insight into the structure, plasticity and regeneration of the nervous system based on molecular, cellular and biochemical approaches.</td>
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<tr>
<td>Content</td>
<td>The main focus is on the structure, plasticity and regeneration of the NS: biology of the adult nervous system; structural plasticity of the adult nervous system, regeneration and repair: networks and nerve fibers, regeneration, pathological loss of cells.</td>
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<tr>
<td>Lecture notes</td>
<td>ETH students: Lecture notes will be provided on Moodle <a href="https://moodle-app2.let.ethz.ch/course/view.php?id=694">https://moodle-app2.let.ethz.ch/course/view.php?id=694</a> Password will be provided at the beginning of the lecture.</td>
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<tr>
<td></td>
<td>UZH students: Lecture notes will be provided on OLAT: <a href="https://www.olat.uzh.ch/olat/dmz/">https://www.olat.uzh.ch/olat/dmz/</a></td>
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</tbody>
</table>
Introduction to transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

### Prerequisites / notice

- Applications of biomedical microrobots
- Materials and fabrication methods
- Observation tools
- Low Reynolds number flows
- Electrostatics

### Literature


The course requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on Moodle / OLAT.

Repetitionsprüfung 15. Juni 2016, HG E 26.1, 9-10.30h

## Electives

### 151-0255-00L
#### Energy Conversion and Transport in Biosystems

**Abstract**
Theory and application of thermodynamics and energy conversion in biological systems and biomedicine at the macro scale and the cellular level.

**Objective**
Theory and application of energy conversion at the macro scale and the cellular level. Understanding of the basic features governing fluid transport in the principal systems of the human cell. Connection of characteristics and patterns from other fields of engineering to biofluidics. Heat and mass transport processes within the human body and relation to biomedical technologies.

**Content**
Mass transfer models for the transport of chemical species in the human cell. Organization and function of the cell membrane and of the cell cytoskeleton. The role of molecular motors in cellular force generation and their function in cell migration. Description of the functionality of these systems and of analytical experimental and computational techniques for understanding of their operation. Introduction to bioengineering approaches for the treatment of common pathogenic conditions of these systems. Introduction to cell metabolism, cellular energy transport and cellular thermodynamics.

**Lecture notes**
Script as well as additional material in the form of hand-outs will be distributed.

**Literature**
Lecture notes and references therein.

### 151-0575-01L
#### Signals and Systems

**Abstract**
Signals arise in most engineering applications. They contain information about the behavior of physical systems. Systems respond to signals and produce other signals. In this course, we explore how signals can be represented and manipulated, and their effects on systems. We further explore how we can discover basic system properties by exciting a system with various types of signals.

**Objective**
Master the basics of signals and systems. Apply this knowledge to problems in the homework assignments and programming exercises.

**Content**

**Lecture notes**
Lecture notes available on course website.

### 151-0604-00L
#### Microrobotics

**Abstract**
Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.

**Objective**
The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.

**Content**
Main topics of the course include:
- Scaling laws at micro/nano scales
- Electrostatics
- Electromagnetism
- Low Reynolds number flows
- Observation tools
- Materials and fabrication methods
- Applications of biomedical microrobots

**Lecture notes**
The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

### 151-0917-00L
#### Mass Transfer

**Abstract**
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

**Objective**
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

**Content**
Fick's laws; application and significance of mass transfer; comparison of Fick's laws with Newton's and Fourier's laws; derivation of Fick's 2nd law; diffusion in dilute and concentrated solutions; rotating disk; dispersion; diffusion coefficients, viscosity and heat conduction (Pr and Sc numbers); Brownian motion; Stokes-Einstein equation; mass transfer coefficients (Nu and Sh numbers); mass transfer across interfaces; Reynolds- and Chilton-Colburn analogies for mass-, heat-, and momentum transfer in turbulent flows; film-, penetration-, and surface renewal theories; simultaneous mass, heat and momentum transfer (boundary layers); homogenous and heterogenous reversible and irreversible reactions; diffusion-controlled reactions; mass transfer and first order heterogenous reaction. Applications.

### Literature


The lecture will be taught in English.

### Prerequisites / notice

- Three tests are offered for practicing the course material. Participation is voluntary.

### 227-0045-00L
#### Signals and Systems I

**Abstract**

**Objective**
Introduction to mathematical signal processing and system theory.

**Content**

**Lecture notes**
Lecture notes, problem set with solutions.

### 327-0103-00L
#### Introduction to Materials Science

**Abstract**
Fundamental knowledge and understanding of the atomistic and macroscopic concepts of material science.

**Objective**
Basic concepts in materials science.

### Data: 06.02.2019 13:00

Autumn Semester 2015

Page 688 of 1434
Abstract
Conduct physical performance tests and measurements that are typically used to assess performance of athletes and/or patients and that deepen the understanding of physiological processes in response to physical exertion.

Objective
Gain hands-on experience in exercise physiology and consolidate knowledge on physiological adaptations to different types and degrees of physical activity and climatic influences. Learn fundamental assessment techniques of the muscular system, the cardio-respiratory system and of whole-body performance, learn scientifically correct data analysis and interpretation of results. Insight into today’s Sports Medicine.

Content
Various exercise tests assessing human performance and assessments of physiological responses to activity (examples are VO2max-test, Conconi-Tests, Determination of anaerobic threshold, Cooper-Test, 1-repetition maximum test, lactate minimum test), dynamometry, mechanography, body composition etc.). Insight into measurements in Sports Medicine.

Lecture notes
Tutorial on Laboratory Experiments in Exercise Physiology
(Edited: Exercise Physiology Lab)

Literature
Schmidt/Lang/Heckmann: Physiologie des Menschen, Springer-Verlag, Heidelberg
Kenney/Wilmore/Costill: Physiology of Sport and Exercise, Human Kinetics

Prerequisites / notice
Prerequisite: An anatomy and physiology classes and lab course in physiology successfully completed (BWS students please contact C. M. Spengler)
Desirable: Exercise Physiology Lecture (concomitantly or passed; is selection criterion in case of more applications than lab spaces)
Content
- Perception of the own posture
- Analysis of the own posture
- Status of the posture standing
- Own training program
- Neutral liability on the
- Back injuries - healthy back
Tension / Stability
- Tone regulation
- sensomotor activity (treats the capacity to feel the own movements, transfer from theory into practice of programming and modifying neuromotoric movements)
- Torso stability 1, 2
Relaxation:
Work-life - Balance
Mental training
Ideas for relaxation (also for kids)
Stress regulation
Massage (introduction in Massage techniques)

376-1117-00L Sport Psychology W 2 credits 2V H. Gubelmann
Abstract
This lecture is intended as an introduction to sport psychology and imparts knowledge on selected areas of the subject.
Objective
Students are given insight into different work areas of sport psychology. In order to understand what «sport psychology» is, it is necessary to explain the essence and tasks of sport psychology and what it relates to, and to work out an underlying basis for key topics, such as cognition and emotions. Students' expertise is furthered by presenting and providing more in-depth treatment of additional topics of sport psychology. Selected intervention forms are intended to provide insight into applied sport psychology and ensure that mental processes and their impact in sport can be recognised. Case studies and practical exercises (e.g. objective training) are intended to prompt students to reflect to a greater extent on the forms in which sport psychology can be applied in their practice of sports and to integrate these in their teaching.

376-1127-00L Sociology of Sport W 2 credits 2V M. Lamprecht
Abstract
These lectures deal with the current changes in society and sport and provide an overview of the many different problems and perspectives of sport sociology.
Objective
The lectures set out to:
- present the different dimensions, functions and interrelationships of present-day sport
- provide an introduction to the central theories and models of (sport) sociology
- show how far sport reflects society and how it changes and becomes more differentiated in the process
- take current examples from newspapers, magazines and television to highlight the sociological view of sport.

376-1155-00L The Musculoskeletal System and Work W 3 credits 2V T. Läubli
Abstract
Consolidated findings of movement sciences concerning deterioration, overload and regeneration of the musculoskeletal system are an important basis for an ergonomic working environment. The following topics are covered: Muscle fatigue during the 8-hour day, use of the computer mouse, backaches, Tendinitis, nerve compression, epidemiology, prevention, rehabilitation, laws, measuring procedures.
Objective
Goal of the course is the activation of physiological and patho-physiological insights for the understanding of loads of the musculoskeletal system during work. Prevention and rehabilitation of work related musculoskeletal disease will be discussed with the help of a bio-computer mouse, backaches, Tendinitis, nerve compression, epidemiology, prevention, rehabilitation, laws, measuring procedures.

376-1581-00L Cancer: Fundamentals, Origin and Therapy W 2 credits 2G H. Nägelli
Abstract
Objective
Students are able to describe selected chemicals, biological and molecular processes that occur in cells spontaneously or after physical or chemical exposure and resulting in a tumor. They are able to list important cancer-inducing agents and explain the respective mechanism of action. They have knowledge of significant risk factors for cancer diseases. They are confronted with the basics of toxicology and they can explain the principle of the most common therapeutic strategies.
The lecture deals with problems of tumor epidemiology (causes, mortality, incidence). Cancer is delineated as a multi-step process. Classes of chemical compounds that induce cancer are discussed as well as the reactive metabolites that may be built from. Covalent binding to DNA is discussed and different types of mutations resulting thereof. A selection of proto-oncogenes and tumor suppressor genes is presented. Their function will be discussed as well as the changes which are found in these genes in tumor cells, starting from single nucleotide exchanges up to large deletions. The reason for genetic predisposition to cancer will be discussed as well as cancer relevant aspects of cell cycle regulation. Phenomenons like angiogenesis and metastasis are presented as well as the mechanisms that protect the genome from mutagenic damage. Further subjects address old and new strategies of cancer treatment. Personalised cancer treatment.

Additional informations are given during the lecture.

Lecture: Training and Coaching I
Author: W. Buholzer
Credits: 3
Note: Handouts with reproductions of all presented transparencies will be distributed.
Abstract: The combining of training and coaching as in the example of sport analysis, which has an effect on youth training and athlete development wird vor Semesterbeginn elektronisch zur Verfügung gestellt.

Lecture: Basics of Exercise Therapy
Author: K. Marschall
Credits: 2
Note: The lecture requires an active participation of the students. All students will participate in individual or group work focussing on specific subject of the lecture. Students will have ample time for preparation during lecture time.
Abstract: Students learn the assessments to plan an exercise-therapy-treatment. Classes of chemical compounds that induce cancer are discussed as well as the reactive metabolites that may be built from. Covalent binding to DNA is discussed and different types of mutations resulting thereof. A selection of proto-oncogenes and tumor suppressor genes is presented. Their function will be discussed as well as the changes which are found in these genes in tumor cells, starting from single nucleotide exchanges up to large deletions. The reason for genetic predisposition to cancer will be discussed as well as cancer relevant aspects of cell cycle regulation. Phenomenons like angiogenesis and metastasis are presented as well as the mechanisms that protect the genome from mutagenic damage. Further subjects address old and new strategies of cancer treatment. Personalised cancer treatment.

Possible from the 5th semester on.
Requirement: "Introduction of Exercise Therapy" passed.

Students learn the assessments to plan an exercise-therapy-treatment. They are able to use them. They're able to integrate biological and medical basics. They are able to prepare a therapy-session. Students learn the assessments to plan an exercise-therapy-treatment.
### Practical Basics in Sports and Exercise Therapy

**W 2 credits 2V**  
B. Spörri Kälín, B. S. Wirth Gasser  

**Abstract**  
Possible from the 5th semester on.  
Requirement: "Introduction of Exercise Therapy" passed.  

**Objective**  
Impart knowledge of practical basics of Sports and Exercise Therapy  

**Content**  
Communication/conversation with patients  
Psychoregulation: relaxation  
Anatomy in vivo  

**Lecture notes**  
Skript will be on lehr-platform  

**Prerequisites / notice**  
The courses "Introduction in Sports and Exercise Therapy" and has been completed successfully.

### Spinal Cord Injury and Exercise

**W 2 credits 2V**  
C. Perret  

**Abstract**  
Intensive discussion concerning complications of a spinal cord injury and their consequences on trainability and exercise performance of persons sitting in a wheelchair. Overview on the clinical application of exercise testing as well as on the implementation of sport scientific findings to optimise performance of spinal cord injured subjects in rehabilitation and elite sports.  

**Objective**  
Knowledge of the pathophysiology and the concomitant complications of a spinal cord injury and the consequences for physical exercise and trainability during rehabilitation as well as in recreational and elite sport.  

**Content**  
The following issues will be discussed: Epidemiology and etiology of spinal cord injury; complications and consequences of spinal cord injury; trainability/exercise physiology and spinal cord injury; history and organisation of wheelchair sports; elite sport and spinal cord injury  

**Literature**  
General literature:  
G.A. Zäch, H. G. Koch  
Paraplegie - ganzheitliche Rehabilitation  
Karger-Verlag, 2006  
ISBN 3-8055-7980-2  

V. Goosen-Tolfrey  
Wheelchair sport: A complete guide for athletes, coaches and teachers  
Human Kinetics, 2010  

Y.C. Varlandewijck, W.R. Thompson  
The Paralympic Athlete  
Wiley-Blackwell, 2011  
ISBN 978-1-4443-3404-3  

Liz Broad  
Sports Nutrition for Paralympic Athletes  
CRC Press 2014  

**Prerequisites / notice**  
Voraussetzung: Vorlesung Anatomie/Physiologie besucht!

### Nucleic Acids and Carbohydrates

**W 6 credits 3G**  
D. Hilvert, P. A. Kast, S. J. Sturla, H. Wennemers  

**Abstract**  
Structure, function and chemistry of nucleic acids and carbohydrates, DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymers and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines  

**Objective**  
Structure, function and chemistry of nucleic acids and carbohydrates, DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymers and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccines  

**Content**  
Structure, function and chemistry of nucleic acids and carbohydrates, DNA/RNA structure and synthesis; recombinant DNA technology and PCR; DNA arrays and genomics; antisense approach and RNAi; polymers and transcription factors; catalytic RNA; DNA damage and repair; carbohydrate structure and synthesis; carbohydrate arrays; cell surface engineering; carbohydrate vaccine  

**Lecture notes**  
No script  

**Literature**  
Mainly based on recent original literature, a detailed list will be distributed during the first lecture

### Physical Chemistry I (for Biology and Pharmacy)

**W 3 credits 2V+1U**  
R. Riek, H. P. Lüthi  

**Abstract**  

**Objective**  
Understanding the fundamental thermonomical properties of chemical and biological systems.  

**Content**  

**Lecture notes**  
In process, will be distributed at the beginning of the first lecture  

**Literature**  

**Prerequisites / notice**  
Prerequisite: mathematics I-II, functions of multiple variables, partial derivatives.

### Medicinal Chemistry I

**W 2 credits 2V**  
J. Hall  

**Abstract**  
The lectures give an overview of selected drugs and the molecular mechanisms underlying their therapeutic effects in disease. The historical and modern-day methods by which these drugs were discovered and developed are described. Structure-function relationships and the biophysical rules underlying ligand-target interactions will be discussed and illustrated with examples.  

**Objective**  
Basic understanding of therapeutic agents with respect to molecular, pharmacological and pharmaceutical properties.  

**Content**  
Molecular mechanisms of action of drugs. Structure function and biophysical basis of ligand-target interactions  

**Lecture notes**  
Will be provided in parts before each individual lecture.
Topics include disease-relevant macroscopic, microscopic, pathobiochemical and functional disturbances of specific organs and organ systems. Principles and technologies for the manufacturing of dosage forms and drug delivery systems. Knowledge of pharmaceutics, excipients, materials, containers, liquid and semi-solid dosage forms, their production, function, quality and application. Comprehension of molecular interactions in solution and colloidal systems. Comprehension of interfacial phenomena and stabilization measures in dosage forms.

The lectures will provide a comprehensive survey of pharmacology and toxicology. Special emphasis is placed on the interrelationship between pharmacological, pathophysiological and clinical aspects.

Lectures will provide a detailed understanding of the fundamentals of drug action and the mechanisms of action and therapeutic use of the important classes of drugs. The lectures are intended for students of pharmaceutical sciences.

Requirements: Knowledge of physical and organic chemistry, biochemistry and biology.

Attendance of Medicinal Chemistry II in the spring semester.

Literature

Prerequisites / notice

535-0421-00L  Galenical Pharmacy I  W  2 credits  2G  J.C. Leroux, B. A. Gander

Abstract
Principles and technologies for the manufacturing of dosage forms and drug delivery systems. Knowledge of pharmaceutics, excipients, materials, containers, liquid and semi-solid dosage forms, their production, function, quality and application. Comprehension of molecular interactions in solution and colloidal systems. Comprehension of interfacial phenomena and stabilization measures in dosage forms.

Objective
Knowledge of the most important pharmaceutical excipients, materials, containers, liquid and semi-solid dosage forms, of their production, function, quality, stability and application. Comprehension of the molecular interactions in solution and colloidal systems. Comprehension of interfacial phenomena and stabilization measures in dispersion dosage forms.

Content
Introduction and overview of important fundamentals, principles and technologies for the development and manufacturing of dosage forms and drug delivery systems. Overview of the most important pharmaceutical excipients and polymers, their structure, properties and processing; importance of materials properties for containers. Pharmaceutical solvents, fundamentals of solubility and solubilization of drugs. Water treatment processes, sterilization techniques and quality requirements of pharmaceutical water. Parenteral dosage forms and liquid opthalmics. Surfactants, micelle formation and colloidal systems. Liquid suspensions and emulsions. Stabilization measures in dosage forms.

Literature
C.-D. Herzelfeldt und J. Kreuter (Hrsg.) Grundlagen der Arzneiformenlehre, Springer Verlag, Berlin 1999

H. Leuenberger (Hrsg.) Martin - Physikalische Pharmazie, Wissenschaftliche Verlagsgesellschaft, Stuttgart 2002


R. Voigt, Pharmazeutische Technologie, 10. Auflage, Deutscher Apotheker Verlag, Stuttgart, 2006


Prerequisites / notice

Language: German and English

535-0521-00L  Pharmacology and Toxicology I  W  2 credits  2V  U. Quitterer

Abstract
The two-semester lecture course will provide a detailed understanding of the fundamentals of drug action and the mechanisms of action and therapeutic use of the important classes of drugs. The lectures are intended for students of pharmaceutical sciences.

Objective
The lectures will provide a comprehensive survey of pharmacology and toxicology. Special emphasis is placed on the interrelationship between pharmacological, pathophysiological and clinical aspects.

Content
Topics include disease-relevant macroscopic, microscopic, pathobiochemical and functional disturbances of specific organs and organ systems. The lectures integrate disease pathway with mechanisms of drug action, usage, metabolism, pharmacokinetics, side effects, toxicity, contraindications and dosage of relevant drug classes. Basic principles of clinical pharmacology and pharmacotherapy will be covered.

Lecture notes
Für jede Vorlesung wird ein Skript abgegeben, das eine Zusammenfassung mit den wichtigsten Stichpunkten beinhaltet.

Literature
Recommended reading:
- or

Comprehensive overview:

English version

The classic textbook in Pharmacology:

Prerequisites / notice

Voraussetzungen: Abschluss Grundstudium
Abstract
The aim of the lecture course is to provide a solid overview of the science and issues in gene technology and genome science.

Topics: Antibody phage technology, protein modification technology, genome projects, genome sequencing, transcriptomics, proteomics and SNP technology. This course is suited for advanced undergraduate and early graduate students in pharmaceutical sciences or related fields.

Objective
The course will provide a solid overview of the science and issues in gene technology and genome science.

Content
1. Antibody phage technology
   - The antibody molecule
   - V genes, CDRs, basics of antibody engineering
   - Principles of phage display
   - Phagemid and phage vectors
   - Antibody libraries
   - Phage display selection methodologies
   - Other phage libraries (peptides, globular proteins, enzymes)
   - Alternative screening/selection methodologies
   - DNA-encoded chemical libraries

2. Proteins: chemical modification and detection of biomolecular interactions
   - Homo- and hetero-dimerization of proteins
   - Chemical modifications of proteins
   - Radioactive labeling of proteins
   - Kinetic association and dissociation constants
   - Affinity constant: definition and its experimental measurement

3. Genomics: Applications to Human Biology
   - Protein cloning and expression
   - Functional Genomics
   - Sequencing genomes and novel sequencing methods
   - Genetic disorders: discovery and pharmaceutical implications
   - Transcriptomics
   - Proteomics
   - Principles of Cancer
   - Principles of Vaccine Development
   - Principles of Gene Therapy

4. Pharmaceuticals: Focus on Discovery
   - Chemical Libraries
   - Protein Therapeutics
   - Consideration on pharmacokinetics and half-life extension

Lecture notes
Skript "Gene Technology" by Prof. Dario Neri

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535-0810-00L Gene Technology W 2 credits 2G D. Neri

---

535-0830-00L Pharmaceutical Immunology W 2 credits 2G D. Neri, C. Halin Winter

---

551-0309-00L Concepts in Modern Genetics W 6 credits 4V Y. Barral, D. Bopp, A. Hajnal, O. Voinnet

---

551-0317-00L Immunology I W 3 credits 2V A. Oxenius, M. Kopf

---

551-0319-00L Cellular Biochemistry (Part I) W 3 credits 2V U. Kutay, C. M. Azzalin,
Bioinformatics I will cover the following topics:

Methods of Biological Analysis

Methods of Biological Analysis

W 3 credits 3G

R. Aebersold, M. Badertscher, K. Weis

Prerequisites / notice
To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

Abstract
Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

Objective
The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry.

The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

Content
Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.

Prerequisites / notice
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Abstract
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R. Aebersold, M. Badertscher, K. Weis

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Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.

Prerequisites / notice
To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.
Some of the lectures are given in the English language.

### Fundamentals of Biology II: Biochemistry and Molecular Biology

**W 4 credits 4V**  
K. Locher, N. Ban, R. Glockshuber, E. Weber-Ban  

**Abstract**  
The course provides an introduction to Biochemistry / Molecular Biology with some emphasis on chemical and biophysical aspects.

**Objective**  
Topics include the structure-function relationship of proteins / nucleic acids, protein folding, enzymatic catalysis, cellular pathways involved in bioenergetics and the biosynthesis and breakdown of amino acids, glycans, nucleotides, fatty acids and phospholipids, and steroids. There will also be a discussion of DNA replication and repair, transcription, and translation.

**Lecture notes / Literature**  
none  

### Consumer Behaviour I

**W 2 credits 2V**  
M. Siegrist, C. Keller, B. S. Sütterlin  

**Abstract**  
Introduction in consumer research. The following aspects will be emphasized in the course: Consumer decision making, individual determinants of consumer behavior, environmental influences on consumer behavior, influencing consumer behavior.

**Objective**  
Introduction in consumer research. The following aspects will be emphasized in the course: Consumer decision making, individual determinants of consumer behavior, environmental influences on consumer behavior, influencing consumer behavior.

### Food Microbiology I

**W 3 credits 2V**  
M. Loesner  

**Abstract**  
This lecture is the first part of a one-year course. It offers insights into the fundamentals and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts and molds present in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms.

**Objective**  
The lecture offers insights into the basics, practical consequences and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts, molds and protozoa in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms. The focus of this first part of the lecture will be on the organisms, but also on the factors which determine spoilage and foodborne disease.

**Content**
1. History of Food Microbiology  
1.1. Short synopsis of foodborne microorganisms  
1.2. Spoilage of Foods  
1.3. Foodborne Disease  
1.4. Food Preservation  
1.5. VIP's of Food Microbiology  
2. Overview of Microorganisms in Foods  
2.1 Origin of foodborne Microorganisms  
2.2. Bacteria  
2.3. Yeasts  
2.4. Molds  
3. Microbial Spoilage of Foods  
3.1. Intrinsic and Extrinsic Parameters  
3.2. Meats, Seafoods, Eggs  
3.3. Milk and Milk Products  
3.4. Vegetable and Fruit Products  
3.5. Miscellaneous (baked goods, nuts, spices, ready-to-eat products)  
3.6. Drinks and Canned Foods  
4. Foodborne Disease  
4.1. Significance and Transmission of Foodborne pathogens  
4.2. Staphylococcus aureus  
4.3. Gram-positive Sporeformers (Bacillus & Clostridium)  
4.4. Listeria monocytogenes  
4.5. Salmonella, Shigella, Escherichia coli  
4.6. Vibrio, Yersinia, Campylobacter  
4.7. Brucella, Mycobacterium, Aeromonas, Plesiomonas  
4.8. Parasites  
4.9. Viruses and Bacteriophages  
4.10. Mycotoxins  
4.11. Bioactive Amines  
4.12. Miscellaneous (Antibiotic-resistant Bacteria, Biofilms)  

**Lecture notes / Literature**  
Electronic copies of the presentation slides (PDF) will be made available for download.

### Introduction to Nutritional Science

**W 3 credits 2V**  
M. B. Zimmermann, C. Wolfrum  

**Abstract**  
This course introduces basic concepts of micro- and macronutrient nutrition. Macronutrients studied include fat-soluble and water-soluble vitamins, minerals and trace elements. Macronutrients include proteins, fat and carbohydrates. Special attention is given to nutrient digestion, bioavailability, metabolism and excretion with some focus on energy metabolism.

**Objective**  
To introduce the students to the both macro- and micronutrients in relation to food and metabolism.

**Content**  
The course is divided into two parts. The lectures on micronutrients are given by Prof. Zimmermann and the lectures on macronutrients are given by Prof. Wolfrum. Prof. Zimmermann discusses the micronutrients, including fat-soluble vitamins, water-soluble vitamins, minerals and trace elements. Prof. Wolfrum introduces basic nutritional aspects of proteins, fats, carbohydrates and energy metabolism. The nutrients are described in relation to digestion, absorption and metabolism. Special aspects of homeostasis and homeorhesis are emphasized.

**Lecture notes / Literature**  
There is no script. Powerpoint presentations will be made available.

### Selected Topics in Physiology Related to Nutrition

**W 3 credits 2V**  
W. Langhans  

**Abstract**  
Gives the students background knowledge necessary for a basic understanding of the complex relationships between food composition and nutrition on one hand and the functioning, as well as the malfunctioning, of major organ systems on the other hand.
Objective
Some basic knowledge in physiology is recommended for this course, which revisits important physiological topics, emphasizing their relation to nutrition. The aim is to give the students background knowledge necessary for a basic understanding of the complex relationships between food composition and nutrition on one hand and the functioning, as well as the malfunctioning, of major organ systems on the other hand. For students with a background in medicine, pharmacy or biology, the course is useful as a review of previously acquired knowledge. Major topics are basic neuroanatomy and neurophysiology; general endocrinology; the physiology of taste and smell; nutrient digestion and absorption; intermediary metabolism and energy homeostasis; and some aspects of cardiovascular physiology and water balance.

752-6403-00L Nutrition and Performance

<table>
<thead>
<tr>
<th>Objective</th>
<th>To understand the potential effects of nutrition on exercise performance, with a focus on concepts and principles of nutrition before, during and after exercise.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content</td>
<td>The course will cover elementary aspects of sports nutrition physiology, including carbohydrate, glycogen, fat, protein and energy metabolism. A main focus will be to understand nutritional aspects before exercise to be prepared for intensive exercise bouts, how exercise performance can be supported by nutrition during exercise and how recovery can be assisted by nutrition after exercise. Although this is a scientific course, it is a goal of the course to translate basic sports nutrition science into practical sports nutrition examples.</td>
</tr>
<tr>
<td>Lecture notes</td>
<td>Lecture slides and required handouts will be available on the ETH website.</td>
</tr>
<tr>
<td>Literature</td>
<td>Information on further reading will be announced during the lecture. There will be some mandatory as well as voluntary readings.</td>
</tr>
</tbody>
</table>

Abstract
The course introduces basic concepts of the interaction between nutrition and exercise and cognitive performance.

Objective
To understand the potential effects of nutrition on exercise performance, with a focus on concepts and principles of nutrition before, during and after exercise.

Content
The course will cover elementary aspects of sports nutrition physiology, including carbohydrate, glycogen, fat, protein and energy metabolism. A main focus will be to understand nutritional aspects before exercise to be prepared for intensive exercise bouts, how exercise performance can be supported by nutrition during exercise and how recovery can be assisted by nutrition after exercise. Although this is a scientific course, it is a goal of the course to translate basic sports nutrition science into practical sports nutrition examples.

Lecture notes
Lecture slides and required handouts will be available on the ETH website.

Literature
Information on further reading will be announced during the lecture. There will be some mandatory as well as voluntary readings.

Prerequisites / notice
General knowledge about nutrition, human biology, physiology and biochemistry is a prerequisite for this course. The course builds on basic nutrition and biochemistry knowledge to address exercise and performance related aspects of nutrition.

The course is designed for 3rd year Bachelor students, Master students and postgraduate students (MAS/CAS).

Language: English
It is strongly recommended to attend the lectures. The lecture (including the handouts) is not designed for distance education.

853-0033-00L Leadership I

| Objective | The aim of this lecture is to give students an introductory overview of relevant topics regarding leadership research and practice, thus enabling them to gain a deeper understanding of the leadership phenomenon. Students should understand different concepts of leadership in the complex interaction between individuals, groups, organisation, context and situation. They should be informed about the evolution of the understanding of mankind in relation to working processes and its impact on organizations and the understanding of leadership theory in the past 100 years. They should grasp the concept of leadership responsibility (leadership ethics) and be able to derive consequences for leadership in practical situations. They should recognize the fundamental importance of communication in leadership situations and receive input which enables them to communicate adequately in specific situations. |
| Prerequisites / notice | The 1-hour written exam will take place during the last lecture in the semester. |

Abstract
The lectures "Leadership I" (WS) and "Leadership II" (SS) have been designed as a two-semester lecture series, but may also be followed independently of one another or in reverse order. "Leadership I" covers the following fields: leadership basics, leadership theories and leadership styles, the concept of leadership responsibility and the role of communication in practical leadership.

Objective
The aim of this lecture is to give students an introductory overview of relevant topics regarding leadership research and practice, thus enabling them to gain a deeper understanding of the leadership phenomenon. Students should understand different concepts of leadership in the complex interaction between individuals, groups, organisation, context and situation. They should be informed about the evolution of the understanding of mankind in relation to working processes and its impact on organizations and the understanding of leadership theory in the past 100 years. They should grasp the concept of leadership responsibility (leadership ethics) and be able to derive consequences for leadership in practical situations. They should recognize the fundamental importance of communication in leadership situations and receive input which enables them to communicate adequately in specific situations.

Prerequisites / notice
The 1-hour written exam will take place during the last lecture in the semester.

Compulsory Electives in Humanities, Social and Political Sciences
Recommended GESS compulsory elective courses (Type B) for D-HEST.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses
ETH/UZH

Sport Practical
Assessments
Sport Practical Basic Education
Sport Practical Advanced Education

Health Sciences and Technology Bachelor - Key for Type

| O | Compulsory | E- | Recommended, not eligible for credits |
| W+ | Eligible for credits and recommended | Z | Courses outside the curriculum |
| W | Eligible for credits | Dr | Suitable for doctorate |

Key for Hours
V | lecture | P | practical/laboratory course |
G | lecture with exercise | A | independent project |
U | exercise | D | diploma thesis |
S | seminar | R | revision course / private study |
K | colloquium |

ECTS | European Credit Transfer and Accumulation System
Special students and auditors need special permission from the lecturers.
### Educational Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0240-22L</td>
<td>Coping with Psychosocial Demands of Teaching (EW4 W DZ)</td>
<td>W</td>
<td>2</td>
<td>3S</td>
<td>A. Deiglmayr, P. Greutmann, S. Hofer</td>
</tr>
<tr>
<td></td>
<td>Number of participants limited to 20.</td>
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<tr>
<td>Abstract</td>
<td>In this class, students will learn concepts and skills for coping with psychosocial demands of teaching</td>
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<tr>
<td>Objective</td>
<td>Students possess theoretical knowledge and practical competences to be able to cope with the psychosocial demands of teaching.</td>
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<td>(1) They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents).</td>
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<td>(2) They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions).</td>
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<th>Hours</th>
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</tr>
</thead>
<tbody>
<tr>
<td>851-0242-06L</td>
<td>Cognitively Activating Instructions in MINT Subjects</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>R. Schumacher</td>
</tr>
<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<tr>
<td>Abstract</td>
<td>This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.</td>
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<tr>
<td>Objective</td>
<td>- Get to know cognitively activating instructions in MINT subjects</td>
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<td></td>
<td>- Get information about recent literature on learning and instruction</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.</td>
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<tbody>
<tr>
<td>851-0242-07L</td>
<td>Human Intelligence</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner, B. Rütsche</td>
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<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<tr>
<td>Abstract</td>
<td>The focus will be on the book &quot;Intelligenz: Grosse Unterschiede und ihre Folgen&quot; by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.</td>
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<tr>
<td>Objective</td>
<td>- Understanding of research methods used in the empirical human sciences</td>
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<td>- Getting to know intelligence tests</td>
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<td>- Understanding findings relevant for education</td>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler</td>
</tr>
<tr>
<td></td>
<td>Number of participants limited to 30.</td>
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</tr>
<tr>
<td>Abstract</td>
<td>Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and two further meetings will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.</td>
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<tr>
<td>Objective</td>
<td>- Understand research methods used in the empirical educational sciences</td>
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<tr>
<td></td>
<td>- Understand and critically examine information from scientific journals and media</td>
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<tr>
<td></td>
<td>- Understand pedagogically relevant findings from the empirical educational sciences</td>
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</table>

### Subject Didactics and Professional Training

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-8001-00L</td>
<td>Didactics of Health Sciences and Technology I</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>S. Maurer</td>
</tr>
<tr>
<td></td>
<td>Only for Health Sciences and Technology TC students.</td>
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</tr>
<tr>
<td>Abstract</td>
<td>In this course students learn the principles and techniques of teaching singular lessons, based on scientific knowledge about learning. The aim is to plan, realize, evaluate and reflect lessons effectively and efficiently.</td>
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</tbody>
</table>
Objective
- Students know how to prepare, conduct and reflect a single lesson based on educational requirements.
- Students take the learning goals as a starting point considering previous knowledge as well as the professional environment and the ambitions of the learners.
- Students apply the basic teaching techniques of their subject area in a sensible way and know how to appropriately arrange the phases of learning.
- Students know how to simplify and present complex technical contents of their subject area.

376-8008-00L Teaching Internship Including Examination Lessons
Health Sciences and Technology

Objective
- Students know how to prepare, conduct and reflect a single lesson based on educational requirements.
- Students take the learning goals as a starting point considering previous knowledge as well as the professional environment and the ambitions of the learners.
- Students apply the basic teaching techniques of their subject area in a sensible way and know how to appropriately arrange the phases of learning.
- Students know how to simplify and present complex technical contents of their subject area.

Abstract
The teaching internship can just be visited if all other courses of TC are completed. Repetition of the teaching internship is excluded even if the examination lessons are to be repeated.

Objective
Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils’ work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Further Subject Didactics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-8011-00L</td>
<td>Mentored Work Subject Didactics Health Sciences and Technology</td>
<td>O</td>
<td>2 credits</td>
<td>4A</td>
<td>S. Maurer</td>
</tr>
</tbody>
</table>

Abstract
The mentored paper is designed to bring together the findings from the FD1 and the FD2. By using various teaching techniques and methods a semester plan, which is based on various curricula will be elaborated for a given topic.

Objective
1. The students have planned a curriculum for a semester course.
2. Students reflect on formative and summative ways such a teaching unit to examine and implement parts of it.
3. The students have implemented parts of the semester curriculum.
4. The students deal with the question to what extent teaching techniques, teaching methods but also sequences of self-study must be involved in the planning.

Health Sciences and Technology TC - Key for Type

| O       | Compulsory                  | E- | Recommended, not eligible for credits |
| W+      | Eligible for credits and recommended | Z  | Courses outside the curriculum       |
| W       | Eligible for credits        | Dr | Suitable for doctorate               |

Key for Hours

| V       | lecture                    | P  | practical/laboratory course         |
| G       | lecture with exercise      | A  | independent project                 |
| U       | exercise                   | D  | diploma thesis                      |
| S       | seminar                   | R  | revision course / private study     |
| K       | colloquium                 |    |                                        |

ECTS
European Credit Transfer and Accumulation System
Special students and auditors need special permission from the lecturers.
The goal of this course is to nurture and develop independent thinking which is a vital component of personal and professional

Advanced Topics in Exercise Physiology

Students gain further knowledge and a deeper understanding of concepts in exercise physiology. Emphasis is put on critical analysis and

Title

Lecturers

Type

ECTS

Hours

Lecturers

Translational Science for Health and Medicine

O

3 credits

2G

J. Goldhahn, C. Wolfrum

After completing this course, students will be able to understand:
- Principles of translational science (including project planning, ethics application, basics of resource management and interdisciplinary communication)

Content

What is translational science and what is it not?

How to identify need?
- Disease concepts and consequences for research
- Basic concepts about incidence, prevalence etc., and orphan indications

How to choose the appropriate research type and methodology
- Ethical considerations including ethics application
- Pros and cons of different types of research
- Coordination of complex approaches incl. timing and resources

How to measure success?
- Outcome variables
- Improving the translational process

Challenges of communication?

How independent is translational science?
- Academic boundary conditions vs. industrial influences

Positive and negative examples will be illustrated by distinguished guest speakers.

Electives

Contemporary Problems of Neural Control of Movement

W

2 credits

2S

N. Wenderoth

For MSc Major "Human Movement Science and Sport" only.

Abstract

Students read, present and discuss seminal papers in the field of Neural Control of Movement and Motor Learning.

Objective

The goal of this course is to nurture and develop independent thinking which is a vital component of personal and professional development. Students will critically evaluate academic papers, present logical arguments, source reliable information and design thought experiments to solve problems relevant to the neural control of behavior.

Prerequisites / notice

Students are required to have successfully completed the course "Neural control of movement and motor learning" and to have basic knowledge of applied statistics. Self-study material will be available at the beginning of the course and statistical knowledge will be tested (central element) in the second course week (open book). Passing this test is a requirement for continuing the course. Students will be required to write essays, give presentations and participate in discussions on a regular basis. Assessment will be made on the basis of the complete aforementioned practical work.

Advanced Topics in Exercise Physiology

W

2 credits

1V

C. Spengler, F. Gabe Beltrami

In this course, students read, present and discuss seminal publications in the area of exercise physiology. The focus lies on critical analysis of scientific content, conceptual as well as ethical aspects of publications. Students are trained in the most common scientific presentation techniques such as oral and poster presentations.

Objective

Students gain further knowledge and a deeper understanding of concepts in exercise physiology. Emphasis is put on critical analysis and discussion of scientific publications as well as on improving scientific presentation skills.

Material will be provided in moodle.

Physical Activities and Health

W

3 credits

2V

E. de Bruin

This course introduces/explores the complex relationship between physical activity, sedentary behavior and health. It will discuss the evolution of current physical activity recommendations. It will examine the current evidence base that has informed physical activity recommendations and that identified physical activity as a key modifiable lifestyle behavior contributing to disease and mortality.

Objective

On completion of this course students will be able to demonstrate:
1. knowledge of and critical awareness of the role of physical activity and sedentary behavior in the maintenance of health and the aetiology, prevention and treatment of disease.
2. thorough knowledge and critical awareness of current recommendations for physical activity, and current prevalence and trends of physical activity and associated diseases
3. awareness of current national and international physical activity policies and how these impact on global challenges

Content

Introduction to Physical Activity for Health, including sedentary behavior
- Physical activity epidemiology: concepts principles and approaches
- Physical activity and all cause morbidity and mortality
- Physical activity and chronic disease; Coronary heart disease, diabetes, bone health, cancer and obesity
- Physical activity and brain health
- Physical activity and sedentary behavior recommendations
- Population prevalence of physical activity and sedentary behavior
- Physical activity policies
- Physical activity assessment

Literature

Core texts for this course are:
- Selective journal articles from relevant journals such as Journal of Physical Activity and Health and Journal of Aging and Physical Activity
Prerequisites / notice: From the BSc-course the following book is recommended: ‘Essentials of strength training and conditioning’ T. Baechle, R. Earle (3rd Edition)

**376-1651-00L Clinical and Movement Biomechanics**

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>376-1651-00L</td>
<td>Clinical and Movement Biomechanics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>S. Lorenzetti, R. List, N. Singh</td>
</tr>
</tbody>
</table>

Abstract: Measurement and modeling of the human movement during daily activities and in a clinical environment.

Objective: The students are able to analyse the human movement from a technical point of view, to process the data and perform modeling with a focus towards clinical application.

Content: This course includes ethical considerations, measurement techniques, clinical testing, accessing movement data and analysis as well as modeling with regards to human movement.

**752-6101-00L Nutrition and Chronic Disease (HS)**

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-6101-00L</td>
<td>Nutrition and Chronic Disease (HS)</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>M. B. Zimmermann</td>
</tr>
</tbody>
</table>

Abstract: To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

Objective: To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.

Content: The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

Lecture notes: There is no script. Powerpoint presentations will be made available on-line to students.

Prerequisites / notice: No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.

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**Elective Courses II**

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0104-00L</td>
<td>Uncertainty Quantification for Engineering &amp; Life Sciences</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>J. Beck, P. Koumoutsakos</td>
</tr>
</tbody>
</table>

Abstract: Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

Objective: The course will teach fundamental concepts of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

Content: Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Lecture notes: The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

Literature: 1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

Prerequisites / notice: Fundamentals of Probability, Fundamentals of Computational Modeling

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-0385-10L</td>
<td>Biomedical Imaging</td>
<td>W</td>
<td>6</td>
<td>5G</td>
<td>S. Kozorke, U. Moser, K. P. Prüsmann, M. Rudin</td>
</tr>
</tbody>
</table>

Abstract: Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.

Objective: To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

Content: - X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

Lecture notes: Lecture notes and handouts


Prerequisites / notice: Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-0386-00L</td>
<td>Biomedical Engineering</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>J. Vårba, S. J. Ferguson, S. Kozerke, U. Moser, M. Rudin, M. P. Wolf, M. Zenobi-Wong</td>
</tr>
</tbody>
</table>

Abstract: Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.

Objective: Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

Lecture slides and case material
- Know effects of work design on competence, motivation, and well-being

Image Analysis and Computer Vision
Abstract

Objective
Overview of the most important concepts of image formation, perception, and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

Content
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several test cases are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

Laboratory course: Insight into measurements in Sports Medicine.
Conconi-Tests, Determination of anaerobic threshold, Cooper-Test, 1-repetition maximum test, lactate minimum test, dynamometry, and of whole-body performance, learn scientifically correct data analysis and interpretation of results. Insight into today's Sports Medicine.

BWS: MANDATORY for "Exercise physiology". 
HST: Possible from the 5th semester on.

Number of participants limited to 36.

Objective
- The organization-technology interaction and its impact on organizational change
- Balancing stability and flexibility in organizations as design criterium
- Modes of organizational change and change methods
- Strategic choices for work design

Content
- Know effects of work design on competence, motivation, and well-being
- Understand links between design of individual jobs and work processes
- Know basic processes involved in systematic organizational change
- Understand the interaction between organization and technology and its impact on organizational change
- Understand relevance of work design for company performance and strategy
- Know and apply methods for analyzing and designing work
- Work design: From Adam Smith to job crafting
- Effects of work design on performance and well-being
- Approaches to analyzing and designing work
- Modes of organizational change and change methods
- Balancing stability and flexibility in organizations as design criterium
- The organization-technology interaction and its impact on work design and organizational change
- Example Flexible working arrangements
- Strategic choices for work design

Technology Entrepreneurship
Abstract
Technology ventures are significantly changing the global economic picture. Technological skills increasingly need to be complemented by entrepreneurial understanding.

Objective
This course offers the fundamentals in theory and practice of entrepreneurship in new technology ventures. Main topics covered are success factors in the creation of new firms, including founding, financing and growing a venture.

Content
See course website

Laboratory Course in Exercise Physiology
Number of participants limited to 36.

Abstract
Conduct physical performance tests and measurements that are typically used to assess performance of athletes and/or patients and that deepen the understanding of physiological processes in response to physical exertion.

Objective
Gain hands-on experience in exercise physiology and consolidate knowledge on physiological adaptations to different types and degrees of physical activity and climatic influences. Learn fundamental assessment techniques of the muscular system, the cardio-respiratory system and of whole-body performance, learn scientifically correct data analysis and interpretation of results. Insight into today's Sports Medicine.

Content
Various exercise tests assessing human performance and assessments of physiological responses to activity (examples are VO2max-test, Conconi-Tests, Determination of anaerobic threshold, Cooper-Test, 1-repetition maximum test, lactate minimum test), dynamometry, mechanography, body composition etc.). Insight into measurements in Sports Medicine.

Laboratory course:
Tutorial on Laboratory Experiments in Exercise Physiology
(Editor: Exercise Physiology Lab)

Literature
Schmidt/Lang/Heckmann: Physiologie des Menschen, Springer-Verlag, Heidelberg
Kenney/Wilmore/Costill: Physiology of Sport and Exercise, Human Kinetics
Unterrichtsmaterialien zu den einzelnen Veranstaltungen werden den Studierenden zur Verfügung gestellt.

Inhaltliche Schwerpunkte der Vorlesung sind:

- Sport Pedagogy
- Understanding for the development and adaptation of sports from the ancient world to present times.
- History of Sports

Ein Skript für die aktuelle Veranstaltung wird abgegeben.

D. Seiler Hubler
C. Spengler

Sport and social change: developments and trends
M. Gisler

Central aspects of Sport related pedagogy will be handled in these lectures. These aspects cover, amongst others, the subject and tasks of

These lectures deal with the current changes in society and sport and provide an overview of the many different problems and perspectives of sport sociology.

- The economy and the media: dependencies, consequences, scandals
- Social inequalities and distinctions: gender differences and group behavior
- Conflicts and politics: sports organizations, doping, violence

Selected materials for the lecture are available under www.LSSFB.ch --> Lehre

Prerequisites / notice

Anatomy and physiology classes and lab course in physiology successfully completed (BWS students please contact C. M. Spengler)

Desirable:
Exercise Physiology Lecture (concomitantly or passed; is selection criterion in case of more applications than lab spaces)
A detailed program with additional references will be delivered at the beginning of the lecture.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Type</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1117-00L</td>
<td>Sport Psychology</td>
<td>2W/2V</td>
<td>W</td>
<td>H. Gubelmann</td>
</tr>
<tr>
<td>Abstract</td>
<td>This lecture is intended as an introduction to sport psychology and imparts knowledge on selected areas of the subject. Students are given insight into different work areas of sport psychology. In order to understand what «sport psychology» is, it is necessary to explain the essence and tasks of sport psychology and what it relates to, and to work out an underlying basis for key topics, such as cognition and emotions. Students’ expertise is furthered by presenting and providing more in-depth treatment of additional topics of sport psychology. Selected intervention forms are intended to provide insight into applied sport psychology and ensure that mental processes and their impact in sport can be recognised. Case studies and practical exercises (e.g. objective training) are intended to prompt students to reflect to a greater extent on the forms in which sport psychology can be applied in their practice of sports and to integrate these in their teaching.</td>
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<tr>
<td>Content</td>
<td>Main Topics</td>
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<tr>
<td>License</td>
<td>Main Topics</td>
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<tr>
<td>376-1177-00L</td>
<td>Human Factors I</td>
<td>2W/2V</td>
<td>W</td>
<td>M. Menozzi Jäckli, R. Boutellier, R. Huang, M. Siegrist</td>
</tr>
<tr>
<td>Abstract</td>
<td>Every day humans interact with various systems. Strategies of interaction, individual needs, physical &amp; mental abilities, and system properties are important factors in controlling the quality and performance in interaction processes. In the lecture, factors are investigated by basic scientific approaches. Discussed topics are important for optimizing people's satisfaction &amp; overall performance.</td>
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<tr>
<td>Objective</td>
<td>The goal of the lecture is to empower students in better understanding the applied theories, principles, and methods in various applications. Students are expected to learn about how to enable an efficient and qualitatively high standing interaction between human and the environment, considering costs, benefits, health, and safety as well. Thus, an ergonomic design and evaluation process of products, tasks, and environments may be promoted in different disciplines. The goal is achieved in addressing a broad variety of topics and embedding the discussion in macroscopic factors such as the behavior of consumers and objectives of economy.</td>
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<tr>
<td>Content</td>
<td>Physiological, physical, and cognitive factors in sensation and perception</td>
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<tr>
<td>License</td>
<td>Physiological, physical, and cognitive factors in sensation and perception</td>
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<tr>
<td>376-1179-00L</td>
<td>Applications of Cybernetics in Ergonomics</td>
<td>1W/1U</td>
<td>W</td>
<td>M. Menozzi Jäckli, Y.Y. Hedinger Huang, R. Huang</td>
</tr>
<tr>
<td>Abstract</td>
<td>Cybernetics systems have been studied and applied in various research fields, such as applications in the ergonomics domain. Research interests include the man-machine interaction (MMI) topic which involving the performance in multi-model interactions, quantification in gestalt principles in product development; or the information processing matter.</td>
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<tr>
<td>Objective</td>
<td>To learn and practice cybernetics principles in interface designs and product development.</td>
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<tr>
<td>Content</td>
<td>Fitt's law applied in manipulation tasks</td>
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<tr>
<td>License</td>
<td>Fitt's law applied in manipulation tasks</td>
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<tr>
<td>376-1219-00L</td>
<td>Rehabilitation Engineering II: Rehabilitation of Sensory and Vegetative Functions</td>
<td>3W/2V</td>
<td>W</td>
<td>R. Riener, R. Gassert, L. Marchal Crespo</td>
</tr>
<tr>
<td>Abstract</td>
<td>Rehab. Engineering is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.</td>
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<tr>
<td>Objective</td>
<td>Provide knowledge on the anatomy and physiology of the human sensory system, related dysfunctions and pathologies, and how rehabilitation engineering can provide sensory restoration and substitution.</td>
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</tbody>
</table>
Introduction, problem definition, overview
Rehabilitation of visual function
- Anatomy and physiology of the visual sense
- Technical aids (glasses, sensor substitution)
- Retina and cortex implants
- Rehabilitation of hearing function
- Anatomy and physiology of the auditory sense
- Hearing aids
- Cochlea Implants
- Rehabilitation and use of kinesthetic and tactile function
- Anatomy and physiology of the kinesthetic and tactile sense
- Tactile/haptic displays for motion therapy (incl. electrical stimulation)
- Role of displays in motor learning
- Rehabilitation of vestibular function
- Anatomy and physiology of the vestibular sense
- Rehabilitation strategies and devices (e.g. BrainPort)
Rehabilitation of vegetative Functions
- Cardiac Pacemaker
- Phrenic stimulation, artificial breathing aids
- Bladder stimulation, artificial sphincter
Brain stimulation and recording
- Deep brain stimulation for patients with Parkinson, epilepsy, depression
- Brain-Computer Interfaces

Literature
Introductory Books:

Selected Journal Articles and Web Links:

Prerequisites / notice
Target Group:
- Students of higher semesters and PhD students of
- D-MAVT, D-ITET, D-INFK, D-HEST
- Biomedical Engineering, Robotics, Systems and Control
- Medical Faculty, University of Zurich
Students of other departments, faculties, courses are also welcome

Biocompatible Materials

376-1714-00L W 4 credits 3G K. Maniura, J. Möller, M. Zenobi-Wong
Abstract

Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

Objective

The class consists of three parts:
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

Content

Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

Lecture notes / Literature

Handouts can be accessed online.


(available online via ETH library)

Handouts provided during the classes and references therein.

376-1720-00L  Application of MATLAB in the Human Movement  W  2 credits  2G  R. van de Langenberg

Abstract

Students will learn to import, process and graphically present experimental data using the MATLAB computing environment. Both the data and the methods of analysis will be typical for experiments in Human Movement Science (i.e. kinematics, kinetics and electromyography).

Objective

Students will acquire the ability to independently load, plot, and process kinematic, kinetic and electromyographic data using the MATLAB computing environment.

Content

Drawbacks of Excel; Possibilities in MATLAB: Import of several data formats; Plot of one and more signals; Removing of an offset and filtering of data based on self-written functions; Normalisation and parametrisation of data; Reliability; Interpolation, Differentiation and Integration in MATLAB.

Literature

During the lecture, several electronically available MATLAB introductions are indicated. Course-specific scripts will be provided by the lecturer.

Prerequisites / notice

A Laptop with MATLAB installed (v2009 or higher) and wireless internet access is mandatory. Two students can share a laptop if necessary. A MATLAB student version can be obtained at Stud-IDES for free.

376-1722-00L  Spinal Cord Injury and Exercise  W  2 credits  2V  C. Perret

Abstract

Intensive discussion concerning complications of a spinal cord injury and their consequences on trainability and exercise performance of persons sitting in a wheelchair. Overview on the clinical application of exercise testing as well as on the implementation of sport scientific findings to optimise performance of spinal cord injured subjects in rehabilitation and elite sports.

Objective

Knowledge of the pathophysiology and the concomitant complications of a spinal cord injury and the consequences for physical exercise and trainability during rehabilitation as well as in recreational and elite sport.

Content

The following issues will be discussed: Epidemiology and etiology of spinal cord injury; complications and consequences of spinal cord injury; trainability/exercise physiology and spinal cord injury; history and organisation of wheelchair sports; elite sport and spinal cord injury prevention. The lecture provides an introduction to the basic principles of trauma biomechanics. Voraussetzung/Vorlesung Anatomie/Physiologie besucht!

Literature

G.A. Zäch, H. G. Koch
Paraplegie - ganzheitliche Rehabilitation
Karger-Verlag, 2006
ISBN 3-8055-7980-2

V. Goosey-Tolfrey
Wheelchair sport: A complete guide for athletes, coaches and teachers
Human Kinetics, 2010

Y.C. Vanlandewijck, W.R. Thompson
The Paralympic Athlete
Wiley-Blackwell, 2011
ISBN 978-1-4443-3404-3

Liz Broad
Sports Nutrition for Paralympic Athletes
CRC Press 2014

376-1974-00L  Colloquium in Biomechanics  W  2 credits  2K  B. Helgason, S. J. Ferguson, R. Müller, J. G. Snedeker, B. Taylor, M. Zenobi-Wong

Abstract

Current topics in biomechanics presented by speakers from academia and industry. Getting insight into actual areas and problems of biomechanics.

376-1985-00L  Trauma Biomechanics  W  4 credits  2V+1U  K.U. Schmitt, M. H. Muser

Abstract

Trauma biomechanics in an interdisciplinary research field investigating the biomechanics of injuries and related subjects such as prevention. The lecture provides an introduction to the basic principles of trauma biomechanics. The lecture serves as an introduction to the field of trauma biomechanics. Emphasis is placed on the interdisciplinary nature of impact biomechanics, which uses the combination of fundamental engineering principles and advanced medical technologies to develop injury prevention measures. Topics include: accident statistics and accident reconstruction, biomechanical response of the human to impact loading, injury mechanisms and injury criteria, test methods (including crash tests), computer simulations using multi-body and finite element modelling techniques, aspects of passive safety of vehicles (focusing on restraint systems and vehicle compatibility). Real world examples mainly from automobile safety are used to augment lecture material.
Lecture notes

Objective

Abstract

Content

Literature

Prerequisites / notice

This lecture introduces the basic principles of injury mechanics and rehabilitation focussing on sports injuries.

Within the scope of this lecture you will learn the basic principles of trauma biomechanics. Based on examples from sports, you will get to know different mechanisms that can possibly result in injury. Investigating the background and cause of injury should allow you to assess the injury risk for sports activities. Furthermore you should be able to develop measures to prevent such injury.

This lecture deals with the basic principles of injury mechanics and rehabilitation. Mechanisms that can result in injury are presented. Furthermore possibilities to prevent injuries are discussed. Thereby the lecture focuses on sports injuries.

Handouts can be downloaded.

A course work is required. The mark of this course work contributes to the final credits for this lecture. Details will be given during the first lecture.

Content

Based on practical examples out of sport, everyday movement and therapy, students use and compare different methods of movement analysis.

During the course students get acquainted with different methods of movement analysis such as functional, morphological, clinical, mechanical, and others. Based on practical examples, these methods are used and compared. The examples range from sport, everyday movement and therapy, such as hockey, gymnastics, acrobatics, badminton, gait / running and strength training. In the first phase of the class, the different approaches are applied. In the second phase, small teams are working on individual projects. These will be discussed and presented in plenum.

Class material will be distributed using the moodle platform.

551-1153-00L
Systems Biology of Metabolism

W 4 credits
2V

U. Sauer, N. Zamboni, M. Zampieri

Number of participants limited to 15.

Starting from contemporary biological problems related to metabolism, the course focuses on systems biological approaches to address them. In a problem-oriented, this-is-how-it-is-done manner, we thereby teach modern methods and concepts.

Develop a deeper understanding of how relevant biological problems can be solved, thereby providing advanced insights to key experimental and computational methods in systems biology.

The course will be given as a mixture of lectures, studies of original research and guided discussions that focus on current research topics. For each particular problem studied, we will work out how the various methods work and what their capabilities/limits are. The problem areas range from microbial metabolism to cancer cell metabolism and from metabolic networks to regulation networks in populations and single cells. Key methods to be covered are various modeling approaches, metabolic flux analyses, metabolomics and other omics.

Script and original publications will be supplied during the course.

The course extends many of the generally introduced concepts and methods of the Concept Course in Systems Biology. It requires a good knowledge of biochemistry and basics of mathematics and chemistry.

572-6105-00L
Epidemiology and Prevention

W 3 credits
2V

M. Eichholzer

The module Epidemiology and Prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented.

Students are able to evaluate the scientific evidence on the effects of diet on human health. To describe the role of nutritional factors in the prevention of chronic diseases. To assess the nutritional status of a population. To put forward preventive measures addressing individuals but also our society in relation to the obesity epidemic.

The module Epidemiology and Prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented. Switzerland taken as an example, the health risks associated with our nutritional habits will be evaluated. Finally, examples of preventive measures addressing individuals but also the society in relation to the obesity epidemic and other threats to health are discussed.

572-6151-00L
Public Health Concepts

W 3 credits
2V

R. Heusser

The module "public health concepts" offers an introduction to key principles of public health. Students get acquainted with the concepts and methods of epidemiology. Students also learn to use epidemiological data for prevention and health promotion purposes. Public health concepts and intervention strategies are presented, using examples from infectious and chronic diseases.

At the end of this module students are able to interpret the results of epidemiological studies. To critically assess scientific literature. To know the definition, dimensions and determinants of health. To plan public health interventions and health promotion projects.

Concepts of descriptive and analytical epidemiology, study designs, measures of effect, confounding and bias, screening, surveillance, definition of health and health promotion, health dimensions and health determinants, prevention strategies, public health interventions, public health action cycle, epidemiology and prevention of infectious and chronic diseases (HIV, Tuberculosis, Obesity, Public health nutrition).

Handouts are provided to students in the classroom.

Language of the course is English.

572-6403-00L
Nutrition and Performance

W 2 credits
2V

S. Mettler, M. B. Zimmermann

The course introduces basic concepts of the interaction between nutrition and exercise and cognitive performance.

To understand the potential effects of nutrition on exercise performance, with a focus on concepts and principles of nutrition before, during and after exercise.

The course will cover elementary aspects of sports nutrition physiology, including carbohydrate, glycogen, fat, protein and energy metabolism. A main focus will be to understand nutritional aspects before exercise to be prepared for intensive exercise bouts, how exercise performance can be supported by nutrition during exercise and how recovery can be assisted by nutrition after exercise. Although this is a scientific course, it is a goal of the course to translate basic sports nutrition science into practical sports nutrition examples.

Lecture slides and required handouts will be available on the ETH website.

Information on further reading will be announced during the lecture. There will be some mandatory as well as voluntary readings.

Data: 06.02.2019 13:00
Autumn Semester 2015
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General knowledge about nutrition, human biology, physiology and biochemistry is a prerequisite for this course. The course builds on basic nutrition and biochemistry knowledge to address exercise and performance related aspects of nutrition.

The course is designed for 3rd year Bachelor students, Master students and postgraduate students (MAS/CAS).

Language: English

It is strongly recommended to attend the lectures. The lecture (including the handouts) is not designed for distance education.

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**Major in Human Health, Nutrition and Environment**

**Compulsory Courses**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Only for students of the Major Human Health, Nutrition and Environment.</td>
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</tbody>
</table>

**Abstract**

Writing of a review paper of scientific quality on a topic in the domain of Human Health, Nutrition and Environment based on critical evaluation of scientific literature.

**Objective**

- Acquisition of knowledge in the field of the review paper
- Assessment of original literature as well as synthesis and analysis of the findings
- Practising of academic writing in English
- Giving an oral presentation with discussion on the topic of the review paper

**Content**

Topics are offered in the domains of the major 'Human Health, Nutrition and Environment' covering 'Public Health', 'Infectious Diseases', 'Nutrition and Health' and 'Environment and Health'.

**Lecture notes**

Guidelines will be handed out in the beginning.

**Literature**

Literature will be identified based on the topic chosen.

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**Electives**

**Elective Courses I**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0629-00L</td>
<td>Applied Biostatistics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>M. Müller</td>
</tr>
</tbody>
</table>

**Abstract**

Principles and main methods in biostatistics with emphasis on practical aspects. Experimental and observational studies. Regression and analysis of variance. Introduction into survival analysis.

**Objective**

Getting an overview of the problems and statistical methods used in health sciences. Practise in using the software R to analyze data and interpreting the results.

**Content**


**Lecture notes**

see teaching document repository

**Literature**


**Prerequisites / notice**

The statistical package R will be used in the exercises. If you are unfamiliar with R, I highly recommend the online R course etutoR.

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**752-6105-00L**

**Epidemiology and Prevention**

The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented.

**Objective**

Students are able
- to evaluate the scientific evidence on the effects of diet on human health
- to describe the role of nutritional factors in the prevention of chronic diseases
- to assess the nutritional status of a population (Switzerland taken as an example)
- to put forward preventive measures addressing individuals but also our society in relation to the obesity epidemic
The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented. Switzerland taken as an example, the health risks associated with our nutritional habits will be evaluated. Finally, examples of preventive measures addressing individuals but also the society in relation to the obesity epidemic and other threats to health are discussed.

752-6151-00L Public Health Concepts

Abstract
The module "public health concepts" offers an introduction to key principles of public health. Students get acquainted with the concepts and methods of epidemiology. Students also learn to use epidemiological data for prevention and health promotion purposes. Public health concepts and intervention strategies are presented, using examples from infectious and chronic diseases.

Objective
At the end of this module students are able:
- to interpret the results of epidemiological studies
- to critically assess scientific literature
- to know the definition, dimensions and determinants of health
- to plan public health interventions and health promotion projects

Content
Concepts of descriptive and analytical epidemiology, study designs, measures of effect, confounding and bias, screening, surveillance, definition of health and health promotion, health dimensions and health determinants, prevention strategies, public health interventions, public health action cycle, epidemiology and prevention of infectious and chronic diseases (HIV, Tuberculosis, Obesity, Public health nutrition).

Lecturers
R. Heusser

Language of the course is English

Elective Courses II

Module: Infectious Diseases

551-0223-00L Immunology III

Abstract
This course provides a detailed understanding of
- development of T and B cells
- the dynamics of an immune response during acute and chronic infection
- mechanisms of immunopathology
- modern vaccination strategies

Key experimental results will be shown to help understanding how immunological textbook knowledge has evolved.

Objective
Obtain a detailed understanding of
- the development, activation, and differentiation of different types of T cells and their effectormechanisms during immune responses,
- Recognition of pathogenic microorganisms by the host cells and molecular events thereafter,
- events and signals for maturation of naive B cells to antibody producing plasma cells and memory B cells.
- Optimization of B cell responses by intelligent design of new vaccines

Content
- Development and selection of CD4 and CD8 T cells, natural killer T cells (NKT), and regulatory T cells (Treg)
- NK T cells and responses to lipid antigens
- Differentiation, characterization, and function of CD4 T cell subsets such as Th1, Th2, and Th17
- Overview of cytokines and their effecter function
- Co-stimulation (signals 1-3)
- Dendritic cells
- Evolution of the "Danger" concept
- Cells expressing Pattern Recognition Receptors and their downstream signals
- T cell function and dysfunction in acute and chronic viral infections

Literature
Documents of the lectures are available for download at: https://moodle-app2.let.ethz.ch/course/view.php?id=998

551-1171-00L Immunology: from Milestones to Current Topics

Abstract
Milestones in Immunology: on old concepts and modern experiments

Objective
The course will cover six grand topics in immunology (B cells, innate immunity, antigen presentation, tumor immunity, thymus and T cells, cytotoxic T cells and NK cells) and for each grand topic four hours will be allocated. During the first double hour, historical milestone papers will be presented by the supervisor providing an overview on the development of the conceptual framework and critical technological advances. The students will also prepare themselves for this double lecture by reading the historical milestone papers and contributing to the discussion. In the following lecture up to four students will present each a recent high impact research paper which emerged from the landmark achievements of the previously discussed milestone concepts.

Content
- Milestones and current topics of innate immunity, antigen presenting, B cells, thymus and T cells, cytotoxic T cells and NK cells, and tumor immunology.

Lecture notes
Original and review articles will be distributed by the lecturer.

Literature
Literaturunterlagen werden vor Beginn des Kurses auf folgender website zugänglich sein: Moodle Course https://moodle-app2.let.ethz.ch/course/view.php?id=1002

636-0017-00L Molecular Evolution, Phylogenetics and Phylodynamics

Abstract
The aim of the course is to provide up-to-date knowledge on how we can obtain an understanding of the evolution and population dynamics of organisms based on their genetic sequencing data, employing key concepts from molecular evolution, phylogenetics and phylodynamics. Throughout the course, we tie the models and methods closely with applications, mainly in the field of epidemiology and evolution.

Data: 06.02.2019 13:00 Autumn semester 2015 Page 709 of 1434
Objective
Attendees will learn what information is contained in genetic sequencing data and how this information is extracted from the sequencing data. The main concepts introduced are:
- models in molecular evolution
- phylogenetic & phylodynamic inference
- maximum likelihood and Bayesian statistics
- stochastic processes

Attendees will apply these concepts to a number of applications yielding biological insight into:
- epidemiology
- pathogen evolution
- macroevolution of species

Content
The course consists of three parts. We first introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Second, we employ these evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylogenomics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades.

Lecture notes
Slides of the lecture will be available online.

Literature
The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:
- * Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST.

Prerequisites / notice
Basic knowledge in linear algebra, analysis, and statistics.

701-0283-01L Seminar in Evolutionary Ecology of Infectious Diseases

W 3 credits 2G D. Croll, S. Bonhoeffer, R. R. Regös

Abstract
Students of this course will discuss current topics from the field of infectious disease biology. From a list of publications, each student chooses some themes that he/she is going to explain and discuss with all other participants and under supervision. The actual topics will change from year to year corresponding to the progress and new results occurring in the field.

Objective
This is an advanced course that will require significant student participation. Students will learn how to evaluate and present scientific literature and trace the development of ideas related to understanding the ecology and evolutionary biology of infectious diseases.

Content
A core set of ~10 classic publications encompassing unifying themes in infectious disease ecology and evolution, such as virulence, resistance, metapopulations, networks, and competition will be presented and discussed. Pathogens will include bacteria, viruses and fungi. Hosts will include animals, plants and humans.

Lecture notes
Publications and class notes can be downloaded from a web page announced during the lecture.

752-4009-00L Molecular Biology of Foodborne Pathogens

W 3 credits 2V M. Loessner, M. Schuppler

Abstract
The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.

Objective
Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks.

Content
Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks?

Lecture notes
Electronic copies of the presentation slides (PDF) will be made available for download to registered students.

Literature
Recommendations will be given in the first lecture

Prerequisites / notice
Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until 11:15 h), with no break.

Module: Nutrition and Health

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-2122-00L</td>
<td>Food and Consumer Behaviour</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>M. Siegrist, C. Hartmann, V. Visschers</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
<td></td>
<td></td>
<td></td>
<td>This course focuses on food consumer behavior, consumer's decision-making processes and consumer's attitudes towards food products.</td>
</tr>
<tr>
<td></td>
<td><strong>Objective</strong></td>
<td></td>
<td></td>
<td></td>
<td>The course provides an overview about the following topics: Factors influencing consumer's food choice, food and health, attitudes towards new foods and food technologies, labeling and food policy issues</td>
</tr>
<tr>
<td>752-5103-00L</td>
<td>Functional Microorganisms in Foods</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>C. Lacroix, T. de Wouters, L. Meile, C. Schwab</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
<td></td>
<td></td>
<td></td>
<td>This integration course will discuss new applications of microorganisms with functional properties in food and functional food products. Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of functional microorganisms to produce food with high quality, safety and potential health benefits for consumers.</td>
</tr>
<tr>
<td></td>
<td><strong>Objective</strong></td>
<td></td>
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<td></td>
<td>To understand the principles, roles and mechanisms of microorganisms with metabolic activities of high potential for application in traditional and functional foods utilization with high quality, safety and potential health benefits for the consumers. This course will integrate basic knowledge in food microbiology, microbial physiology, biochemistry, and technology.</td>
</tr>
</tbody>
</table>
This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products and characterization of functionality and safety of food bacteria. Specialists from the Laboratory of Food Biotechnology, as well as invited speakers from the industry will contribute to the selected topics as follows:

- **Probiotics and Prebiotics**: Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.

- **Bioprotective Cultures and Antimicrobial Metabolites**: Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.

- **Legal and Protection Issues Related Functional Foods**

- **Industrial Biotechnology of Flavor and Taste Development**

- **Safety of Food Starter Cultures and Probiotics**

Students will be required to complete a group project on food products and ingredients with of from functional bacteria. The project will involve information research and analysis followed by an oral presentation and short written report.

**Lecture notes**

Copy of the power point slides from lectures will be provided.

**Literature**

A list of references will be given at the beginning of the course for the different topics presented during this course.

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### 752-6101-00L Nutrition and Chronic Disease (HS)

**Abstract**

To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

**Objective**

To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.

**Content**

The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

**Literature**

There is no script. Powerpoint presentations will be made available on-line to students.

**Prerequisites / notice**

No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.

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### 752-6402-00L Nutrigenomics

**Abstract**

Nutrigenomics - toward personalized nutrition?

Breakthroughs in biology recently led nutrition scientists to apply modern tools (genomics, transcriptomics, proteomics, metabolomics, genetics, epigenetics) to the analysis of the interactions of food with humans. The lecture presents these tools and illustrates their application in selected topics relevant to human nutrition and food sciences.

**Objective**

- Overall understanding of the transdisciplinary research being conducted under the term nutrigenomics.
- Overall understating of the omics technologies used in nutrigenomics and their applications to human nutrition and food science.
- Ability to critically evaluate the potential and risks associated with the field of nutrigenomics

**Content**

- The lecture is completed by an optional project entitled 'Personalized Nutrition' in which the students have the opportunity to receive a personalized nutritional guidance that is based on their own genetic makeup. The scientific literature on which the genetic tests are based is presented by the students during the lecture.

**Lecture notes**

The script is composed of circa 450 slides (ca 18 slides/lecture) organized in 9 modules

Module A
From biochemical nutrition research to nutrigenomics

Module B
Nutritional genomics

Module C
Nutrigenetics

Module D
Nutri-epigenomics

Module E
Transcriptomics in nutrition research

Module F
Proteomics in nutrition research

Module G
Metabolomics in nutrition research

Module H
Nutritional systems biology

Module I
Individualized nutrition - opportunities and challenges

**Literature**

No extra reading requested. Most slides in the lecture are referenced with web adresses.

**Prerequisites / notice**

Basic training in biochemistry, molecular biology, physiology, and human nutrition. Interest in interdisciplinary sciences linking molecular biology to human health. Interest in the application of analytical laboratory methods to the understanding of human biology, in particular nutrition.

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### Module: Environment and Health

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-1341-00L</td>
<td>Water Resources and Drinking Water</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>S. Hug, M. Berg, F. Hammes, U. von Gunten</td>
</tr>
</tbody>
</table>
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Natural processes, anthropogenic pollution, legislation of groundwater and surface water and of drinking water as well as water treatment will be discussed for industrialized and developing countries.

The course will prepare students to communicate more effectively across disciplinary boundaries, and will provide them with deep insights into the various frontiers.

Each lecturer will first give an overview of the state-of-the art in his/her field, and then describe the research highlights in his/her own research group. While preparing their Final Projects and discussing them in front of the class, the students will deepen their understanding of how to apply a range of new technologies to solve specific scientific problems and technical challenges. Exposure to the different frontiers will also improve their ability to conduct effective nanoscale research, recognize the broader significance of their work and to start collaborations.

Starting with the fabrication and analysis of nanoparticles and nanostructured materials that enable a variety of scientific and technical applications, the course will give an overview of what nanotechnology is all about, from analytical techniques to nanosystems, from physics to biology. Students will start to appreciate the extent to which scientific communities are meeting at the nanoscale. They will learn about the specific challenges and what is currently sizzling in the respective fields, and learn the vocabulary that is necessary to communicate effectively across departmental boundaries.

The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality.

The course is a cross disciplinary scientific research that is motivated by the need for practical applications that help people. The course should help to clarify basics of translational science, illustrate successful applications and should enable students to integrate key features into their future projects.

After completing this course, students will be able to understand: Principles of translational science (including project planning, ethics application, basics of resource management and interdisciplinary communication)

What is translational science and what is it not?

How to identify need?

- Disease concepts and consequences for research

- Basics about incidence, prevalence etc., and orphan indications

How to choose the appropriate research type and methodology

- Ethical considerations including ethics application

- Pros and cons of different types of research

- Coordination of complex approaches incl. timing and resources

How to measure success?

- Outcome variables

- Improving the translational process

Challenges of communication?

- How independent is translational science?

- Academic boundary conditions vs. industrial influences

Positive and negative examples will be illustrated by distinguished guest speakers.

The goal of the course is to give Master and Graduate students from all interested departments an overview of what nanotechnology is all about, from analytical techniques to nanosystems, from physics to biology. Students will start to appreciate the extent to which scientific communities are meeting at the nanoscale. They will learn about the specific challenges and what is currently sizzling in the respective fields, and learn the vocabulary that is necessary to communicate effectively across departmental boundaries.

Many disciplines are meeting at the nanoscale, from physics, chemistry to engineering, from the life sciences to medicine. The course will change the way we do science and result in so many new technologies.

Handouts will be distributed

Will be mentioned in handouts
Introduction, problem definition, overview
Rehabilitation of visual function
- Anatomy and physiology of the visual sense
- Technical aids (glasses, sensor substitution)
- Retina and cortex implants
- Rehabilitation of hearing function
- Anatomy and physiology of the auditory sense
- Hearing aids
- Cochlea Implants
- Rehabilitation and use of kinesthetic and tactile function
- Anatomy and physiology of the kinesthetic and tactile sense
- Tactile/haptic displays for motion therapy (incl. electrical stimulation)
- Role of displays in motor learning
- Rehabilitation of vestibular function
- Anatomy and physiology of the vestibular sense
- Rehabilitation strategies and devices (e.g. BrainPort)
Rehabilitation of vegetative Functions
- Cardiac Pacemaker
- Phrenic stimulation, artificial breathing aids
- Bladder stimulation, artificial sphincter
Brain stimulation and recording
- Deep brain stimulation for patients with Parkinson, epilepsy, depression
- Brain-Computer Interfaces

Literature
Introductory Books:

Selected Journal Articles and Web Links:

Prerequisites / notice
Applicable Biostatistics

| 401-0629-00L | Applied Biostatistics | W | 4 credits | 3G | M. Müller |

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 713 of 1434
Principles and main methods in biostatistics with emphasis on practical aspects. Experimental and observational studies. Regression and analysis of variance. Introduction into survival analysis.

Getting an overview of the problems and statistical methods used in health sciences. Practise in using the software R to analyze data and interpreting the suites.


see teaching document repository


The statistical package R will be used in the exercises.

If you are unfamiliar with R, I highly recommend the online R course etutorR.

### Elective Courses II

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0255-00L</td>
<td>Energy Conversion and Transport in Biosystems</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>D. Poulilakos, A. Ferrari</td>
</tr>
<tr>
<td>Abstract</td>
<td>Theory and application of thermodynamics and energy conversion in biological systems and biomedicine at the macro scale and the cellular level.</td>
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<tr>
<td>Objective</td>
<td>Theory and application of energy transport at the macro scale and the cellular level. Understanding of the basic features governing fluid transport in the principal systems of the human cell. Connection of characteristics and patterns from other fields of engineering to biofluidics. Heat and mass transport processes within the human body and relation to biomedical technologies.</td>
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<tr>
<td>Content</td>
<td>Mass transfer models for the transport of chemical species in the human cell. Organization and function of the cell membrane and of the cell cytoskeleton. The role of molecular motors in cellular force generation and their function in cell migration. Description of the functionality of these systems and of analytical experimental and computational techniques for understanding of their operation. Introduction to bioengineering approaches for the treatment of common pathogenic conditions of these systems. Introduction to cell metabolism, cellular energy transport and cellular thermodynamics.</td>
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<tr>
<td>Lecture notes</td>
<td>Script as well as additional material in the form of hand-outs will be distributed.</td>
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</tr>
<tr>
<td>Literature</td>
<td>Lecture notes and references therein.</td>
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<tr>
<td>151-0604-00L</td>
<td>Microrobotics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>B. Nelson</td>
</tr>
<tr>
<td>Abstract</td>
<td>Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.</td>
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<tr>
<td>Objective</td>
<td>The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.</td>
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<tr>
<td>Content</td>
<td>Main topics of the course include: - Scaling laws at micro/nano scales - Electrostatics - Electromagnetism - Low Reynolds number flows - Observation tools - Materials and fabrication methods - Applications of biomedical microrobots</td>
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<tr>
<td>Lecture notes</td>
<td>The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The lecture will be taught in English.</td>
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<tr>
<td>227-0391-00L</td>
<td>Medical Image Analysis</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>P. C. Cattin, M. A. Reyes Aguirre</td>
</tr>
<tr>
<td>Abstract</td>
<td>It is the objective of this lecture to introduce the basic concepts used in Medical Image Analysis. In particular the lecture focuses on shape representation schemes, segmentation techniques, and the various image registration methods commonly used in Medical Image Analysis applications.</td>
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<tr>
<td>Objective</td>
<td>This lecture aims to give an overview of the basic concepts of Medical Image Analysis and its application areas. Basic knowledge of computer vision would be helpful.</td>
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<td>Prerequisites / notice</td>
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<tr>
<td>227-0447-00L</td>
<td>Image Analysis and Computer Vision</td>
<td>W</td>
<td>6</td>
<td>3V+1U</td>
<td>G. Székely, O. Göksel, L. Van Gool</td>
</tr>
<tr>
<td>Objective</td>
<td>Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.</td>
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<tr>
<td>Content</td>
<td>The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.</td>
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<tr>
<td>Lecture notes</td>
<td>Course material Script, computer demonstrations, exercises and problem solutions</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C. The course language is English.</td>
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<tr>
<td>227-0965-00L</td>
<td>Micro and Nano-Tomography of Biological Tissues</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>M. Stampapani, K. S. Mader</td>
</tr>
<tr>
<td>Abstract</td>
<td></td>
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<tr>
<td>Objective</td>
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<tr>
<td>Content</td>
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<tr>
<td>Lecture notes</td>
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<tr>
<td>Prerequisites / notice</td>
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</table>
Methods & Models for fMRI Data Analysis

This course teaches methods and models for fMRI data analysis, covering all aspects of statistical parametric mapping (SPM), incl. preprocessing, the general linear model, statistical inference, multiple comparison corrections, event-related designs, and Dynamic Causal Modelling (DCM), a Bayesian framework for identification of nonlinear neuronal systems from neurophysiological data.

To obtain in-depth knowledge of the theoretical foundations of SPM and DCM and of their application to empirical fMRI data.

This course teaches state-of-the-art methods and models for fMRI data analysis. It covers all aspects of statistical parametric mapping (SPM), incl. preprocessing, the general linear model, frequentist and Bayesian inference, multiple comparison corrections, and event-related designs, and Dynamic Causal Modelling (DCM), a Bayesian framework for identification of nonlinear neuronal systems from neurophysiological data. A particular emphasis of the course will be on methodological questions arising in the context of studies in psychiatry, neurology and neuroeconomics.

Computational Biology

Study of computational techniques, algorithms and data structures used to solve problems in computational biology. Topics: basic biology, string alignment, phylogeny (distance, character, parsimony), molecular evolution, multiple sequence alignment, probabilistic and statistical models, Markov models, microarrays, dynamic programming, maximum likelihood and specialized DNA and protein analysis.

Familiarize the students with the basic concepts of molecular biology and the models and algorithms used to understand, classify and predict behaviour of living organism. This course is at the most basic level, where the main issues, mostly of molecular sequences, are studied.

This course lies in the intersection between Computer Science and Molecular Biology. The main purpose is to study computational techniques, algorithms and data structures which are usually applied to solve problems in Molecular Biology and Biochemistry.

The following topics are likely to be covered: Introduction, mathematical models of evolution, protein and DNA sequence alignment and its meaning, phylogenetic tree construction, multiple sequence alignments, secondary structure prediction, molecular dynamics, threading, role of bioinformatics in drug design, etc. From the computer science point of view we concentrate our attention in practical solutions for the above problems. Biological knowledge is an asset but not a prerequisite.

Surfaces, Interfaces and their Applications I

After being introduced to the physical/chemical principles and importance of surfaces and interfaces, the student is introduced to the most important theories that can be used to characterize surfaces. Later, liquid interfaces are treated, followed by an introduction to the fields of tribology (friction, lubrication, and wear) and corrosion.

To gain an understanding of the physical and chemical principles, as well as the tools and applications of surface science, and to be able to choose appropriate surface-analytical approaches for solving problems.

Introduction to Surface Science

Physical Structure of Surfaces

Surface Forces (static and dynamic)

Adsorbates on Surfaces

Surface Thermodynamics and Kinetics

The Solid-Liquid Interface

Electron Spectroscopy

Vibrational Spectroscopy on Surfaces

Scanning Probe Microscopy

Introduction to Tribology

Introduction to Corrosion Science

Script Download:
https://www.surface.mat.ethz.ch/education/courses/surfaces_interfaces_and_their_applications_I

Surfaces, Interfaces and their Applications I

327-0505-00L

| W | 3 credits | 2V+1U | N. Spencer, M. P. Heuberger, L. Isla |

Abstract

After being introduced to the physical/chemical principles and importance of surfaces and interfaces, the student is introduced to the most important theories that can be used to characterize surfaces. Later, liquid interfaces are treated, followed by an introduction to the fields of tribology (friction, lubrication, and wear) and corrosion.

To gain an understanding of the physical and chemical principles, as well as the tools and applications of surface science, and to be able to choose appropriate surface-analytical approaches for solving problems.

Introduction to Surface Science

Physical Structure of Surfaces

Surface Forces (static and dynamic)

Adsorbates on Surfaces

Surface Thermodynamics and Kinetics

The Solid-Liquid Interface

Electron Spectroscopy

Vibrational Spectroscopy on Surfaces

Scanning Probe Microscopy

Introduction to Tribology

Introduction to Corrosion Science

Script Download:
https://www.surface.mat.ethz.ch/education/courses/surfaces_interfaces_and_their_applications_I

Surface, Interfaces and their Applications I

Prerequisites / notice

Chemistry:
General undergraduate chemistry
including basic chemical kinetics and thermodynamics

Physics:
General undergraduate physics
including basic theory of diffraction and basic knowledge of crystal structures

Technology Entrepreneurship

Technology ventures are significantly changing the global economic picture. Technological skills increasingly need to be complemented by entrepreneurial understanding.

This course offers the fundamentals in theory and practice of entrepreneurship in new technology ventures. Main topics covered are success factors in the creation of new firms, including founding, financing and growing a venture.

This course provides theory-grounded knowledge and practice-driven skills for founding, financing, and growing new technology ventures. A critical understanding of dos and don'ts is provided through highlighting and discussing real life examples and cases.

See course website

Lecture notes
Lecture slides and case material

Human Factors I

This course teaches methods and models for fMRI data analysis, covering all aspects of statistical parametric mapping (SPM), incl.

The lecture includes a general introduction to the principles of tomographic imaging from image formation to image reconstruction. It provides the physical and engineering basics to understand how imaging beamlines at synchrotron facilities work, looks into the recently developed phase contrast methods, and explores the first applications of X-ray nano-tomographic experiments.

The course finally provides the necessary background to understand the quantitative evaluation of tomographic data, from basic image analysis to complex morphometrical computations and 3D visualization, keeping the focus on biomedical applications.

Lecture notes
Available online

Literature
Will be indicated during the lecture.
Abstract
Every day humans interact with various systems. Strategies of interaction, individual needs, physical & mental abilities, and system properties are important factors in controlling the quality and performance in interaction processes. In the lecture, factors are investigated by basic scientific approaches. Discussed topics are important for optimizing people's satisfaction & overall performance.

Objective
The goal of the lecture is to empower students in better understanding the applied theories, principles, and methods in various applications. Students are expected to learn about how to enable an efficient and qualitatively high standing interaction between human and the environment, considering costs, benefits, health, and safety as well. Thus, an ergonomic design and evaluation process of products, tasks, and environments may be promoted in different disciplines. The goal is achieved in addressing a broad variety of topics and embedding the discussion in macroscopic factors such as the behavior of consumers and objectives of economy.

Content
- Physiological, physical, and cognitive factors in sensation and perception
- Body spaces and functional anthropometry
- Experimental techniques in assessing human performance and well-being
- Human factors and ergonomics in system designs, product development and innovation
- Human information processing and biological cybernetics
- Interaction among consumers, environments, behavior, and tasks

Literature

376-1179-00L Applications of Cybernetics in Ergonomics W 1 credit 1U
M. Menozzi Jäckli, Y.Y. Hedinger Huang, R. Huang

Abstract
Cybernetics systems have been studied and applied in various research fields, such as applications in the ergonomics domain. Research interests include the man-machine interaction (MMI) topic which involving the performance in multi-model interactions, quantification in gestalt principles in product development; or the information processing matter.

Objective
To learn and practice cybernetics principles in interface designs and product development.

Content
- Fitt's law applied in manipulation tasks
- Hick-Hyman law applied in design of the driver assistance systems - Vigilance applied in quality inspection
- Accommodationvergence crosslink function
- Cross-link models in neuroscience - the ocular motor control system
- Human performance in optimization of production lines

Literature

376-1279-00L Virtual Reality in Medicine W 3 credits 2V
R. Riemer, M. Harders

Abstract
Virtual Reality has the potential to support medical training and therapy. This lecture will derive the technical principles of multi-modal (audiovisual, haptic, tactile etc.) input devices, displays and rendering techniques. Examples are presented in the fields of surgical training, intra-operative augmentation, and rehabilitation. The lecture is accompanied by practical courses and excursions.

Objective
Provide theoretical and practical knowledge of new principles and applications of multi-modal simulation and interface technologies in medical education, therapy, and rehabilitation.

Content
Virtual Reality has the potential to provide descriptive and practical information for medical training and therapy while relieving the patient and/or the physician. Multi-modal interactions between the user and the virtual environment facilitate the generation of high-fidelity sensory impressions, by using not only visual and auditory modalities, but also kinesthetic, tactile, and even olfactory feedback. On the basis of the existing physiological constraints, this lecture will derive the technical requirements and principles of multi-modal input devices, displays, and rendering techniques. Several examples are presented that are currently being developed or already applied for surgical training, intra-operative augmentation, and rehabilitation. The lecture will be accompanied by several practical courses on graphical and haptic display devices as well as excursions to facilities equipped with large-scale VR equipment.

Target Group:
Students of higher semesters and PhD students of
- D-HEST, D-MAVT, D-ITE, D-INFK, D-PHYS
- Robotics, Systems and Control Master
- Biomedical Engineering/Movement Science and Sport
- Medical Faculty, University of Zurich

Literature

Prerequisites / notice
The course language is English.
Basic experience in Information Technology and Computer Science will be of advantage.
More details will be announced in the lecture.

376-1351-00L Micro/Nanotechnology and Microfluidics for Biomedical Applications W 2 credits 2V
E. Delamarche

Abstract
This course is an introduction to techniques in micro/nanotechnology and to microfluidics. It reviews how many familiar devices are built and can be used for research and biomedical applications. Transistors for DNA sequencing, beakers for patterning proteins, hard-disk technology for biosensing and scanning microfluidics for analyzing tissue sections are just a few examples of the covered topics.

Objective
The main objective of the course is to introduce micro/nanotechnology and microfluidics to students having a background in the life sciences. The course should familiarize the students with the techniques used in micro/nanotechnology and show them how micro/nanotechnology pervades throughout life sciences. Microfluidics will be emphasized due to their increasing importance in research and medical applications. The second objective is to have life science students less intimidated by micro/nanotechnology and make them able to link instruments and techniques to specific problems that they might have in their projects/studies. This will also help students getting access to the ETHZ/IBM Nanotech Center infrastructure if needed.

Content
Mostly formal lectures (2 x 45 min), with a 2 hour visit and introduction to cleanroom and micro/nanotechnology instruments, last 3 sessions would be dedicated to the presentation and evaluation of projects by students (3 students per team).

Prerequisites / notice
Nanotech center and lab visit at IBM would be mandatory, as well as attending the student project presentations.

376-1504-00L Physical Human Robot Interaction (pHRI) W 4 credits 2V+2U
R. Gassert, O. Lamberty, R. Riemer

Abstract
This course focuses on the emerging, interdisciplinary field of physical human-robot interaction, bringing together themes from robotics, real-time control, human factors, haptics, virtual environments, interaction design and other fields to enable the development of human-oriented robotic systems.

Number of participants limited to 26.
The objective of this course is to give an introduction to the fundamentals of physical human robot interaction, through lectures on the underlying theoretical/mechatronics aspects and application fields, in combination with a hands-on lab tutorial. The course will guide students through the design and evaluation process of such systems.

By the end of this course, you should understand the critical elements in human-robot interactions - both in terms of engineering and human factors - and use these to evaluate and design safe and efficient assistive and rehabilitative robotic systems. Specifically, you should be able to:

1) identify critical human factors in physical human-robot interaction and use these to derive design requirements;
2) compare and select mechatronic components that optimally fulfill the design requirements;
3) derive a model of the device dynamics to guide and optimize the selection and integration of selected components into a functional system;
4) design control hardware and software and implement and test human-interactive control strategies on the physical setup;
5) characterize and optimize such systems using both engineering and psychophysical evaluation metrics;
6) investigate and optimize one aspect of the physical setup and convey and defend the gained insights in a technical presentation.

This course provides an introduction to fundamental aspects of physical human-robot interaction. After an overview of human haptic, visual and auditory sensing, neurophysiology and psychophysics, principles of human-robot interaction systems (kinematics, mechanical transmissions, robot sensors and actuators used in these systems) will be introduced. Throughout the course, students will gain knowledge of interaction control strategies including impedance/admittance and force control, haptic rendering basics and issues in device design for humans such as transparency and stability analysis, safety hardware and procedures. The course is organized into lectures that aim to bring students up to speed with the basics of these systems, readings on classical and current topics in physical-human-robot interaction, laboratory sessions and lab visits.

Students will attend laboratory sessions where they will implement the theoretical aspects learned during the lectures. Here the salient features of haptic device design will be identified and theoretical aspects will be implemented in a haptic system based on the haptic paddle (http://edu.haptics.org/index.php/HapticDevices/HapticPaddles), by creating simple dynamic haptic virtual environments and understanding the performance limitations and causes of instabilities (direct/virtual coupling, friction, damping, time delays, sampling rate, state quantization, etc.) during rendering of different mechanical properties.

Objective

Content

Literature

Prerequisites / notice

Lecture notes

Will be distributed through the document repository before the lectures. http://www.relab.ethz.ch/education/courses/phri.html


This lecture serves as an introduction to the field of trauma biomechanics. Emphasis is placed on the interdisciplinary nature of impact prevention. The lecture provides an introduction to the basics of trauma biomechanics.

**Objective**

- Provides an introduction to the basics of trauma biomechanics.
- Emphasis on the interdisciplinary nature of impact prevention.

**Content**

- Introduction to the basic principles of trauma biomechanics.
- This course includes ethical considerations, measurement techniques, clinical testing, accessing movement data and analysis as well as modeling with regards to human movement.

**Literature**


## 376-1974-00L: Colloquium in Biomechanics

**Abstract**

Current topics in biomechanics presented by speakers from academia and industry.

**Objective**

- Getting insight into actual areas and problems of biomechanics.

**Literature**

- Available via homepage.

## 402-0674-00L: Physics in Medical Research: From Atoms to Cells

**Abstract**

Scanning probe and diffraction techniques allow studying activated atomic processes during early stages of epitaxial growth. For quantitative description, rate equation analysis, mean-field nucleation and scaling theory. An overview on the controlled delivery and targeting of drugs is presented, with a focus on anticancer drugs, therapeutic peptides, proteins, nucleic acids and vaccines.

**Objective**

- The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocyte behaviour.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxidic and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostuctures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure's shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.
Introduction into structural and functional aspects of the immune system.
Basic knowledge of the mechanisms and the regulation of an immune response.

- Introduction and historical background
- Innate and adaptive immunity, Cells and organs of the immune system
- B cells and antibodies
- Generation of diversity
- Antigen presentation and Major Histocompatibility (MHC) antigens
- Thymus and T cell selection
- Autoimmunity
- Cytotoxic T cells and NK cells
- Th1 and Th2 cells, regulatory T cells
- Allergies
- Hypersensitivities
- Vaccines, immune-therapeutic interventions

Electronic access to the documentation will be provided. The link can be found at "Lernmaterialien"

The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

Students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalization of biochemical processes.
Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.

Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials.

Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

### Biological Engineering and Biotechnology

**Objective**

- Insight Into The Mammalian Cell Cycle. Cycling, The Balance Between Proliferation and Cancer - Implications For Biopharmaceutical Manufacturing.
- The Licence To Kill. Apoptosis Regulatory Networks - Engineering of Survival Pathways To Increase Robustness of Production Cell Lines.
- Everything Under Control I. Regulated Transgene Expression in Mammalian Cells - Facts and Future.
- Secretion Engineering. The Traffic Jam getting out of the Cell.
- The Clinics.

**Lecture notes**

Handout during the course.

### Major in Molecular Health Sciences

#### Compulsory Courses

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
376-0300-00L | Translational Science for Health and Medicine | O | 3 credits | 2G | J. Goldhahn, C. Wolfrum

**Abstract**

Translational science is a cross disciplinary scientific research that is motivated by the need for practical applications that help people. The course should help to clarify basics of translational science, illustrate successful applications and should enable students to integrate key features into their future projects.

**Objective**

After completing this course, students will be able to understand:

Principles of translational science (including project planning, ethics application, basics of resource management and interdisciplinary communication)
Content

What is translational science and what is it not?

How to identify need?
- Disease concepts and consequences for research
- Basics about incidence, prevalence etc., and orphan indications

How to choose the appropriate research type and methodology
- Ethical considerations including ethics application
- Pros and cons of different types of research
- Coordination of complex approaches incl. timing and resources

How to measure success?
- Outcome variables
- Improving the translational process

Challenges of communication?

How independent is translational science?
- Academic boundary conditions vs. industrial influences

Positive and negative examples will be illustrated by distinguished guest speakers.

Electives

Elective Courses I

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-0205-00L</td>
<td>Molecular Disease Mechanisms I</td>
<td>W</td>
<td>6 credits</td>
<td>4V</td>
<td>C. Wolfrum, C. Ciaudo, M. Ristow, M. Stoffel, A. Wutz, M. Zenobi-Wong</td>
</tr>
</tbody>
</table>

Abstract

The mechanisms of disease development will be studied. Main topics will be: Genetic regulation of disease development with a focus on monogenic and polygenic forms. In addition the methods used in elucidating genetic components in disease progression will be discussed. Ageing and development associated disease progression including the underlying molecular mechanisms.

Objective

To understand the mechanisms governing disease development with a special emphasis on genetic and ageing associated components.

Elective Courses II

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0223-00L</td>
<td>Immunology III</td>
<td>W</td>
<td>4 credits</td>
<td>2V</td>
<td>M. Kopf, M. Bachmann, J. Kisielow, A. Lanzavecchia, S. R. Leibundgut, A. Oxenius, R. Spörri</td>
</tr>
</tbody>
</table>

Abstract

This course provides a detailed understanding of
- development of T and B cells
- the dynamics of an immune response during acute and chronic infection
- mechanisms of immunopathology
- modern vaccination strategies

Key experimental results will be shown to help understanding how immunological text book knowledge has evolved.

Objective

Obtain a detailed understanding of
- the development, activation, and differentiation of different types of T cells and their effectormechanisms during immune responses,
- Recognition of pathogenic microorganisms by the host cells and molecular events thereafter,
- events and signals for maturation of naive B cells to antibody producing plasma cells and memory B cells.
- Optimization of B cell responses by intelligent design of new vaccines

Content

- Development and selection of CD4 and CD8 T cells, natural killer T cells (NKT), and regulatory T cells (Treg)
- NK T cells and responses to lipid antigens
- Differentiation, characterization, and function of CD4 T cell subsets such as Th1, Th2, and Th17
- Overview of cytokines and their effector function
- Co-stimulation (signals 1-3)
- Dendritic cells
- Evolution of the "Danger" concept
- Cells expressing Pattern Recognition Receptors and their downstream signals
- T cell function and dysfunction in acute and chronic viral infections

Literature

Documents of the lectures are available for download at: https://moodle-app2.let.ethz.ch/course/view.php?id=998

Prerequisites / notice

Immunology I and II

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0317-00L</td>
<td>Immunology I</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>A. Oxenius, M. Kopf</td>
</tr>
</tbody>
</table>

Abstract

Introduction into structural and functional aspects of the immune system.

Basic knowledge of the mechanisms and the regulation of an immune response.

Objective

Introduction into structural and functional aspects of the immune system.

Basic knowledge of the mechanisms and the regulation of an immune response.

Content

- Introduction and historical background
- Innate and adaptive immunity, Cells and organs of the immune system
- B cells and antibodies
- Generation of diversity
- Antigen presentation and Major Histoincompatibility (MHC) antigens
- Thymus and T cell selection
- Autoimmunity
- Cytotoxic T cells and NK cells
- Th1 and Th2 cells, regulatory T cells
- Allergies
- Hypersensitivities
- Vaccines, immune-therapeutic interventions

Lecture notes

Electronic access to the documentation will be provided. The link can be found at “Lernmaterialien”

Literature


Prerequisites / notice

Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a “Sessionsprüfung”.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0512-00L</td>
<td>Current Topics in Molecular and Cellular Neurobiology</td>
<td>W</td>
<td>2 credits</td>
<td>1S</td>
<td>U. Suter</td>
</tr>
</tbody>
</table>

Number of participants limited to 8.
Abstract: The course is a literature seminar or "journal club". Each Friday a student, or a member of the Suter Lab in the Institute of Molecular Health Sciences, will present a paper from the recent literature.

Objective: The course introduces you to recent developments in the fields of cellular and molecular neurobiology. It also supports you to develop your skills in critically reading the scientific literature. You should be able to grasp what the authors wanted to learn i.e. their goals, why the authors chose the experimental approach they used, the strengths and weaknesses of the experiments and the data presented, and how the work fits into the wider literature in the field. You will present one paper yourself, which provides you with practice in public speaking.

Content: You will present one paper yourself. Give an introduction to the field of the paper, then show and comment on the main results (all the papers we present are available online, so you can show original figures with a beamer). Finish with a summary of the main points and a discussion of their significance.

You are expected to take part in the discussion and to ask questions. To prepare for this you should read all the papers beforehand (they will be announced a week in advance of the presentation).

Lecture notes: Presentations will be made available after the seminars.

Literature: We cover a range of themes related to development and neurobiology. Before starting your preparations, check with Jorge Pereira (jorge.pereira@biol.ethz.ch), who helps you with finding an appropriate paper.

Prerequisites / notice: You must attend at least 80% of the journal clubs, and give a presentation of your own. At the end of the semester there will be a 30 minute oral exam on the material presented during the semester. The grade will be based on the exam (45%), your presentation (45%), and a contribution based on your active participation in discussion of other presentations (10%).

551-0571-00L From DNA to Diversity (University of Zurich)

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

UZH Module Code: BIO336

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract: The evolution of the various body-plans is investigated by means of comparison of developmentally essential control genes of molecularly analysed model organisms.

Objective: By the end of this module, each student should be able to:
- recognize the universal principles underlying the development of different animal body plans.
- explain how the genes encoding the molecular toolkit have evolved to create animal diversity.
- relate changes in gene structure or function to evolutionary changes in animal development.

Key skills: By the end of this module, each student should be able to:
- present and discuss a relevant evolutionary topic in an oral presentation
- select and integrate key concepts in animal evolution from primary literature
- participate in discussions on topics presented by others

551-1003-00L Methods of Biological Analysis

W 2 credits 2V A. Hajnal, D. Bopp, E. Hafen

Abstract: Principles of the most important separation techniques and the interpretation of molecular spectra.

Objective: Knowledge of the necessary basics and the possibilities of application of the relevant spectroscopical and separation methods in analytical chemistry.


Lecture notes: A comprehensive script is available in the HCI-Shop. A summary of the part "Spektroskopie" defines the relevant material for the exam.

Literature:
- K. Cammann, Instrumentelle Analytische Chemie, Verfahren, Anwendungen, Qualitätssicherung, Spektrum Akademischer Verlag, Heidelberg, 2001;

Prerequisites / notice: Prerequisites:
- 529-1001-01 V *Allgemeine Chemie I (für Biol./Pharm.Wiss.)*
- 529-1001-00 P *Allgemeine Chemie I (für Biol./Pharm.Wiss.)*
- 529-1011-00 G "Organische Chemie I (für Biol./Pharm.Wiss.)"

551-1105-00L Glycobiology

W 4 credits 2V M. Aebi, T. Hennet

Abstract: Structural principles, nomenclature and different classes of glycosylation. The different pathways of N- and O-linked protein glycosylation and glycolipid biosynthesis in prokaryotes and eukaryotes are discussed. Specific glycan binding proteins and their role in deciphering the glycan code are presented. The role of glycans in infectious diseases, antigen mimicry and autoimmunity are discussed.

Objective: Detailed knowledge in 1) the different areas of prokaryotic and eukaryotic glycobiology, in particular in the biosynthesis of glycoproteins and glycolipids, 2) the cellular machinery required for these pathways, 3) the principles of carbohydrate/protein interaction, 4) the function of lectins, 5) the role of glycans in infectious disease.

Content: Structure and linkages; analytical approaches; N-linked protein glycosylation (ER, Golgi); glycan-assisted protein folding and quality control; O-linked protein glycosylation; glucosaminoglycans; glycolipids; prokaryotic glycosylation pathways; lectins; glycans and infectious disease

Lecture notes: handouts


**Prerequisites / notice**

The course will be in English. It will include the preparation of short essays (marked) about defined topics in Glycobiology.

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**551-1145-00L**

**Viral and Non-Viral Vectors for Human Gene-Therapy - W**

from Pathogens to Safe Medical Applications

*No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.*

**UZH Module Code: BIO709**

**Abstract**

Basic aspects of virology, the viral mechanisms for transfer of genetic material into cells, different vector-systems and target cells, animal models, specific applications for inborn diseases of the immune system and of metabolism, adverse effects, and new developments of vector systems will be taught.

**Objective**

Knowledge of important viral and non-viral vector systems.

Knowledge of application in human diseases.

Knowledge of limiting factors.

---

**551-1153-00L**

**System Biology of Metabolism**

**W**

4 credits

2V

U. Sauer, N. Zamboni, M. Zampieri

**Abstract**

Starting from contemporary biological problems related to metabolism, the course focuses on systems biological approaches to address them. In a problem-oriented, this-is-how-it-is-done manner, we thereby teach modern methods and concepts.

**Objective**

Develop a deeper understanding of how relevant biological problems can be solved, thereby providing advanced insights to key experimental and computational methods in systems biology.

---

**551-1171-00L**

**Immunology: from Milestones to Current Topics**

**W**

4 credits

2S

B. Ludewig, M. Kopf, A. Oxenius

**Abstract**

Milestones in Immunology: on old concepts and modern experiments

**Objective**

The course will cover several grand topics in immunology (B cells, innate immunity, antigen presentation, tumor immunity, thymus and T cells, cytotoxic T cells and NK cells) and for each grand topic four hours will be allocated. During the first double hour, historical milestone papers will be presented by the supervisor providing an overview on the development of the conceptual framework and critical technological advances. The students will also prepare themselves for this double lecture by reading the historical milestone papers and contributing to the discussion. In the following lecture up to four students will present each a recent high impact research paper which emerged from the landmark achievements of the previously discussed milestone concepts.

**Content**

Milestones and current topics of innate immunity, antigen presentation, B cells, thymus and T cells, cytotoxic T cells and NK cells, and tumor immunology.

**Literature**

Original and review articles will be distributed by the lecturer.

---

**551-1303-00L**

**Current Research Topics in Cellular Biochemistry**

**W**

4 credits

2S

V. Panse, C. M. Azzalin, V. Korkhov, R. Kroschewski, P. Picotti, A. E. Smith, F. van Drogen

**Abstract**

Introduction, presentation, evaluation, critical discussion and written analysis of recent scientific articles in the research area of cellular biochemistry.

**Objective**

The goal of the course is to train students in critical analysis of current research. Analysis by individual students will be assessed in oral and written form. The students will be able to introduce, present, evaluate, critically discuss and write about recent scientific articles in the research area of cellular biochemistry.

**Content**

The course is composed of seminar lectures on specific topics, followed by discussions of scientific papers relevant to these topics. The students will work in small groups under the supervision of a tutor. Each group prepares and presents a lecture, and leads a critical discussion of the selected articles. While being exposed to advanced research in cellular biochemistry, the students practice the critical reading of scientific literature, the evaluation of experimental approaches, and the interpretation of results.

**Literature**

The relevant references to primary literature and review articles will be provided during the course.

---

**551-1323-00L**

**Fundamentals of Biology II: Biochemistry and Molecular Biology**

**W**

4 credits

4V

K. Locher, N. Ban, R. Glockshuber, E. Weber-Ban

**Abstract**

The course provides an introduction to Biochemistry / Molecular Biology with some emphasis on chemical and biophysical aspects.

**Objective**

Topics include the structure-function relationship of proteins / nucleic acids, protein folding, enzymatic catalysis, cellular pathways involved in bioenergetics and the biosynthesis and breakdown of amino acids, glycanas, nucleotides, fatty acids and phospholipids, and steroids. There will also be a discussion of DNA replication and repair, transcription, and translation.

**Literature**

None

**Prerequisites / notice**

Some of the lectures are given in the English language.

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**636-0003-00L**

**Biological Engineering and Biotechnology**

**W**

6 credits

3V

M. Fussenegger

**Abstract**

Biological Engineering and Biotechnology will cover the latest biotechnological advances as well as their industrial implementation to engineer mammalian cells for use in human therapy. This lecture will provide forefront insights into key scientific aspects and the main points in industrial decision-making to bring a therapeutic from target to market.
Attendees will learn what information is contained in genetic sequencing data and how this information is extracted from the sequencing data. The main concepts introduced are:

- models in molecular evolution
- phylogenetic & phylodynamic inference
- maximum likelihood and Bayesian statistics
- stochastic processes

Attendees will apply these concepts to a number of applications yielding biological insight into:

- epidemiology
- pathogen evolution
- macroevolution of species

The course consists of three parts. We first introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Second, we employ these evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamics processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades.

Lecture notes

Slides of the lecture will be available online.

Prerequisites / notice

Basic knowledge in linear algebra, analysis, and statistics.

636-0017-00L Molecular Evolution, Phylogenetics and Phylodynamics W 4 credits 3G T. Stadler

Abstract

The aim of the course is to provide up-to-date knowledge on how we can obtain an understanding of the evolution and population dynamics of organisms based on their genetic sequencing data, employing key concepts from molecular evolution, phylogenetics and phylodynamics. Throughout the course, we tie the models and methods closely with applications, mainly in the field of epidemiology and evolution.

Objective

Attendees will learn what information is contained in genetic sequencing data and how this information is extracted from the sequencing data. The main concepts introduced are:

- models in molecular evolution
- phylogenetic & phylodynamic inference
- maximum likelihood and Bayesian statistics
- stochastic processes

Content

The course consists of three parts. We first introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Second, we employ these evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamics processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades.

Lecture notes

Slides of the lecture will be available online.

Prerequisites / notice

Basic knowledge in linear algebra, analysis, and statistics.

636-0507-00L Synthetic Biology II W 4 credits 4A S. Panke, Y. Benenson, J. Stelling

Abstract

7 months biological design project, during which the students are required to give presentations on advanced topics in synthetic biology (specifically genetic circuit design) and then select their own biological system to design. The system is subsequently modeled, analyzed, and experimentally implemented. Results are presented at an international student competition at the MIT (Cambridge).

Objective

The students are supposed to acquire a deep understanding of the process of biological design including model representation of a biological system, its thorough analysis, and the subsequent experimental implementation of the related problems.

Content

Presentations on advanced synthetic biology topics (eg genetic circuit design, adaptation of systems dynamics, analytical concepts, large scale de novo DNA synthesis), project selection, modeling of selected biological system, design space exploration, sensitivity analysis, conversion into DNA sequence, (DNA synthesis external,) implementation and analysis of design, summary of results in form of scientific presentation and poster, presentation of results at the iGEM international student competition (www.igem.org).

Lecture notes

Handouts during course

Prerequisites / notice

The final presentation of the project is typically at the MIT (Cambridge, US). Other competing schools include regularly Imperial College, Cambridge University, Harvard University, UC Berkeley, Princeton University, CalTech, etc.

This project takes place between end of Spring Semester and beginning of Autumn Semester. Registration in April.

Please note that the number of ECTS credits and the actual work load are disconnected.

752-4009-00L Molecular Biology of Foodborne Pathogens W 3 credits 2V M. Loessner, M. Schuppler

Abstract

The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant associated pathogens and microbial risks.

Objective

Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks.

Content

Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks?

Lecture notes

Electronic copies of the presentation slides (PDF) will be made available for download to registered students.

Literature

Recommendations will be given in the first lecture

Prerequisites / notice

Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until 11:15 h), with no break.

752-6101-00L Nutrition and Chronic Disease (HS) W 3 credits 2V M. B. Zimmermann

Abstract

To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

Objective

To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.
The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

There is no script. Powerpoint presentations will be made available on-line to students.

To be provided by the individual lecturers, at their discretion.

No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.

752-6105-00L Epidemiology and Prevention W 3 credits 2V M. Eichholzer

The module Epidemiology and Prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented.

Students are able
- to evaluate the scientific evidence on the effects of diet on human health
- to describe the role of nutritional factors in the prevention of chronic diseases
- to assess the nutritional status of a population (Switzerland taken as an example)
- to put forward preventive measures addressing individuals but also our society in relation to the obesity epidemic

The module Epidemiology and Prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented. Switzerland taken as an example, the health risks associated with our nutritional habits will be evaluated. Finally, examples of preventive measures addressing individuals but also the society in relation to the obesity epidemic and other threats to health are discussed.

Major in Neurosciences

Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-0300-00L</td>
<td>Translational Science for Health and Medicine</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>J. Goldhahn, C. Wolfrum</td>
</tr>
</tbody>
</table>

Translational science is a cross disciplinary scientific research that is motivated by the need for practical applications that help people. The course should help to clarify basics of translational science, illustrate successful applications and should enable students to integrate key features into their future projects.

After completing this course, students will be able to understand:
- Principles of translational science (including project planning, ethics application, basics of resource management and interdisciplinary communication)
- What is translational science and what is it not?
- How to identify need?
- Disease concepts and consequences for research
  - Basics about incidence, prevalence etc., and orphan indications
- How to choose the appropriate research type and methodology
- Ethical considerations including ethics application
- Pros and cons of different types of research
- Coordination of complex approaches incl. timing and resources
- How to measure success?
- Outcome variables
- Improving the translational process
- Challenges of communication?
- How independent is translational science?
- Academic boundary conditions vs. industrial influences

Positive and negative examples will be illustrated by distinguished guest speakers.

Electives

Elective Courses I

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1305-00L</td>
<td>Development of the Nervous System</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>E. Stoeckli, further lecturers</td>
</tr>
</tbody>
</table>

The course covers the development of the nervous system (NS) with a focus on neurogenesis and migration, axon growth, synapse formation, mol. & cell. mechanisms, and diseases of the developing NS.

The aim is to give a deepened insight into the normal development, of the nervous system based on molecular, cellular and biochemical approaches.

The main focus is on the development of the NS: Early development of the NS, cellular processes, nerve fiber growth, building of synapses and neuronal networks.

Must be downloaded from OLAT: https://www.olat.uzh.ch/olat/dmz/ as BIO344

The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on OLAT.

Auxiliary tools:
None. Bring something to write and your student ID

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<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1305-01L</td>
<td>Structure, Plasticity and Repair of the Nervous System</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>M. E. Schwab, L. Filli, K. A. Martin, further lecturers</td>
</tr>
</tbody>
</table>

The course covers the structure, plasticity and regeneration of the adult nervous system (NS) with focus on: sensory systems, cognitive functions, learning and memory, molecular and cellular mechanisms, animal models, and diseases of the NS.

The aim is to give a deepened insight into the structure, plasticity and regeneration of the nervous system based on molecular, cellular and biochemical approaches.

The main focus is on the structure, plasticity and regeneration of the NS: biology of the adult nervous system; structural plasticity of the adult nervous system, regeneration and repair: networks and nerve fibers, regeneration, pathological loss of cells.

ETH students: Lecture notes will be provided on Moodle https://moodle-app2.let.ethz.ch/course/view.php?id=694
Password will be provided at the beginning of the lecture.

UZH students: Lecture notes will be provided on OLAT: https://www.olat.uzh.ch/olat/dmz/

The lecture requires reading of book chapters, handouts and original scientific papers. Further information will be given in the individual lectures and are mentioned on Moodle / OLAT.

Repetitionsprüfung 15. Juni 2016, HG E 26.1, 9-10.30h
### Elective Courses II

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0104-00L</td>
<td>Uncertainty Quantification for Engineering &amp; Life Sciences</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>J. Beck, P. Koumoutsakos</td>
</tr>
<tr>
<td>Abstract</td>
<td>Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.</td>
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<tr>
<td>Objective</td>
<td>The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.</td>
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<tr>
<td>Content</td>
<td>Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modeling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
| Literature | 1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia  
2. Probability Theory: The Logic of Science by E. T. Jaynes  
3. Class Notes |
| Prerequisites / notice | Fundamentals of Probability, Fundamentals of Computational Modeling |
| 227-0447-00L | Image Analysis and Computer Vision | W    | 6 credits | 3V+1U | G. Székely, O. Göksel, L. Van Gool |
| Objective  | Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises. |
| Content    | The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed. |
| Lecture notes | Course material Script, computer demonstrations, exercises and problem solutions |
| Prerequisites / notice | Prerequisites: Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C.  
The course language is English. |
| 227-1035-00L | Dynamical Systems in Biology | W    | 6 credits | 2V+1U | R. Stoop |
| Abstract   | This lecture uses the concepts from dynamical systems (Course: "Computable Chaos in Dynamical Systems") for the description of salient phenomena in complex examples from population dynamics, neuroinformatics and system biology. A particular focus is on the concept of limit cycle solutions and their coupling. |
| Objective  | Applying concepts from nonlinear dynamics to biological systems. Combining theoretical modeling with supporting computer simulations. |
| 227-1037-00L | Introduction to Neuroinformatics | W    | 6 credits | 2V+1U | K. A. Martin, M. Cook, V. Mante, M. Pfeiffer |
| Abstract   | The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented. |
| Objective  | Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monocultures of physics, maths, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enchantments and challenges that we all face in taking this major 21st century problem and how each discipline can contribute to discovering solutions. |
| Content    | This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks. |
| 227-1045-00L | Readings in Neuroinformatics | W    | 3 credits | 1S    | G. Indiveri, M. Cook, D. Kiper |
| Abstract   | Thirteen major areas of research have been selected, which cover the key concepts that have led to our current ideas of how the nervous system is built and functions. We will read both original papers and explore the conceptual links between them and discuss the 'sociology' of science, the pursuit of basic science questions over a century of research. |
Objective

It is a commonplace that scientists rarely cite literature that is older than 10 years and when they do, they usually cite one paper that serves as the representative for a larger body of work that has long since been incorporated anonymously in textbooks. Worse than that, many authors have not even read the papers they cite in their own publications. This course, Foundations of Neuroscience is one antidote.

Thirteen major areas of research have been selected, which cover the key concepts that have led to our current ideas of how the nervous system is built and functions. Understood in this sense, we will explore these areas of research by reading the original publications, instead of relying on someone else’s digested summary from a textbook or review. By doing this, we will learn how the discoveries were made, what instrumentation was used, how the scientists interpreted their own findings, and how their work, often over many decades and by many different scientists, linked together to generate the current view of mechanism and structure. We will also explore the personalities of the scientists and the context in which they made their seminal discoveries. To give one concrete example, in 1890 Roy and Sherrington showed that there was a neural activity-dependent regulation of blood flow in the brain. One hundred years later, Ogawa discovered that they could use Nuclear Magnetic Resonance (NMR) to measure a blood oxygen-level dependent (BOLD) signal, which they showed was neural activity-dependent. This discovery led to the development of human functional Magnetic Resonance Imaging (fMRI), which has revolutionized neuropsychology and neuropsychiatry. We will read both these original papers and explore the conceptual links between them and discuss the links between them and the sociology of science, which in this case, the pursuit of basic science questions over a century of research, led to an explosion in applications. We will also explore the personalities of the scientists and the context in which they made their seminal discoveries. Each week the course members will be given original papers to read for homework, they will have to write a short abstract for each paper. We will then meet weekly with the course leader (KACM) and an assistant for an hour or so long interactive seminar. An intimate knowledge of the papers will be assumed so that the discussion does not center simply on an exposition of the contents of the papers. Assessment will in the form of a written exam in which the students will be given a paper and asked to write a short abstract of the contents.

Content

It is a commonplace that scientists rarely cite literature that is older than 10 years and when they do, they usually cite one paper that serves as the representative for a larger body of work that has long since been incorporated anonymously in textbooks. Worse than that, many authors have not even read the papers they cite in their own publications. This course, Foundations of Neuroscience is one antidote.

Thirteen major areas of research have been selected, which cover the key concepts that have led to our current ideas of how the nervous system is built and functions. Unusually, we will explore these areas of research by reading the original publications, instead of reading someone else’s digested summary from a textbook or review. By doing this, we will learn how the discoveries were made, what instrumentation was used, how the scientists interpreted their own findings, and how their work, often over many decades and by many different scientists, linked together to generate the current view of mechanism and structure. We will also explore the personalities of the scientists and the context in which they made their seminal discoveries. To give one concrete example, in 1890 Roy and Sherrington showed that there was a neural activity-dependent regulation of blood flow in the brain. One hundred years later, Ogawa discovered that they could use Nuclear Magnetic Resonance (NMR) to measure a blood oxygen-level dependent (BOLD) signal, which they showed was neural activity-dependent. This discovery led to the development of human functional Magnetic Resonance Imaging (fMRI), which has revolutionized neuropsychology and neuropsychiatry. We will read both these original papers and explore the conceptual links between them and discuss the sociology of science, which in this case, the pursuit of basic science questions over a century of research, led to an explosion in applications. Each week the course members will be given between 2 and 4 papers to read for homework and we will then meet weekly for an hour long interactive seminar. An intimate knowledge of the papers will be assumed so that the discussion does not center simply on an exposition of the contents of the papers. Assessment will be done continuously as the individual students are asked to explain a figure, technique, or concept.

Literature

We display articles pertaining to the issues we cover in the class on the course’s webpage.

Prerequisites / notice

Since we are all experts on consciousness, we expect active participation and discussions!

227-1047-00L

Consciousness: From Philosophy to Neuroscience

Abstract

This seminar reviews the philosophical and phenomenological as well as the neurobiological aspects of consciousness. The subjective features of consciousness as well as the differences with perception and memory are important factors in controlling the quality and performance in interaction processes. In the lecture, factors are investigated by basic scientific approaches. Discussed topics are important for optimizing people’s satisfaction & overall performance.

Objective

The course’s goal is to give an overview of the contemporary state of consciousness research, with emphasis on the contributions brought by modern cognitive neuroscience. We aim to clarify concepts, explain their philosophical and scientific backgrounds, and to present some of the recent developments.

Content

The course includes discussions of scientific as well as philosophical articles. We review current thoughts on models of consciousness, and proposals for the neural correlate of consciousness (NCC).

237-1177-00L

Human Factors I

Abstract

Every day humans interact with various systems. Strategies of interaction, individual needs, physical & mental abilities, and system properties are important factors in controlling the quality and performance in interaction processes. In the lecture, factors are investigated by basic scientific approaches. Discussed topics are important for optimizing people’s satisfaction & overall performance.

Objective

The goal of the lecture is to empower students in better understanding the applied theories, principles, and methods in various applications. Emphasis is placed on students developing their own thinking through a discussion-centered course structure.

Content

- Physiological, physical, and cognitive factors in sensation and perception
- Body spaces and functional anthropology
- Experimental techniques in assessing human performance and well-being
- Human factors and ergonomics in system designs, product development and innovation
- Human information processing and biological cybernetics
- Interaction among consumers, environments, behavior, and tasks

Literature


376-1179-00L

Applications of Cybernetics in Ergonomics

Abstract

Cybernetics systems have been studied and applied in various research fields, such as applications in the ergonomics domain. Research interests include the man-machine interaction (MMI) topic which involving the performance in multi-model interactions, quantification in gestalt principles in product development; or the information processing features.

Objective

To learn and practice cybernetics principles in interface designs and product development.

Content

- Fitt’s law in applied manipulation tasks
- Hick-Hyman law in applied design of the driver assistance systems
- Vigilance applied in quality inspection
- Accommodationvergence crosslink function
- Cross-link models in neurobiology- the ocular motor control system
- Human performance in optimization of production lines

Literature


376-1414-00L

Current Topics in Brain Research

Abstract

Different national and international scientific guests are invited to present and discuss their actual scientific results.

Data: 06.02.2019 13:00 - Autumn Semester 2015

Page 726 of 1434
Objective
To exchange scientific knowledge and data and to promote communication and collaborations among researchers.

Content
Different scientific guests working in the field of molecular cognition, neurochemistry, neuromorphology and neurophysiology present their latest scientific results.

Lecture notes
no handout

Literature
no literature

376-1504-00L

Physical Human Robot Interaction (pHRI)

W 4 credits 2V+2U R. Gassert, O. Lamberty, R. Rienner

Number of participants limited to 26.

Abstract
This course focuses on the emerging, interdisciplinary field of physical human-robot interaction, bringing together themes from robotics, real-time control, human factors, haptics, virtual environments, interaction design and other fields to enable the development of human-oriented robotic systems.

Objective
The objective of this course is to give an introduction to the fundamentals of physical human robot interaction, through lectures on the underlying theoretical/mechanical principles and application fields, in combination with a hands-on lab tutorial. The course will guide students through the design and evaluation process of such systems.

By the end of this course, you should understand the critical elements in human-robot interactions - both in terms of engineering and human factors - and use these to evaluate and design safe and efficient assistive and rehabilitative robotic systems. Specifically, you should be able to:

1) identify critical human factors in physical human-robot interaction and use these to derive design requirements;
2) compare and select mechatronic components that optimally fulfill the defined design requirements;
3) derive a model of the device dynamics to guide and optimize the selection and integration of selected components into a functional system;
4) design control hardware and software and implement and test human-interactive control strategies on the physical setup;
5) characterize and optimize such systems using both engineering and psychophysical evaluation metrics;
6) investigate and optimize one aspect of the physical setup and convey and defend the gained insights in a technical presentation.

Content
This course provides an introduction to fundamental aspects of physical human-robot interaction. After an overview of human haptic, visual and auditory sensing, neurophysiology, principles of human-robot interaction systems (kinematics, mechanical transmissions, robot sensors and actuators used in these systems) will be introduced. Throughout the course, students will gain knowledge of interaction control strategies including impedance/admittance and force control, haptic rendering basics and issues in device design for humans such as transparency and stability analysis, safety hardware and procedures. The course is organized into lectures that aim to bring students up to speed with the basics of these systems, readings on classical and current topics in physical human-robot interaction, laboratory sessions and lab visits. Students will attend periodic laboratory sessions where they will implement the theoretical aspects learned during the lectures. Here the salient features of haptic devices will be identified and theoretical aspects will be implemented in a haptic system based on the haptic paddle (http://eduhaptics.org/index.php/HapticDevices/HapticPaddles), by creating simple dynamic haptic virtual environments and understanding the performance limitations and causes of instabilities (direct/virtual coupling, friction, damping, time delays, sampling rate, sensor quantization, etc.) during rendering of different mechanical properties.

Lecture notes
Will be distributed through the document repository before the lectures.

http://www.rel.tzi-aachen.de/education/courses/phri.html

Literature
Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Basic knowledge of the mechanisms and the regulation of an immune response. Basic knowledge of the mechanisms and the regulation of an immune response.

Introduction into structural and functional aspects of the immune system. Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a "Sessionsprüfung".

Introduction into structural and functional aspects of the immune system. Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response.

Introduction into structural and functional aspects of the immune system.

Concepts of modern genetics and genomics, including principles of classical genetics; yeast genetics; gene mapping; forward and reverse genetics; structure and function of eukaryotic chromosomes; molecular mechanisms and regulation of transcription, replication, DNA-repair and recombination; analysis of developmental processes; epigenetics and RNA interference.

Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes. Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression. Cellular Biochemistry (Part I) is taught in English.

Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

Basic knowledge of the mechanisms of foodborne diseases, with focus on interactions of the associated pathogens and microbial risks.
Content Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks?

Lecture notes Electronic copies of the presentation slides (PDF) will be made available for download to registered students.

Literature Recommendations will be given in the first lecture.

Prerequisites / notice Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until 11:15 h), with no break.

752-6403-00L Nutrition and Performance W 2 credits 2V S. Mettler, M. B. Zimmermann

Abstract The course introduces basic concepts of the interaction between nutrition and exercise and cognitive performance.

Objective To understand the potential effects of nutrition on exercise performance, with a focus on concepts and principles of nutrition before, during and after exercise.

Content The course will cover elementary aspects of sports nutrition physiology, including carbohydrate, glycogen, fat, protein and energy metabolism. A main focus will be to understand nutritional aspects before exercise to be prepared for intensive exercise bouts, how exercise performance can be supported by nutrition during exercise and how recovery can be assisted by nutrition after exercise. Although this is a scientific course, it is a goal of the course to translate basic sports nutrition science into practical sports nutrition examples.

Lecture notes Lecture slides and required handouts will be available on the ETH website.

Literature Information on further reading will be announced during the lecture. There will be some mandatory as well as voluntary readings.

Prerequisites / notice General knowledge about nutrition, human biology, physiology and biochemistry is a prerequisite for this course. The course builds on basic nutrition and biochemistry knowledge to address exercise and performance related aspects of nutrition.

Language: English

It is strongly recommended to attend the lectures. The lecture (including the handouts) is not designed for distance education.

Practical Training and Semester Project

Practical Training and Semester Project only for majors below-mentioned:
- Human Movement Science and Sport
- Health Technologies
- Molecular Health Sciences
- Neurosciences

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>376-2110-00L</td>
<td>Internship 12 Weeks (Research or Job Oriented)</td>
<td>W</td>
<td>15</td>
<td>34P</td>
<td>Professors</td>
</tr>
<tr>
<td>Abstract</td>
<td>Practical Training Internships are either research-oriented for exercising scientific (laboratory) methods or job-related for giving insight into the future world of work (industry, services, school). Students should exercise scientific working and/or get realistic insights into future jobs. This version of internships lasts for at least 12 weeks full time equivalent.</td>
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<td>Objective</td>
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<tr>
<td>376-2111-00L</td>
<td>Internship 8 Weeks (Research or Job Oriented)</td>
<td>W</td>
<td>10</td>
<td>23P</td>
<td>Professors</td>
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<tr>
<td>Abstract</td>
<td>Practical Training Internships are either research-oriented for exercising scientific (laboratory) methods or job-related for giving insight into the future world of work (industry, services, school). Students should exercise scientific working and/or get realistic insights into future jobs. This version of internships lasts for at least 8 weeks full time equivalent.</td>
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<tr>
<td>Objective</td>
<td>Students should exercise scientific working and/or get realistic insights into future jobs.</td>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>376-2112-00L</td>
<td>Internship 4 Weeks (Research or Job Oriented)</td>
<td>W</td>
<td>5</td>
<td>11P</td>
<td>Professors</td>
</tr>
<tr>
<td>Abstract</td>
<td>Practical Training Internships are either research-oriented for exercising scientific (laboratory) methods or job-related for giving insight into the future world of work (industry, services, school). Students should exercise scientific working and/or get realistic insights into future jobs. This version of internships lasts for at least 4 weeks full time equivalent.</td>
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<td>Objective</td>
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Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-HEST.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Research Internship

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>376-2100-00L</td>
<td>Research Internship</td>
<td>O</td>
<td>15</td>
<td>36A</td>
<td>Professors</td>
</tr>
<tr>
<td>Abstract</td>
<td>12-week internship intended for exercising (independent) scientific working. Students shall exercise scientific working as preparation for their master thesis.</td>
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<tr>
<td>Objective</td>
<td>The Research Internship lasts for at least 12 weeks full time equivalent. It can be combined with the Master Thesis.</td>
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<tr>
<td>Prerequisites / notice</td>
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Master Thesis

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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>376-2000-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30</td>
<td>71D</td>
<td>Supervisors</td>
</tr>
</tbody>
</table>
| Only students fulfilling the following criteria can start with their master thesis:
  a. successful completion of the bachelor programme;  
b. fulfillment of any additional requirements necessary to
gain admission to the master programme.

Abstract
6-months research study with topics from the chosen major within the field of Health Sciences and Technology. In general, it includes the study of existing literature, the specification of the research question, the choice of the methodological approach, the collection, analysis and interpretation of data, and the written and oral reporting of the findings.

Objective
The students shall demonstrate their ability to carry out a structured, scientific piece of work independently.

Prerequisites / notice
The Master Thesis can only be started after the Bachelor Degree was obtained and/or master admission requirements have been fulfilled.

Course Units for Additional Admission Requirements
The courses below are only for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>406-0253-AAL</td>
<td>Mathematics I &amp; II: Enrolment only for MSc students who need this course as additional requirement.</td>
<td>E-</td>
<td>13 credits</td>
<td>28R</td>
<td>A. Cannas da Silva</td>
</tr>
<tr>
<td>551-0110-AAL</td>
<td>Fundamentals of Biology II: Microbiology: Enrolment only for MSc students who need this course as additional requirement.</td>
<td>E-</td>
<td>2 credits</td>
<td>2R</td>
<td>J. Vorholt-Zambelli</td>
</tr>
<tr>
<td>551-0108-AAL</td>
<td>Fundamentals of Biology II: Plant Biology: Enrolment only for MSc students who need this course as additional admission requirement.</td>
<td>E-</td>
<td>2 credits</td>
<td>2R</td>
<td>W. Gruissem</td>
</tr>
</tbody>
</table>

Literature
- Bretscher, O.: Linear Algebra with Applications (Pearson Prentice Hall).
- Thomas, G. B.: Thomas’ Calculus, Parts 2 (Pearson Addison-Wesley).

Health Sciences and Technology Master - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Compulsory</th>
<th>Recommended, not eligible for credits</th>
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</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr Suitable for doctorate</td>
</tr>
<tr>
<td>Key for Hours</td>
<td>P</td>
<td>practical/laboratory course</td>
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<td>V</td>
<td>G</td>
<td>lecture with exercise</td>
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<td>U</td>
<td>A</td>
<td>exercise</td>
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<td>S</td>
<td>D</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>R</td>
<td>colloquium</td>
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</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
High-Energy Physics (Joint Master with EP Paris)

Core Subjects

Core Courses in Theoretical Physics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>402-0843-00L</td>
<td>Quantum Field Theory I</td>
<td>W</td>
<td>10</td>
<td>4V+2U</td>
<td>G. Isidori</td>
</tr>
</tbody>
</table>

Abstract
This course discusses the quantisation of fields in order to introduce a coherent formalism for the combination of quantum mechanics and special relativity. Topics include:
- Relativistic quantum mechanics
- Quantisation of bosonic and fermionic fields
- Interactions in perturbation theory
- Scattering processes and decays
- Radiative corrections

Objective
The goal of this course is to provide a solid introduction to the formalism, the techniques, and important physical applications of quantum field theory. Furthermore, it prepares students for the advanced course in quantum field theory (Quantum Field Theory II), and for work on research projects in theoretical physics, particle physics, and condensed-matter physics.

Core Courses in Experimental Physics

<table>
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<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>402-0891-00L</td>
<td>Phenomenology of Particle Physics I</td>
<td>W</td>
<td>10</td>
<td>3V+2U</td>
<td>A. Gehrmann-De Ridder, C. Grab</td>
</tr>
</tbody>
</table>

Abstract
Topics to be covered both in Phenomenology of Particle Physics I and II:
- Relativistic kinematics
- Cross section and phase space
- Elements of quantum electrodynamics
- Perturbation theory
- Unitary symmetries and QCD
- Electroweak interaction
- Flavour physics
- Neutrino physics

Objective
Introduction into modern particle physics

Content
Topics to be covered both in Phenomenology of Particle Physics I and II:
- Relativistic kinematics
- Cross section and phase space
- Elements of quantum electrodynamics
- Perturbation theory
- Unitary symmetries and QCD
- Electroweak interaction
- Flavour physics
- Neutrino physics

Literature
I.R. Aitchison, A.J.G. Hey, "Gauge Theories in Particle Physics"
A. Seiden, "Particle Physics - A comprehensive introduction"
F. Halzen, A. Martin, "Quarks and Leptons"

Electives

Optional Subjects in Physics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0715-00L</td>
<td>Low Energy Particle Physics</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>A. S. Antognini, F. Piegsa</td>
</tr>
</tbody>
</table>

Abstract
Low energy particle physics provides complementary information to high energy physics with colliders. In this lecture, we will concentrate on selected experiments, using mainly neutrons and muons, which have significantly improved our understanding of particle physics today.

Objective
The course aims to provide an introduction to selected advanced topics in low energy particle physics with neutrons and muons.

Content
Low energy particle physics provides complementary information to high energy physics with colliders. At the Large Hadron Collider one directly searches for new particles at energies up to the TeV range. In a complementary way, low energy particle physics indirectly probes the existence of such particles and provides constraints for "new physics", making use of precision and high intensities. Besides the sensitivity to effects related with new physics (e.g. lepton flavor violation, symmetry violations, CPT tests, search for electric dipole moments, new low mass exchange bosons etc.), low energy physics provides the best test of QED (electron g-2), the best tests of bound-state QED (atomic physics and exotic atoms), precise determinations of fundamental constants, information about the CKM matrix, precise information on the weak and strong force even in the non-perturbative regime etc.

In this lecture, we will concentrate on selected experiments, using mainly neutrons and muons, which have significantly improved our understanding of particle physics today. Starting from a general introduction on high intensity/high precision particle physics and the main characteristics of muons and neutrons and their production, we will then focus on the discussion of fundamental problems and ground-breaking experiments:

- Production and characteristics of muon and neutron beams
- Ultracold neutron production
- Measurement of the neutron lifetime and electric dipole moment
- The neutron in the gravitational field and its electric charge
- Muon and neutron decay correlations
- Lepton flavour violations with muons to search for new physics
- What atomic physics can do for particle physics and vice versa
- Laser experiments at accelerators
- From myonic hydrogen to the proton structure and bound-state QED
- From pionic hydrogen to the strong interaction and effective field theories
- etc.

Literature
Golub, Richardson & Lamoreaux: "Ultra-Cold Neutrons"
Rauh & Werner: "Neutron Interferometry"
Carlile & Willis: "Experimental Neutron Scattering"
Byrne: "Neutrons, Nuclei and Matter"
Klapdor-Kleingrothaus: "Non Accelerator Particle Physics"
Experimental Methods and Instruments of Particle Physics

**Abstract**

**Objective**
Acquire an in-depth understanding and overview of the essential elements of experimental methods in particle physics, including accelerators and experiments.

**Content**
1. Examples of modern experiments
2. Basics: Bethe-Bloch, radiation length, nucl. interaction length, fixed-target vs. collider, principles of measurements: energy- and momentum-conservation, etc
3. Physics and layout of accelerators
4. Charged particle tracking and vertexing
5. Calorimetry
6. Particle identification
7. Analysis methods: invariant and missing mass, jet algorithms, b-tagging
8. Special detectors: extended airshowers, emulsions, cryogenic detectors for dark matter detection
9. MC simulations (GEANT), trigger, readout, electronics

**Lecture notes**
Slides are handed out regularly, see www.physik.uzh.ch/lectures/empp/

**Lecture notes**
See lecture home page: http://ihp-lx2.ethz.ch/AstroTeilchen/

**Literature**

**Neutrino Physics**

**Abstract**
Theoretical basis and selected experiments to determine the properties of neutrinos and their interactions (mass, spin, helicity, chirality, oscillations, interactions with leptons and quarks).

**Objective**
Introduction to the physics of neutrinos with special consideration of phenomena connected with neutrino masses.

**Lecture notes**
Script

**Literature**


D.O. Caldwell, Current Aspects of Neutrino Physics, Springer.

After the course the student should have a good knowledge of some of the most relevant theories beyond the Standard Model and have acquired the necessary theoretical background to understand the main production and decay channels of the Higgs boson at high-energy colliders, and the corresponding experimental signatures.

The Physics of Electroweak Symmetry Breaking

Abstract

The aim is to understand the need of physics beyond the Standard Model, the basic techniques of model building in theories BSM and the elements of collider physics required to analyze their phenomenological implications. After an introduction to the SM and alternative theories of electroweak symmetry breaking, we will investigate these issues in the context of models with warped extra dimensions.

Objective

After the course the student should have a good knowledge of some of the most relevant theories beyond the Standard Model and have the techniques to understand those theories that have not been surveyed in the course. He or she should be able to compute the constraints on any model of new physics, its successes explaining current experimental data and its main phenomenological implications at colliders.

Prerequisites / notice

The former title of this course unit was "The Physics Beyond the Standard Model". If you already got credits for "The Physics Beyond the Standard Model" (402-0898-00L), you cannot get credits for "The Physics of Electroweak Symmetry Breaking" (402-0898-00L).

Literature

C. Misner, K. Thorne and J. Wheeler: Gravitation
S. Carroll - Spacetime and Geometry: An Introduction to General Relativity
R. Wald - General Relativity
S. Weinberg - Gravitation and Cosmology
N. Straumann - General Relativity with applications to Astrophysics

402-0899-65L Higgs Physics W 6 credits 2V+1U M. Donegà, M. Grazzini

Abstract

The course introduces the theory and phenomenology of the recently discovered Higgs boson. With this course the students will receive a detailed introduction to the physics of the Higgs boson in the Standard Model. They will acquire the necessary theoretical background to understand the main production and decay channels of the Higgs boson at high-energy colliders, and the corresponding experimental signatures.

Objective

With this course the students will receive a detailed introduction to the physics of the Higgs boson in the Standard Model. They will acquire the necessary theoretical background to understand the main production and decay channels of the Higgs boson at high-energy colliders, and the corresponding experimental signatures.

Content

Theory part:
- the Standard Model and the mass problem; WW scattering and the no-lose theorem
- the Higgs mechanism and its implementation in the Standard Model
- radiative corrections and the screening theorem
- theoretical constraints on the Higgs mass; the hierarchy problem
- Higgs production in e+e- collisions
- Higgs production at hadron colliders
- Higgs decays to fermions and vector bosons
- Higgs differential distributions, rapidity distribution, pt spectrum and jet vetoes
- Higgs properties and beyond the Standard Model perspective
- Outlook: The Higgs sector in weakly coupled and strongly coupled new physics scenarios.

Experimental part:
- Introductory material:
  - reminders of detectors/accelerators
  - reminders of statistics: likelihoods, hypothesis testing
  - reminders of multivariate techniques: Neural Networks, Decision Trees
- Main topics:
  - pre-history (pre-LEP)
  - LEP1: measurements at the Z-pole
  - LEP2: towards the limit mH<114 GeV
  - TeVatron searches
- LHC:
  -- main channels overview
  -- dissect on analysis
  -- combine information from all channels
  -- differential measurements
  -- off-shell measurements
- Future:
  -- pseudo-observables / EFT
  -- Beyond Standard Model

Literature

- Higgs Hunter's Guide
(by S.Dawson, J. Gunion, H. Haber and G. Kane)

Prerequisites / notice

Prerequisites: Quantum Field Theory I, Phenomenology of Particle Physics I

402-0777-00L Particle Accelerator Physics and Modeling I W 6 credits 2V+1U A. Adelmann

Abstract

This is the first of two courses, introducing particle accelerators from a theoretical point of view and covers state-of-the-art modeling techniques. It emphasizes the multidisciplinary aspect of the field, both in methodology (numerical and computational methods) and with regard to applications such as medical, industrial, material research and particle physics.

Objective

You understand the building blocks of particle accelerators. Modern analysis tools allows you to model state-of-the-art particle accelerators. In some of the exercises you will be confronted with next generation machines. We will develop a Python simulation tool (AcceLEGOrator) that reflects the theory from the lecture.

Content

- Particle Accelerators an Overview
- Relativity for Accelerator Physicists
- Building Blocks of Particle Accelerators
- Lie Algebraic Structure of Classical Mechanics and Applications to Particle Accelerators
- Symplectic Maps & Analysis of Maps
- Particle Tracking
- Linear & Circular Machines
- Cyclotrons
- Free Electron Lasers
- Collective effects in linear approximation
- Preview of Particle Accelerator Physics and Modeling II

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 734 of 1434
This is a guided self-study of original papers and of advanced textbooks in theoretical physics. Within the general topic, determined each semester.

This course unit is an alternative if no suitable "Proseminar Theoretical Physics" is available or if the proseminar is already overbooked.

D. A. Salamon
F. Nessi-Tedaldi
Professors

During semester breaks 6-12 students stay for 3 weeks at PSI and participate in a hands-on course on experimental particle physics. A small real experiment is performed in common, including apparatus design, construction, running and data analysis. The course includes some lectures, but the focus lies on the practical aspects of experimenting.

W. Boothby "An introduction to differentiable manifolds and Riemannian geometry"
J.M. Lee "Introduction to smooth manifolds"
M.P. Do Carmo "Riemannian Geometry"

Lecture notes Lecture Notes on "Functional Analysis" by D.A. Salamon

Prerequisites / notice Will be given as block course, language: English. For students of both ETH and University of Zurich.

#### Optional Subjects in Mathematics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3531-00L</td>
<td>Differential Geometry I</td>
<td>W</td>
<td>10</td>
<td>4V+1U</td>
<td>M. Burger</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course is an introduction to differential and riemannian geometry.</td>
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<tr>
<td>Objective</td>
<td>The aim is to lead students from a reasonable knowledge of advanced calculus, basic knowledge of general topology and solid knowledge of linear algebra to fundamental knowledge of differentiable manifolds and their basic tools. Riemannian geometry, some basic Lie theory, and de Rham cohomology will be developed as applications.</td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>W. Boothby &quot;An introduction to differentiable manifolds and Riemannian geometry&quot;</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>J.M. Lee &quot;Introduction to smooth manifolds&quot;</td>
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<tr>
<td></td>
<td>M.P. Do Carmo &quot;Riemannian Geometry&quot;</td>
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<tr>
<td>401-3461-00L</td>
<td>Functional Analysis I</td>
<td>W</td>
<td>10</td>
<td>4V+1U</td>
<td>D. A. Salamon</td>
</tr>
<tr>
<td>Abstract</td>
<td>Baire category; Banach and Hilbert spaces, bounded linear operators; Three Fundamental Principles: Uniform Boundedness, Open Mapping/Closed Graph, Hahn-Banach; Convexity; Dual Spaces: weak and weak* topologies, Banach-Alaoglu, reflexive spaces; Ergodic Theorem; compact operators and Fredholm theory, Closed Image Theorem; Spectral theory, self-adjoint operators.</td>
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</tbody>
</table>

Prerequisites / notice

Lecture notes Lecture Notes on "Functional Analysis" by D.A. Salamon

#### Proseminars and Semester Papers

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0717-MSL</td>
<td>Particle Physics at CERN</td>
<td>W</td>
<td>9</td>
<td>18P</td>
<td>F. Nessi-Tedaldi, W. Lustermann</td>
</tr>
<tr>
<td>Abstract</td>
<td>During the semester break participating students stay for 4 weeks at CERN and perform experimental work relevant to our particle physics projects. Dates to be agreed upon.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>Students learn, by doing, the needed skills to perform a small particle physics experiment: setup, problem solving, data taking, analysis, interpretation and presentation in a written report of publication quality.</td>
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</tr>
<tr>
<td>Content</td>
<td>Detailed information in:</td>
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<tr>
<td></td>
<td><a href="http://www@cmsdoc.cern.ch/~nessi/ETHTeilchenpraktikumCERN.html">http://www@cmsdoc.cern.ch/~nessi/ETHTeilchenpraktikumCERN.html</a></td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Language of instruction: English or German</td>
<td></td>
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<tr>
<td>402-0719-MSL</td>
<td>Particle Physics at PSI (Paul Scherrer Institute)</td>
<td>W</td>
<td>9</td>
<td>18P</td>
<td>C. Grab</td>
</tr>
<tr>
<td>Abstract</td>
<td>During semester breaks 6-12 students stay for 3 weeks at PSI and participate in a hands-on course on experimental particle physics.</td>
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<tr>
<td>Objective</td>
<td>Students learn all the different steps it takes to perform a complete particle physics experiment in a small team. They acquire skills to do this themselves in the team, including design, construction, data taking and data analysis.</td>
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<tr>
<td>402-0210-95L</td>
<td>Proseminar Theoretical Physics: Particle Physics at the Energy Frontier</td>
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<tr>
<td>Number of participants limited to 24.</td>
<td>W</td>
<td>9</td>
<td>4S</td>
<td>A. Lazopoulos</td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>A guided self-study of original papers and of advanced textbooks in theoretical physics. Within the general topic, determined each semester, participants give a presentation on a particular subject and deliver a written report.</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>402-0217-MSL</td>
<td>Theoretical Semester Project in a Group of the Physics Department</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Number of participants limited to 24.</td>
<td>W</td>
<td>9</td>
<td>18A</td>
<td>A. Lazopoulos, C. Anastasiou, N. Beisert, G. Blatter, P. De Forcrand, M. Gaberdiel, G. M. Graf, S. Huber, R. Renner, T. C. Schulthess, M. Sigrist, M. Troyer</td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>This course unit is an alternative if no suitable &quot;Proseminar Theoretical Physics&quot; is available or if the proseminar is already overbooked. Die Leistungskontrolle erfolgt aufgrund eines oder mehrerer schriftlicher Berichte bzw. einer schriftlichen Arbeit. Vorträge können ein zusätzlicher Bestandteil der Leistungskontrolle sein.</td>
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</tr>
<tr>
<td>402-0215-MSL</td>
<td>Experimental Semester Project in a Group of the Physics Department</td>
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</tr>
<tr>
<td>Number of participants limited to 24.</td>
<td>W</td>
<td>9</td>
<td>18A</td>
<td>Professors</td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>The aim of the project is to give the student experience in working in a research environment, carrying out physics experiments, analysing and interpreting the resulting data.</td>
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</tr>
</tbody>
</table>
Prerequisites / notice  Die Leistungskontrolle erfolgt aufgrund eines oder mehrerer schriftlicher Berichte bzw. einer schriftlichen Arbeit. Ein Vortrag über die gewonnenen Ergebnisse ist ein obligatorischer Bestandteil der Leistungskontrolle.

### Compulsory Electives in Humanities, Social and Political Sciences

**Recommended GESS compulsory elective courses (Type B) for D-PHYS.**

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/ÜZH

### Master's Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-2000-00L</td>
<td>Scientific Works in Physics</td>
<td>O</td>
<td>0 credits</td>
<td></td>
<td>D. Würz</td>
</tr>
</tbody>
</table>
|              | Target audience: Master students who cannot document to have received an adequate training in working scientifically. Mandatory for all Master students with matriculation in the autumn semester 2014 or later.
|              | Optional for Master students with matriculation until or before the spring semester 2014.
|              | Directive

**Abstract**

- Literature Review: ETH-Library, Journals in Physics, Google Scholar; Thesis Structure: The IMRAD Model; Document Processing: LaTeX and BibTeX, Mathematical Writing, AVETH Survival Guide; ETH Guidelines for Integrity; Authorship Guidelines; ETH Citation Etiquettes; Declaration of Originality.

**Objective**

Basic standards for scientific works in physics: How to write a Master Thesis. What to know about research integrity.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>462-0900-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30 credits</td>
<td>57D</td>
<td>Supervisors</td>
</tr>
<tr>
<td></td>
<td>The Master's thesis is normally conducted in the fourth semester and concludes the degree programme. With the Master's thesis students verify their ability to undertake independent and scientifically structured work in the area of high energy physics.</td>
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</tbody>
</table>

**Prerequisites / notice**

The time limit for completing the Master's thesis is six months.

---

**High-Energy Physics (Joint Master with EP Paris) - Key for Type**

O  Compulsory

W+ Eligible for credits and recommended

W  Eligible for credits

E- Recommended, not eligible for credits

Z Courses outside the curriculum

Dr Suitable for doctorate

**Key for Hours**

V lecture

G lecture with exercise

U exercise

S seminar

K colloquium

P practical/laboratory course

A independent project

D diploma thesis

R revision course / private study

**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Computer Science (General Courses)

Computer Science for Non-Computer Scientists

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0834-00L</td>
<td>Information Systems for Engineers</td>
<td>Z</td>
<td>4</td>
<td>2V+1U</td>
<td>R. Marti</td>
</tr>
</tbody>
</table>

Abstract

Foundations of information systems from a user's viewpoint. The focus is on structured data: relational databases, the data language SQL, designing relational databases. Additional topics: Information Retrieval (searching documents), and estimating their relevance and authority with respect to free-text queries; XML as a format for data exchange; Characteristics and processing of "Big Data"

Objective

Following the course should enable students to

1. answer non-trivial queries on existing relational databases by formulating (entry-level) SQL statements, as well as to add new database content and to update or delete existing content,
2. formalize facts as perceived in the real world in terms of the entity-relationship model, and derive a set of normalized relations (tables) which define the structure of a relational database
3. explain how a database management system (DBMS) essentially works and what kind of services it provides
4. understand how a web search engine such as Google basically works
5. know and apply the core concepts to structure and query XML-documents
6. list the characteristics of "Big Data" and know the basics of processing "Big Data"

Content

Die Lehrveranstaltung vermittelt Grundlagen und Konzepte von Informationssystemen aus der Sicht eines Anwenders.

Im Zentrum stehen relationale Datenbanksysteme, die Abfrage- und Datenmanipulationssprache SQL, sowie der Entwurf bzw. die Strukturierung relationaler Datenbanken. Dieser Stoff wird auch in praktischen Übungen vertieft.

Weitere Themen sind der Umgang mit unstrukturierten und semistrukturierten Daten, die Integration von Daten aus verschiedenen autonomen Informationssystemen, sowie eine Übersicht der Architektur von Datenbanksystemen.

Inhalt:
1. Einleitung,
2. Das Relationenmodell,
3. Die Abfrage- und Datenmanipulationssprache SQL
5. Architektur relationaler Datenbanksysteme.

Literature

Vorlesungsunterlagen (PowerPoint Folien, teilweise auch zusätzlicher Text) werden auf der Web-Site publiziert. Der Kauf eines Buches wird nicht vorausgesetzt.


Als englischtentes Werk kann z.B.


empfohlen werden (Umfang: 1349 Seiten).

Prerequisites / notice

Voraussetzung:
Elementare Kenntnisse von Mengenlehre und logischen Ausdrücken.

252-0835-00L  | Computer Science I                         | Z    | 4    | 2V+2U | F. O. Friedrich

Abstract

The course covers the fundamental concepts of computer programming with a focus on systematic algorithmic problem solving. Taught language is C++. No programming experience is required.

Objective

Primary educational objective is to learn programming with C++. When successfully attended the course, students have a good command of the mechanisms to construct a program. They know the fundamental control and data structures and understand how an algorithmic problem is mapped to a computer program. They have an idea of what happens "behind the scenes" when a program is translated and executed.

Secondary goals are an algorithmic computational thinking, understanding the possibilities and limits of programming and to impart the way of thinking of a computer scientist.

Content

The course covers fundamental data types, expressions and statements, (Limits of) computer arithmetic, control statements, functions, arrays, structural types and pointers. The part on object orientation deals with classes, inheritance and polymorphism, simple dynamic data types are introduced as examples, in general, the concepts provided in the course are motivated and illustrated with algorithms and applications.

Lecture notes

A script written in English will be provided during the semester. The script and slides will be made available for download on the course web page.

Literature

Bjarne Stroustrup: Einführung in die Programmierung mit C++, Pearson Studium, 2010

Prerequisites / notice

From AS 2013, an admission to the exam does not any more formally require an attending of the recitation sessions. Handing in solutions to the weekly exercise sheets is thus not mandatory, but we strongly recommend it.

Examination is a one hour-long written test.
The students learn to apply selected concepts and tools from computer science for working on interdisciplinary projects. The following topics are covered: publishing over the internet, processing and visualizing time series, visualizing multi-dimensional data, managing data with lists and tables and with relational databases, introduction to macro programming, universal methods for algorithm design.

Objective
The students learn to
- choose and apply appropriate tools from computer science,
- process and analyze real-world data from their subject of study,
- handle the complexity of real-world data,
- know universal methods for algorithm design.

Content
1. The role of computer science in science
2. Understanding the computer and automate processes of problem solving by programming,
3. Choose and apply appropriate tools from computer science,
4. Process and analyze real-world data from their subject of study,
5. Handle the complexity of real-world data,

Lecture notes
All materials for the lecture are available at www.gdi.ethz.ch

Prerequisites / notice
This course is based on application-oriented learning. The students spend most of their time working through electronic tutorials and discussing their results with teaching assistants.
Abstract
The unit "Computer Science in Secondary School Mathematics" addresses key contributions of computer science to general education, the tight relations between the algorithmic and the mathematical way of thinking, and the thoughtful choice of computer science topics for high school mathematics classes.

Objective
The general goal of the course consists in presenting ways to teach fundamentals of computer science, which are closely related to contents and methods of mathematics. After attending the course unit, a mathematics teacher is able to teach selected fundamentals of computer science in mathematics classes.

Content
The main topics of the course unit "Computer Science in Secondary School Mathematics" represent a scientific and didactic added value for mathematics classes.

Lecture notes
In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester. Literatur wird angegeben. Zusätzliche Unterlagen und Folien werden zur Verfügung gestellt.

Literature

ECTS
Z 4 credits 2V+1U

Courses outside the curriculum

Computer Science Colloquium
Invited talks, covering the entire scope of computer science. External Listeners are welcome at no charge. A detailed schedule is published at the beginning of each semester.

Colloquium on Mathematics, Computer Science, and Education
Subject didactics for mathematics and computer science teachers.

Didactics colloquium

Generally Accessible Seminars and Colloquia

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>251-0100-00L</td>
<td>Computer Science Colloquium</td>
<td>E-</td>
<td>0 credits</td>
<td>2K</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Objective
Top international computer scientists take the floor at the distinguished computer science colloquium. Our guest speakers present impacting topics across various areas of the discipline. The colloquium series is held every semester and also includes inaugural and farewell lectures of the department's professors. The colloquium is a noteworthy event for all graduate students. Outside attendance is equally welcome.

Content
Eingeladene Vorträge aus dem gesamten Bereich der Informatik, zu denen auch Auswärtige kostenlos eingeladen sind. Zu Semesterbeginn erscheint jeweils ein ausführliches Programm.

Colloquium on Mathematics, Computer Science, and Education
Subject didactics for mathematics and computer science teachers.

Computer Science (General Courses) - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Key for Hours</th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
<td>P</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
<td></td>
</tr>
</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Computer Science Bachelor

1. Semester

First Year Examinations

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0211-00L</td>
<td>Analysis I</td>
<td>O</td>
<td>7</td>
<td>4V+2U</td>
<td>M. Struve</td>
</tr>
<tr>
<td>Abstract</td>
<td>Real and complex numbers, vectors, functions, limits, sequences, series, power series, differentiation and integration in one variable, introduction to ordinary differential equations</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>Real and complex numbers, vectors, functions, limits, sequences, series, power series, differentiation and integration in one variable, introduction to ordinary differential equations</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content</td>
<td>Real and complex numbers, vectors, functions, limits, sequences, series, power series, differentiation and integration in one variable, introduction to ordinary differential equations</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lecture notes</td>
<td>Michael Struve. <em>Analysis für Informatik.</em> ETH Zürich, 2010.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

252-0021-00L Introduction to Programming O 7 credits 4V+2U B. Meyer

Abstract: Introduction to fundamental concepts of modern programming and operational skills for developing high-quality programs, including large programs as in industry. The course introduces software engineering principles with an object-oriented approach based on Design by Contract as present in Eiffel. For the second time we offer a supporting MOOC (online) version with more exercises and a hint system.

Objective: Many people can write programs. The "Introduction to Programming" course goes beyond that basic goal: it teaches the fundamental concepts and skills necessary to perform programming at a professional level. As a result of successfully completing the course, students master the fundamental control structures, data structures, reasoning patterns and programming language mechanisms characterizing modern programming, as well as the fundamental rules of producing high-quality software. They have the necessary programming background for later courses introducing programming skills in specialized application areas.

Content: Basics of object-oriented programming. Objects and classes. Pre- and postconditions, class invariants, Design by Contract. Fundamental control structures. Assignment and References. Basic hardware concepts. Fundamental data structures and algorithms. Recursion. Inheritance and deferred classes, introduction into event-driven design and concurrent programming. Basic concepts of Software Engineering such as the software process, specification and documentation, reuse and quality assurance.

Prerequisites / notice: The course uses an "Outside-In" approach enabling students, right from the beginning, to use an advanced graphical library and produce significant applications. Students then learn step by step how the library is built, as a source of imitation and inspiration.

The course covers not only basic concepts of programming but also some advanced topics seldom encountered in introductory courses, such as recursion, undecidability, event-driven programming, multiple inheritance and others.

401-0131-00L Linear Algebra O 7 credits 4V+2U M. Pollefeys, A. Steiger

Abstract: Application oriented introduction to linear algebra (vector spaces, linear transformations, matrices), matrix decompositions (LU, QR, eigenvalue, and singular value decomposition). Introduction to the programming environment Matlab.

Objective: Die Lernziele sind: - die fundamentalen Konzepte der linearen Algebra gut zu verstehen - in der Lage zu sein, mit Hilfe von Matlab Rechenaufgaben zu lösen - Anwendungen der linearen Algebra in der Informatik kennenzulernen

Content: Linear Algebra: Linear systems of equations, vectors and matrices, norms and scalar products, LU decomposition, vector spaces and linear transformations, least squares problems, QR decomposition, determinants, eigenvalues and eigenvectors, singular value decomposition, applications.

Prerequisites / notice: Lecture notes "Linear Algebra" (Gutknecht) in German, with English expressions for all technical terms.

252-0023-00L Discrete Mathematics O 8 credits 5V+2U U. Maurer

Abstract: Content: Mathematical reasoning and proofs, abstraction. Sets, relations (e.g. equivalence and order relations), functions, combinatorics, (un-)countability, graph theory, number theory, algebra (groups, rings, fields, polynomials, subalgebras, morphisms), logic (propositional and predicate logic, proof calculi).

Objective: The primary goals of this course are (1) to introduce the most important concepts of discrete mathematics, (2) to understand and appreciate the role of abstraction and mathematical proofs, and (3) to discuss a number of applications, e.g. in cryptography, coding theory, and algorithm theory.

Content: See course description.

Prerequisites / notice: available (in English)

3. Semester

Compulsory Courses (3. Sem.)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0057-00L</td>
<td>Theoretical Computer Science</td>
<td>O</td>
<td>8</td>
<td>4V+2U+1A</td>
<td>J. Hromkovic, E. Welzl</td>
</tr>
<tr>
<td>Abstract</td>
<td>Concepts to cope with: a) what can be accomplished in a fully automated fashion (algorithmically solvable) b) How to measure the inherent difficulty of tasks (problems) c) What is randomness and how can it be useful? d) What is nondeterminism and what role does it play in CS? e) How to represent infinite objects by finite automata and grammars?</td>
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</tr>
<tr>
<td>Objective</td>
<td>Learning the basic concepts of computer science along their historical development</td>
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</tbody>
</table>
This lecture gives an introduction to theoretical computer science, presenting the basic concepts and methods of computer science in its historical context. We present computer science as an interdisciplinary science which, on the one hand, investigates the border between the possible and the impossible and the quantitative laws of information processing, and, on the other hand, designs, analyzes, verifies, and implements computer systems.

The main topics of the lecture are:
- alphabets, words, languages, measuring the information content of words, representation of algorithmic tasks
- finite automata, regular and context-free grammars
- Turing machines and computability
- complexity theory and NP-completeness
- design of algorithms for hard problems

Lecture notes
The lecture is covered in detail by the textbook "Theoretical Computer Science".

Further reading:

More exercises and examples in:
6. A. Asteroth, Ch. Baier: Theoretische Informatik

Prerequisites / notice
During the semester, two non-obligatory test exams will be offered.

**252-0061-00L**

**Abstract**

Introduction to computer architecture and system programming:

Instruction sets, storage hierarchies, runtime structures with an emphasis on computers as engines for the execution of compiled programs. Interaction between system software and the hardware. Problems that arise from the final representation, performance measurement and tuning, and program portability issues are covered.

**Objective**

The objective is to allow students to understand all aspects of the execution of compiled (C) programs on modern architectures -- the instruction set, the storage resources (registers, stack, memory), input/output, the impact of compiler decisions, and the interaction between the operating system and hardware. Two main themes are correctness issues (esp. those that arise from the finite representation of data) and performance issues (incl. measurement and tuning issues). The interface to the operating system is discussed to prepare for subsequent classes on more advanced systems topics.

The two key goals are:

1) To equip students with a thorough understanding of how to write correct programs that run fast on modern computer, and
2) How to write correct and efficient low-level systems code.

This course does not cover how to design or build a processor or computer.

**Content**

This course provides an overview of "computers" as a platform for the execution of (compiled) computer programs. This course provides a programmer's view of how computer systems execute programs, store information, and communicate. The course introduces the major computer architecture structures that have direct influence on the execution of programs (processors with registers, caches, other levels of the memory hierarchy, supervisor/kernel mode, and I/O structures) and covers implementation and representation issues only to the extent that they are necessary to understand the structure and operation of a computer system.

The course attempts to expose students to the practical issues that affect performance, portability, security, robustness, and extensibility. This course provides a foundation for subsequent courses on operating systems, networks, compilers and many other courses that require an understanding of the system-level issues. Topics covered include: machine-level code and its generation by optimizing compilers, address translation, input and output, trap/event handlers, performance evaluation and optimization (with a focus on the practical aspects of data collection and analysis).

**Literature**

The course is based in part on "Computer Systems: A Programmer's Perspective" (2nd Edition) by R. Bryant and D. O'Hallaron, with some additional material.

**Prerequisites / notice**

252-0024-00L Parallel Programming,
252-0014-00L Digital Circuits

**401-0613-00L**

**Abstract**

Basic concepts from probability and statistics:
- introduction to probability theory
- short introduction to basic concepts and methods from statistics

Basic concepts from probability and statistics:
- introduction to probability theory
- short introduction to basic concepts and methods from statistics
Objective a) ability to understand the covered methods from probability theory and to apply them in other contexts
b) probabilistic thinking and stochastic modelling
c) ability to perform basic statistical tests and to interpret the results

Content Basic concepts from probability and statistics with special emphasis on the topics needed in computer science

The conceptual goals are
- the laws of randomness and probabilistic thinking (thinking in probabilities)
- understanding and intuition for stochastic modelling
- simple and basic methods from statistics

The contents of the course encompasses
- an introduction to probability theory: basic concepts (probability space, probability measure), independence, random variables, discrete and continuous distributions, conditional probability, expectation and variance, limit theorems
- methods from statistics: parameter estimation, maximum likelihood and moment methods, tests, confidence intervals

Lecture notes
Lecture notes for the course (in German) will be made available electronically at the beginning of the course.

401-0663-00L Numerical Methods for CSE O 7 credits 4V+2U R. Hiptmair
Abstract The course gives an introduction into fundamental techniques and algorithms of numerical mathematics which play a central role in numerical simulations in science and technology. The courses focuses on fundamental ideas and algorithmic aspects of numerical methods. The exercises involve actual implementation of numerical methods.
Objective * Knowledge of the fundamental algorithms in numerical mathematics
* Knowledge of the essential terms in numerical mathematics and the techniques used for the analysis of numerical algorithms
* Ability to choose the appropriate numerical method for concrete problems
* Ability to interpret numerical results
* Ability to implement numerical algorithms efficiently
Content
1. Direct Methods for linear systems of equations
2. Interpolation
3. Iterative Methods for non-linear systems of equations
4. Krylov methods for linear systems of equations
5. Eigensolvers
6. Least Squares Techniques
7. Filtering Algorithms
8. Approximation of Functions
9. Numerical Quadrature
10. Clustering Techniques
11. Single Step Methods for ODEs
12. Stiff Integrators
13. Structure Preserving Integrators

Lecture notes
Lecture slides will be made available to participants.

Literature
M. Hanke-Bourgeois "Grundlagen der Numerischen Mathematik und des wissenschaftlichen Rechnens", BG Teubner, 2002
C. Moler, Numerical computing with MATLAB, SIAM, 2004
P. Deuflhard and A. Hohmann, "Numerische Mathematik I", DeGruyter, 2002

Prerequisites / notice
The course will be accompanied by programming exercises relying on the high level programming language MATLAB. A brief introduction to Matlab will be given during the first week.

Compensatory Courses
Compulsory major courses count as compensatory courses.

Major

Compulsory Major Courses

Major in Computer and Software Engineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0210-00L</td>
<td>Compiler Design</td>
<td>O</td>
<td>8 credits</td>
<td>4V+3U</td>
<td>T. Gross</td>
</tr>
<tr>
<td>Objective</td>
<td>Learn principles of compiler design, gain practical experience designing and implementing a medium-scale software system.</td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>This course uses compilers as example to expose modern software development techniques. The course introduces the students to the fundamentals of compiler construction. Students will implement a simple yet complete compiler for an object-oriented programming language for a realistic target machine. Students will learn the use of appropriate tools (parser generators); the implementation language is Java. Throughout the course, students learn to apply their knowledge of theory (automata, grammars, stack machines, program transformation) and well-known programming techniques (module definitions, design patterns, frameworks, software reuse) in a software project.</td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Prior exposure to modern techniques for program construction, knowledge of at least one processor architecture at the assembly language level.</td>
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</tr>
</tbody>
</table>

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In theoretical and practical homework assignments students will learn to apply and implement the presented concepts and algorithms.

Lecture notes
A scriptum will be handed out for a part of the course. Copies of the slides will be available for download. We will also provide a detailed list of references and textbooks.

Literature

- **Major in Computational Science**
  - **151-0107-20L High Performance Computing for Science and Engineering (HPCSE I)**
    - **Abstract**: This course introduces algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications in science and engineering.
    - **Objective**: Introduction to HPC for scientists and engineers
    - **Content**: Programming models and languages: 1. C++ threading (2 weeks) 2. OpenMP (4 weeks) 3. MPI (5 weeks)
    - **Lecture notes**: http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1

- **Major in Theoretical Computer Science**
  - **252-0209-00L Algorithms, Probability, and Computing**
    - **Abstract**: Advanced design and analysis methods for algorithms and data structures: Randomized algorithms, search trees, point location, minimum cut, linear programming, randomized algebraic algorithms (matchings), probabilistically checkable proofs.
    - **Objective**: Studying and understanding of fundamental advanced concepts in algorithms, data structures and complexity theory.

- **Electives**
  - **252-2601-02L Software Engineering Laboratory: Open-Source EiffelStudio**
    - **Abstract**: This course is an opportunity to take part in leading-edge software construction and gain academic credit for it. The EiffelStudio environment provides a rich basis of extensions and new developments.
    - **Objective**: This course is an opportunity to take part in leading-edge software construction and gain academic credit for it. The EiffelStudio environment provides a rich basis of extensions and new developments.

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Content
The growing popularity of open-source projects provides a fertile ground for creative software developers to demonstrate and hone their design and implementation skills. This course is an opportunity to take part in leading-edge software construction and gain academic credit for it. The EiffelStudio environment (in 2006, 2 million lines of open-source code) provides a rich basis of potential extensions and new developments. The course is not structured as a traditional set of lectures but is laboratory-style: students choose a project and meet regularly with assistants to report progress and obtain guidance. The results produced should meet standards of quality software engineering; the best developments are candidate for inclusion in actual software releases. This is an opportunity to learn by doing and to encounter the challenges of large, production-grade software development.

252-3110-00L
Human Computer Interaction
W 4 credits 2V+1U O. Hilliges, M. Norrie
Abstract
The course provides an introduction to the field of human-computer interaction, emphasising the central role of the user in system design. Through detailed case studies, students will be introduced to different methods used to analyse the user experience and shown how these can inform the design of new interfaces, systems and technologies.
Objective
The goal of the course is that students should understand the principles of user-centred design and be able to apply these in practice.
Content
The course will introduce students to various methods of analysing the user experience, showing how these can be used at different stages of system development from requirements analysis through to usability testing. Students will get experience of designing and carrying out user studies as well as analysing results. The course will also cover the basic principles of interaction design. Practical exercises related to touch and gesture-based interaction will be used to reinforce the concepts introduced in the lecture. To get students to further think beyond traditional system design, we will discuss issues related to ambient information and awareness.

252-4101-00L
ACM-Lab
W 4 credits 3P A. Steger
Abstract
Solve programming problems from previous ACM Programming Contests (see http://acm.uva.es/problemset/); learn and use efficient programming methods and algorithms.
Objective
The objective of this course is to learn how to solve algorithmic problems given as descriptions in natural language, similar to those posed in ACM Programming Contests. This includes appropriate problem modeling, choice of suitable (combinatorial) algorithms, and their efficient implementation using C/C++ and the STL.

151-0107-20L
High Performance Computing for Science and Engineering (HPCSE I)
W 4 credits 4G P. Koumoutsakos, M. Troyer
Abstract
This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications in problems in science and engineering.
Objective
Introduction to HPC for scientists and engineers
Fundamental of:
1. Parallel Computing Architectures
2. MultiCores
3. ManyCores
Content
Programming models and languages:
1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)
Computers and methods:
1. Hardware and architectures
2. Libraries
3. Particles: N-body solvers
4. Fields: PDEs
5. Stochastics: Monte Carlo
Lecture notes
http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1
Class notes, handouts

227-0627-00L
Applied Computer Architecture
W 6 credits 4G A. Gunzinger
Abstract
This lecture gives an overview of the requirements and the architecture of parallel computer systems, performance, reliability and costs.
Objective
Understand the function, the design and the performance modeling of parallel computer systems.
Content
The lecture "Applied Computer Architecture" gives technical and corporate insights in the innovative Computer Systems/Architectures (CPU, GPU, FPGA, special processors) and their real implementations and applications. Often the designs have to deal with technical limits. Which computer architecture allows the control of the over 1000 magnets at the Swiss Light Source (SLS)? Which architecture is behind the alarm center of the Swiss Railway (SBB)? Which computer architectures are applied for driver assistance systems? Which computer architecture is hidden behind a professional digital audio mixing desk? How can data volumes about 30 TB/s, produced by a proton accelerator, be processed in real time? Can the weather forecast also be processed with GPUs? How can a good computer architecture be found? Which are the driving factors in successful computer architecture design?
Lecture notes
Script and exercices sheets.
Prerequisites / notice
Basics of computer architecture.

227-0945-00L
Cell and Molecular Biology for Engineers I
W 3 credits 3G C. Frei
Abstract
This course is part I of a two-semester course.
The course gives an introduction into cellular and molecular biology, specifically for students with a background in engineering. The focus will be on the basic organization of eukaryotic cells, molecular mechanisms and cellular functions. Textbook knowledge will be combined with results from recent research and technological innovations in this area.
Objective
After completing this course, engineering students will be able to apply their previous training in the quantitative and physical sciences to modern biology. Students will also learn the principles how biological models are established, and how these models can be tested.
Content
Lectures will include the following topics: DNA, chromosomes, RNA, protein, genetics, gene expression, membrane structure and function, vesicular traffic, cellular communication, energy conversion, cytoskeleton, cell cycle, cellular growth, apoptosis, autophagy, cancer, development and stem cells.
In addition, three journal clubs will be held, where one/two publications will be discussed. For each journal club, students (alone or in groups of up to three students) have to write a summary and discussion of the publication. These written documents will be graded, and count as 25% for the final grade.
Lecture notes
Scripts of all lectures will be available.
Literature

227-1037-00L
Introduction to Neuroinformatics
W 6 credits 2V+1U K. A. Martin, M. Cook, V. Mante, M. Pfeiffer
Abstract
This course provides an introduction to neuroinformatics, the application of computer science and information technology to neuroscience.
Objective
The course will cover the following topics: data representation, data processing, data analysis, and data visualization.
Content
Lectures will cover the following topics: data representation, data processing, data analysis, and data visualization.

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Abstract The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.

Objective Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monocultures of physics, maths, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enchantments and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions.

Content This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.

Seminar

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-2600-05L</td>
<td>Software Engineering Seminar</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>T. Gross</td>
</tr>
</tbody>
</table>

Abstract The course is an introduction to research in software engineering, based on reading and presenting high quality research papers in the field. The instructor may choose a variety of topics or one topic that is explored through several papers.

Objective The main goals of this seminar are 1) learning how to read and understand a recent research paper in computer science; and 2) learning how to present a technical topic in computer science to an audience of peers.

Content The technical content of this course falls into the general area of software engineering but will vary from semester to semester.

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-INFK:

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Bachelor Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0500-00L</td>
<td>Bachelor’s Thesis</td>
<td>O</td>
<td>10 credits</td>
<td>21D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract The Bachelor thesis is the final requirement of the BSc program and is supervised by one of the D-INFK professors. The thesis encourages students to show and produce a scientifically structured work.

Objective In their Bsc thesis students should demonstrate their ability to carry out independent, structured scientific work.

Prerequisites / notice The supervisor of the thesis defines the task, start and end date. A written report will be prepared on the scientific studies carried out, followed by a final presentation. The thesis must be handed in within 6 months.

Computer Science Bachelor - Key for Type

| O       | Compulsory            | E-   | Recommended, not eligible for credits |
| W+      | Eligible for credits  | Z    | Courses outside the curriculum       |
| W       | Eligible for credits  | Dr   | Suitable for doctorate               |

Key for Hours

| V     | lecture              | P    | practical/laboratory course |
| G     | lecture with exercise| A    | independent project         |
| S     | exercise             | D    | diploma thesis              |
| K     | colloquium           | R    | revision course / private study |

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
The general objective of the course consists in highlighting the tight connection between the mathematical and algorithmic way of thinking. Literature from the learning sciences is critically discussed with a focus on research methods.

### Title
- Understanding of research methods used in the empirical human sciences

### ECTS
3

### Hours
2S

### Lecturers
B. Rütsche, P. Edelsbrunner, P. Edelsbrunner

The unit "Subject Didactics of Computer Science I" addresses key contributions of computer science to general education. The course deals with the thoughtful choice of educational contents for computer science classes, which takes into account its comprehensibility for different age groups as well as didactic approaches suitable for a successful knowledge transfer.

#### Objective
- The general objective of the course consists in highlighting the tight connection between the mathematical and algorithmic way of thinking and the approaches adopted by engineering disciplines, and in reflecting on teaching approaches for sustainable computer science teaching activities.

- The students understand the fundamental concepts of computer science in the context of a broad and deep knowledge. Through this understanding, they manage to prepare teaching materials for a successful knowledge transfer and to pass their passion for the subject on to their pupils.

- The students know various teaching methods as well as their advantages and disadvantages. They can handle inhomogeneous prior knowledge of the learners inside a class. Besides holding classes, the students do care about the individual pupil support.

- They encourage the autonomy of the learners, manage to work with diverse target groups and to establish a positive learning environment.

- The students are able to express themselves using a comprehensible and refined professional language, both in a spoken and a written way, and they master the basic terminology of computer science. Besides the English terms, they are familiar with the corresponding German expressions. The students are able to produce detailed, matured, linguistically correct and design-wise appealing teaching materials.

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**Data: 06.02.2019 13:00  Autumn Semester 2015  Page 747 of 1434**
The course "Subject Didactics of Computer Science II" addresses key contributions of computer science to general education. The chosen topics support the young learners in developing a unique and indispensable way of thinking, in enhancing their understanding of our world as well as in achieving university education entrance qualifications.

The main topics of the course unit "Subject Didactics of Computer Science II" are the didactics of finite state automata, of formal languages and of the introduction to programming. The unit focuses on contents of computer science that contribute to general education. This involves the understanding of fundamental scientific concepts such as algorithm, complexity, determinism, computation, automata, verification, testing and programming language as well as the way to embed them into a scientifically sound and didactically sustainable computer science course.

In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester.

J. Hromkovic, G. Serafini

**Prerequisites / Literature**

Lehrdiplom-Studierende müssen diese Lerneinheit zusammen mit dem Einführungspraktikum Informatik - 272-0201-00L - belegen.

**271-0102-00L Teaching Internship Including Examination Lessons in Computer Science**

Teaching Internship Computer Science for TC and Teaching Diploma Computer Science as Minor Subject. Repetition of the Teaching Internship is excluded even if Examination Lessons are to be repeated.

**Abstract**

Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as assessed as Examination Lessons.

**Objective**

- Students use their specialist-subject, educational-science and subject-didactics training to draw up to teaching concepts for computer science.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils' work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

**Content**

The Studierenden sammeln Erfahrungen in der Unterrichtsführung, der Auseinandersetzung mit Lernenden, der Klassenbetreuung und der Wissensvermittlung. Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.


**272-0103-00L Mentored Work Subject Didactics Computer Science**

Mentored Work Subject Didactics in Computer Science for TC, Teaching Diploma and Teaching Diploma Computer Science as Minor Subject

**Abstract**

In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

**Objective**

- The objective is for the students:
  - to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
  - to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

**Content**

Die Studierenden sammeln Erfahrungen in der Unterrichtsführung, der Auseinandersetzung mit Lernenden, der Klassenbetreuung und der Wissensvermittlung. Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.


**Literature**

Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

**Notice**

Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.
### Specialized Courses in Respective Subject with Educational Focus

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<td>272-0400-00L</td>
<td>Mentored Work Specialised Courses in the Respective W+</td>
<td></td>
<td>2</td>
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<td>J. Hromkovic, G. Serafini</td>
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<tr>
<td></td>
<td>Subject with Educational Focus Computer Sc A</td>
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<td>In the mentored work on their subject specialisation, students link high-school and university aspects of the subject, thus strengthening their teaching competence with regard to curriculum decisions and the future development of the tuition. They compile texts under supervision that are directly comprehensible to the targeted readers - generally specialist-subject teachers at high-school level.</td>
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<td>The aim is for the students</td>
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<td>- to familiarise themselves with a new topic by obtaining material and studying the sources, so that they can selectively extend their specialist competence in this way.</td>
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<td>- to independently develop a text on the topic, with special focus on its mathematical comprehensibility in respect of the level of knowledge of the targeted readers.</td>
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<td>- To try out different options for specialist further training in their profession.</td>
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<td>Thematische Schwerpunkte:</td>
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<td>Lernformen:</td>
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<tr>
<td>272-0401-00L</td>
<td>Mentored Work Specialised Courses in the Respective W</td>
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<td>4A</td>
<td>J. Hromkovic, G. Serafini</td>
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<td></td>
<td>Subject with Educational Focus Computer Sc B</td>
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<td>Abstract</td>
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<tr>
<td>263-2800-00L</td>
<td>Design of Parallel and High-Performance Computing</td>
<td>W</td>
<td>7</td>
<td>3V+2U+1A</td>
<td>T. Hoefler, M. Püschel</td>
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<td>Understand concurrency paradigms and models from a higher perspective and acquire skills for designing, structuring and developing possibly large concurrent software systems. Become able to distinguish parallelism in problem space and in machine space. Become familiar with important technical concepts and with concurrency folklore.</td>
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<td>252-0341-01L</td>
<td>Information Retrieval</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>T. Hofmann</td>
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<td>Introduction to information retrieval with a focus on text documents and images. Main topics comprise extraction of characteristic features from documents, index structures, retrieval models, search algorithms, benchmarking, and feedback mechanisms. Searching the web, images and XML collections demonstrate recent applications of information retrieval and their implementation.</td>
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<td>In depth understanding of managing, indexing, and retrieving documents with text, image and XML content. Knowledge about basic search algorithms on the web, benchmarking of search algorithms, and relevance feedback methods.</td>
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<td>252-0535-00L</td>
<td>Machine Learning</td>
<td>W</td>
<td>6</td>
<td>3V+2U</td>
<td>J. M. Buhmann</td>
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<td>Abstract</td>
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<td>Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.</td>
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<td>Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.</td>
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<td>The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.</td>
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<td>Topics covered in the lecture include:</td>
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<td>- Bayesian theory of optimal decisions</td>
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<td>- Maximum likelihood and Bayesian parameter inference</td>
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<td></td>
<td>- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)</td>
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<td></td>
<td>- Ensemble methods: Bagging and Boosting</td>
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<td></td>
<td>- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off</td>
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<td></td>
<td>- Non parametric density estimation: Parzen windows, nearest neighbour</td>
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<td>- Dimension reduction: principal component analysis (PCA) and beyond</td>
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<tr>
<td></td>
<td>Lecture notes</td>
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<td></td>
<td>No lecture notes, but slides will be made available on the course webpage.</td>
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</tbody>
</table>
Game theory provides a formal model to study the behavior and interaction of self-interested users and programs in large-scale distributed computer systems without central control. The course discusses algorithmic aspects of game theory.

This course discusses algorithmic aspects of game-theoretic models, with a focus on recent algorithmic and mathematical developments. Rather than giving an overview of such developments, the course aims to study selected important topics in depth.

Outline:
- Introduction to classical game theoretic concepts.
- Existence of stable solutions (equilibrium), algorithms for computing equilibria, computational complexity.
- The cost difference between an optimum under central control and an equilibrium under selfish agents, known as the "price of anarchy".
- Auction-like mechanisms and algorithms that "direct" the actions of selfish agents into a certain desired equilibrium situation.
- Selected current research topics of Algorithmic Game Theory, such as Web-Search Based Keyword Auctions, or Information Cascading in Social Networks.

Prerequisites / notice
Audience: Although this is a Computer Science course, we encourage the participation from all students who are interested in this topic. Several copies of both books are available in the Computer Science library.

Requirements: You should enjoy precise mathematical reasoning. You need to have passed a course on algorithms and complexity. No knowledge of game theory is required.

Computer Science TC - Key for Type

| O   | Compulsory               | E- | Recommended, not eligible for credits |
| W+  | Eligible for credits and recommended | Z  | Courses outside the curriculum |
| W   | Eligible for credits     | Dr | Suitable for doctorate |

Key for Hours

| V   | lecture                 | P   | practical/laboratory course |
| G   | lecture with exercise   | A   | independent project |
| U   | exercise                | D   | diploma thesis |
| S   | seminar                 | R   | revision course / private study |
| K   | colloquium              |     |                           |

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Number | Title                                      | Type | ECTS | Hours | Lecturers               
---     | ---                                        | ---   | ---   | ---    | ---                     
851-0242-06L | **Cognitively Activating Instructions in MINT Subjects** (excluding Teaching Diploma Sport). | W     | 2 credits | 2S    | R. Schumacher                    

Number of participants limited to 30.

This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

Abstract
This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.

Objective
- Get to know cognitively activating instructions in MINT subjects
- Get information about recent literature on learning and instruction

Prerequisites / notice
Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

851-0242-07L | **Human Intelligence** (excluding Teaching Diploma Sport). | W     | 1 credit | 1S    | E. Stern, P. Edelsbrunner, B. Rütsche

Number of participants limited to 30.

This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

Abstract
The focus will be on the book "Intelligenz: Grosse Unterschiede und ihre Folgen" by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.

Objective
- Understanding of research methods used in the empirical human sciences
- Getting to know intelligence tests
- Understanding findings relevant for education

851-0242-08L | **Research Methods in Educational Science** | W     | 1 credit | 1S    | P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler

Number of participants limited to 30.

This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

Abstract
Literature from the learning sciences is critically discussed with a focus on research methods.
At the first meeting, working groups will be assembled and two further meetings will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.

Objective
- Understand research methods used in the empirical educational sciences
- Understand and critically examine information from scientific journals and media
- Understand pedagogically relevant findings from the empirical educational sciences


Number of participants limited to 20.

The successful completion of both course no. 851-0240-00L "Menschliches Lernen (EW 1)" and course no. 851-0238-01L "Unterstützung und Diagnose von Wissenserwerbsprozessen (EW 3)" is a necessary prerequisite for this course.

Abstract
In teams of two, participants in this seminar conduct their own research project. Each team is advised by one of the researchers serving as lecturers in this course. Basic conceptual and methodological issues are the topic of a series of plenary meetings; however, the major part of the work is done in small-group meetings with the advising researcher, and in self-directed research projects.

Objective
The course is targeted at advanced students who have taken an interest in gathering practical research experience in the field of Learning & Instruction. In teams of two, students conduct their own research projects (planning, conducting, analyzing, interpreting, and presenting research); thus, the course requires a high amount of self-directed working. Students are personally advised, and supported in their research project, by one of the researchers serving as lecturers in this course. During the first half the semester, relevant methodological knowledge and skills are practiced during plenary meetings and in students’ independent reading (e.g. generating and testing research questions, designing experiments, and analyzing data in the field of Learning and Instruction)

Learning goals include:
- Participants can illustrate and explain basic methods and concepts for research in the fields of Learning and Instruction, e.g. with the help of practical examples.
- Participants can generate testable research questions for a topic relevant in the fields of Learning and Instruction.
- Participants can design and conduct a study that is relevant for answering their research question.
- Participants can summarize and evaluate the main results from a study in the field of learning and Instruction, with regard to the research question being asked.

see Educational Science Teaching Diploma
# Subject Didactics in Computer Science

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>272-0101-00L</td>
<td><strong>Mentored Work Subject Didactics Computer Science</strong></td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>G. Serafini, J. Hromkovic</td>
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</tbody>
</table>

**Abstract**
The unit "Subject Didactics of Computer Science I" addresses key contributions of computer science to general education. The course deals with the thoughtful choice of educational contents for computer science classes, which takes into account its comprehensibility for different age groups as well as didactic approaches suitable for a successful knowledge transfer.

**Objective**
The general objective of the course consists in highlighting the tight connection between the mathematical and algorithmic way of thinking and the approaches adopted by engineering disciplines, and in reflecting on teaching approaches for sustainable computer science teaching activities.

The students understand the fundamental concepts of computer science in the context of a broad and deep knowledge. Through this understanding, they manage to prepare teaching materials for a successful knowledge transfer and to pass their passion for the subject on to their pupils.

The students know various teaching methods as well as their advantages and disadvantages. They can handle inhomogeneous prior knowledge of the learners inside a class. Besides holding classes, the students do care about the individual pupil support.

They encourage the autonomy of the learners, manage to work with diverse target groups and to establish a positive learning environment.

The students are able to express themselves using a comprehensible and refined professional language, both in a spoken and a written way, and they master the basic terminology of computer science. Besides the English terms, they are familiar with the corresponding German expressions. The students are able to produce detailed, matured, linguistically correct and design-wise appealing teaching materials.

The course "Subject Didactics of Computer Science I" addresses key contributions of computer science to general education. The chosen topics support the young learners in developing a unique and indispensable way of thinking, in enhancing their understanding of our world as well as in achieving university education entrance qualifications.

The main topics of the course unit "Subject Didactics of Computer Science I" are the didactics of finite state automata, of formal languages and of the introduction to programming. The unit focuses on contents of computer science that contribute to general education. This involves the understanding of fundamental scientific concepts such as algorithm, complexity, determinism, computation, automata, verification, testing and programming language as well as the way to embed them into a scientifically sound and didactically sustainable computer science course.

In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester.

**Content**
The main topics of the course unit "Subject Didactics of Computer Science I" are the didactics of finite state automata, of formal languages and of the introduction to programming. The unit focuses on contents of computer science that contribute to general education. This involves the understanding of fundamental scientific concepts such as algorithm, complexity, determinism, computation, automata, verification, testing and programming language as well as the way to embed them into a scientifically sound and didactically sustainable computer science course.

In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester.

**Prerequisites / notice**
Lehrdiplom-Studierende müssen diese Lerneinheit zusammen mit dem Einführungspraktikum Informatik - 272-0201-00L - belegen.

272-0103-00L  **Mentored Work Subject Didactics Computer Science**  A  2 credits  4A  J. Hromkovic, G. Serafini

**Abstract**
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

**Objective**
The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

**Content**
Thematic Schwerpunkte
Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

**Literature**
Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

**Prerequisites / notice**
Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

272-0104-00L  **Mentored Work Subject Didactics Computer Science**  B  2 credits  4A  J. Hromkovic, G. Serafini

**Abstract**
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

**Objective**
The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

**Content**
Thematic Schwerpunkte
Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

**Literature**
Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

**Prerequisites / notice**
Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.
Abstract
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

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The objective is for the students:
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- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Content
Thematic Schwerpunkte
Die Gegenstände der montorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

Literature
Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

Prerequisites / notice
Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

Professional Training

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>272-0201-00L</td>
<td>Introductory Practical in Computer Science</td>
<td>O</td>
<td>3</td>
<td>6P</td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
</tbody>
</table>

Abstract
During the introductory teaching practice, the students sit in on five lessons given by the teacher responsible for their teaching practice, and teach five lessons themselves. The students are given observation and reflection assignments by the teacher responsible for their teaching practice.

Objective
Right at the start of their training, students acquire initial experience with the observation of teaching, the establishment of concepts for teaching and the implementation of teaching. This early confrontation with the complexity of everything that teaching involves helps students decide whether they wish to, and, indeed, ought to, continue with the training. It forms a basis for the subsequent pedagogical and subject-didactics training.

Content
Den Studierenden bietet das Einführungspraktikum einen Einblick in den Berufsalltag einer Lehrperson.

Literature
Wird von der Praktikumslehrperson bestimmt.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
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<tr>
<td>272-0202-00L</td>
<td>Professional Exercises</td>
<td>O</td>
<td>2</td>
<td>4U</td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
</tbody>
</table>

Abstract
In the course Professional Exercises the students achieve additional school-relevant experiences. The students carry out individually specified, practice related projects, in which they support, document or reflect on learning processes.

Objective
Achievement of additional school-relevant experiences. The students carry out individually specified, practice related projects, in which they support, document or reflect on learning processes.

Content

Literature
Wird von der Praktikumslehrperson bestimmt.

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>272-0203-00L</td>
<td>Teaching Internship in Computer Science</td>
<td>O</td>
<td>8</td>
<td>17P</td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
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</table>

Abstract
The teaching practice takes in 50 lessons: 30 are taught by the students, and the students sit in on 20 lessons. The teaching practice lasts 4-6 weeks. It gives students the opportunity to implement the contents of their specialty in the educational science and subject-didactics training in the classroom. Students also conduct work assignments in parallel to their teaching practice.

Objective
- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics in their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They acquire the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils’ work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Content

Literature
Findet in der Regel am Schluss der Ausbildung, vor Ablegung der Prüfungslektionen statt.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>272-0204-00L</td>
<td>Teaching Internship in Computer Science</td>
<td>W</td>
<td>4</td>
<td>9P</td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
</tbody>
</table>

Abstract
This is a supplement to the Teaching Internship required to obtain a Teaching Diploma in the corresponding subject. It is aimed at enlarging the already acquired teaching experience. Students observe 10 lessons and teach 15 lessons independently.
Die Literatur ist themenspezifisch. Sie muss je nach Situation selber beschafft werden oder wird zur Verfügung gestellt.

In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-specialisation they are in a position to independently develop a text on the topic, with special focus on its mathematical comprehensibility in respect of the level of knowledge the targeted readership.

J. Hromkovic, G. Serafini


**Teaching Diploma in 2 Subjects in One-Step Procedure:** no courses from this category have to be completed.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>272-0400-00L</td>
<td>Mentored Work Specialised Courses in the Respective O Subject with Educational Focus Computer Sc A</td>
<td>O</td>
<td>2</td>
<td>4A</td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>In the mentored work on their subject specialisation, students link high-school and university aspects of the subject, thus strengthening their teaching competence with regard to curriculum decisions and the future development of the tuition. They compile texts under supervision that are directly comprehensible to the targeted readers - generally specialist-subject teachers at high-school-level.</td>
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<td>Objective</td>
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<td></td>
<td>The aim is for the students</td>
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<td></td>
<td>- to familiarise themselves with a new topic by obtaining material and studying the sources, so that they can selectively extend their specialist competence in this way.</td>
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<td></td>
<td>- to independently develop a text on the topic, with special focus on its mathematical comprehensibility in respect of the level of knowledge of the targeted readership.</td>
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<td></td>
<td>- To try out different options for specialist further training in their profession.</td>
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<td></td>
<td>Content</td>
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<tr>
<td></td>
<td>Thematic Schwerpunkte</td>
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<td></td>
<td>Lernformen:</td>
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<tr>
<td></td>
<td>Literature</td>
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<td></td>
<td>Die Literatur ist themenspezifisch. Sie muss je nach Situation selber beschafft werden oder wird zur Verfügung gestellt.</td>
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<td></td>
<td>Prerequisites / notice</td>
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<tr>
<td></td>
<td>Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.</td>
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</table>

J. Hromkovic, G. Serafini

In the mentored work on their subject specialisation, students link high-school and university aspects of the subject, thus strengthening their teaching competence with regard to curriculum decisions and the future development of the tuition. They compile texts under supervision that are directly comprehensible to the targeted readers - generally specialist-subject teachers at high-school level.
The aim is for the students to familiarise themselves with a new topic by obtaining material and studying the sources, so that they can selectively extend their specialist competence in this way.

To independently develop a text on the topic, with special focus on its mathematical comprehensibility in respect of the level of knowledge of the targeted readership.

To try out different options for specialist further training in their profession.

**Content**

Thematic objectives:

- Introduction to information retrieval with a focus on text documents and images. Main topics comprise extraction of characteristic features from documents, index structures, retrieval models, search algorithms, benchmarking, and feedback mechanisms. Searching the web, images and XML collections demonstrate recent applications of information retrieval and their implementation.

Lernformen:


Die Literatur ist themenspezifisch. Sie muss je nach Situation selber beschafft werden oder wird zur Verfügung gestellt.

Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

**Objective**

- In depth understanding of managing, indexing, and retrieving documents with text, image and XML content. Knowledge about basic search algorithms on the web, benchmarking of search algorithms, and relevance feedback methods.

**Content**

Randomized Algorithms and probabilistic methods are algorithms that "flip coins" to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.

- Las Vegas & Monte Carlo algorithms; inequalities of Markov, Chebyshev, Chernoff; negative correlation; Markov chains: convergence, rapidly mixing; generating functions; Examples include: min cut, median, balls and bins, routing in hypercubes, 3SAT, card shuffling, random walks

**Objective**

- After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.

**Lecture notes**

- No lecture notes, but slides will be made available on the course webpage.

**Literature**

- Solid basic knowledge in analysis, statistics and numerical methods for CSE. Experience in programming for solving the project tasks.

**Objective**

- Randomized Algorithms and Probabilistic Methods
- W 7 credits
- 3V+2U+1A
- A. Steger

**Abstract**

Randomized algorithms are algorithms that "flip coins" to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.

**Lecture notes**

- No lecture notes, but slides will be made available on the course webpage.

**Literature**


**Objective**

- To try out different options for specialist further training in their profession.

- Learning the basic concepts of game theory and mechanism design, acquiring the computational paradigm of self-interested agents, and using these concepts in the computational and algorithmic setting.
This lecture gives an introduction to theoretical computer science, presenting the basic concepts and methods of computer science in its historical context. We present computer science as an interdisciplinary science which, on the one hand, investigates the border between the possible and the impossible and the quantitative laws of information processing, and, on the other hand, designs, analyzes, verifies, and implements computer systems.

The main topics of the lecture are:
- alphabets, words, languages, measuring the information content of words, representation of algorithmic tasks
- finite automata, regular and context-free grammars
- Turing machines and computability
- complexity theory and NP-completeness
- design of algorithms for hard problems

The Internet is a typical example of a large-scale distributed computer system without central control, with users that are typically only interested in their own good. For instance, they are interested in getting high bandwidth for themselves, but don't care about others, and the same is true for computational load or download rates. Game theory provides a particularly well-suited model for the behaviour and interaction of such selfish users and programs. Classical game theory dates back to the 1930s and typically does not consider algorithmic aspects at all. Only a few years back, algorithms and game theory have been considered together, in an attempt to reconcile selfish behavior of independent agents with the common good.

This course discusses algorithmic aspects of game-theoretic models, with a focus on recent algorithmic and mathematical developments. Rather than giving an overview of such developments, the course aims to study selected important topics in depth.

Outline:
- Introduction to classical game theoretic concepts.
- Existence of stable solutions (equilibria), algorithms for computing equilibria, computational complexity.
- The cost difference between an optimum under central control and an equilibrium under selfish agents, known as the "price of anarchy".
- Auction-like mechanisms and algorithms that "direct" the actions of selfish agents into a certain desired equilibrium situation.
- Selected current research topics of Algorithmic Game Theory, such as Web-Search Based Keyword Auctions, or Information Cascading in Social Networks

Literature

"Game Theory and Strategy", Philip D. Straffin, The Mathematical Association of America, 5th printing, 2004

Prerequisites / notice

Several copies of both books are available in the Computer Science library.

Audience: Although this is a Computer Science course, we encourage the participation from all students who are interested in this topic.

Requirements: You should enjoy precise mathematical reasoning. You need to have passed a course on algorithms and complexity. No knowledge of game theory is required.

Design of Parallel and High-Performance Computing

Lecture notes
No lecture notes.

Advanced topics in parallel / concurrent programming.
Understand concurrency paradigms and models from a higher perspective and acquire skills for designing, structuring and developing possibly large concurrent software systems. Become able to distinguish parallelism in problem space and in machine space. Become familiar with important technical concepts and with concurrency folklore.

Compulsory Elective Courses

Further course offerings from the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

Additional Requirements (ETH-Masterstudents in PHYS/MATH/CSE)

Theoretical Computer Science

Lecture notes
The lecture is covered in detail by the textbook "Theoretical Computer Science".

Basic literature:


Further reading:


More exercises and examples in:

6. A. Asteroth, Ch. Baier: Theoretische Informatik

During the semester, two non-obligatory test exams will be offered.
Abstract
Introduction to computer architecture and system programming:

Instruction sets, storage hierarchies, runtime structures with an emphasis on computers as engines for the execution of compiled programs. Interaction between system software and the hardware. Problems that arise from the final representation, performance measurement and tuning, and program portability issues are covered.

Objective
The objective is to allow students to understand all aspects of the execution of compiled (C) programs on modern architectures -- the instruction set, the storage resources (registers, stack, memory), input/output, the impact of compiler decisions, and the interaction between the operating system and hardware. Two main themes are correctness issues (esp. those that arise from the finite representation of data) and performance issues (incl. measurement and tuning issues). The interface to the operating system is discussed to prepare for subsequent classes on more advanced systems topics.

The two key goals are:

1) To equip students with a thorough understanding of how to write correct programs that run fast on modern computer, and
2) How to write correct and efficient low-level systems code.

This course does not cover how to design or build a processor or computer.

Content
This course provides an overview of "computers" as a platform for the execution of (compiled) computer programs. This course provides a programmer's view of how computer systems execute programs, store information, and communicate. The course introduces the major computer architecture structures that have direct influence on the execution of programs (processors with registers, caches, other levels of the memory hierarchy, supervisor/kernel mode, and I/O structures) and covers implementation and representation issues only to the extend that they are necessary to understand the structure and operation of a computer system.

The course attempts to expose students to the practical issues that affect performance, portability, security, robustness, and extensibility. This course provides a foundation for subsequent courses on operating systems, networks, compilers and many other courses that require an understanding of the system-level issues. Topics covered include: machine-level code and its generation by optimizing compilers, address translation, input and output, trap/event handlers, performance evaluation and optimization (with a focus on the practical aspects of data collection and analysis).

Literature
The course is based in part on "Computer Systems: A Programmer's Perspective" (2nd Edition) by R. Bryant and D. O'Hallaron, with some additional material.

Prerequisites
252-0024-00L Parallel Programming,
252-0014-00L Digital Circuits

Part 2

Number Title Type ECTS Hours Lecturers
252-0209-00L Algorithms, Probability, and Computing W 8 credits 4+2U+1A E. Welzl, T. Holenstein, A. Steger

Abstract
Advanced design and analysis methods for algorithms and data structures: Random(ized) Search Trees, Point Location, Minimum Cut, Linear Programming, Randomized Algebraic Algorithms (matchings), Probabilistically Checkable Proofs (introduction).

Objective
Studying and understanding of fundamental advanced concepts in algorithms, data structures and complexity theory.

Literature
Will be handed out.

Introduction to Algorithms by T. H. Cormen, C. E. Leiserson, R. L. Rivest;
Randomized Algorithms by R. Motwani und P. Raghavan;
Computational Geometry - Algorithms and Applications by M. de Berg, M. van Kreveld, M. Overmars, O. Schwarzkopf.

Computer Science as Second Subject
Important: You can only enrol in the courses of subject didactics and professional training as a subsidiary subject if you have not more than 12 CP left for additional requirements.

Subject Didactics in Computer Science

Number Title Type ECTS Hours Lecturers
272-0101-00L Subject Didactics of Computer Science I O 4 credits 3G G. Serafini, J. Hromkovic

Abstract
Simultaneous enrolment in Introductory Practical in Computer Science - course 272-0201-00L - is compulsory.

The unit "Subject Didactics of Computer Science I" addresses key contributions of computer science to general education. The course deals with the thoughtful choice of educational contents for computer science classes, which takes into account its comprehensibility for different age groups as well as didactic approaches suitable for a successful knowledge transfer.

Data: 06.02.2019 13:00
Autumn Semester 2015
Page 757 of 1434
### Objective

The general objective of the course consists in highlighting the tight connection between the mathematical and algorithmic way of thinking and the approaches adopted by engineering disciplines, and in reflecting on teaching approaches for sustainable computer science teaching activities.

The students understand the fundamental concepts of computer science in the context of a broad and deep knowledge. Through this understanding, they manage to prepare teaching materials for a successful knowledge transfer and to pass their passion for the subject on to their pupils.

They know various teaching methods as well as their advantages and disadvantages. They can handle inhomogeneous prior knowledge of the learners inside a class. Besides holding classes, the students do care about the individual pupil support.

They encourage the autonomy of the learners, manage to work with diverse target groups and to establish a positive learning environment.

The students are able to express themselves using a comprehensible and refined professional language, both in a spoken and a written way, and they master the basic terminology of computer science. Besides the English terms, they are familiar with the corresponding German expressions. The students are able to produce detailed, matured, linguistically correct and design-wise appealing teaching materials.

### Content

The course "Subject Didactics of Computer Science I" addresses key contributions of computer science to general education. The chosen topics support the young learners in developing a unique and indispensable way of thinking, in enhancing their understanding of our world as well as in achieving university education entrance qualifications.

The main topics of the course unit "Subject Didactics of Computer Science I" are the didactics of finite state automata, of formal languages and of the introduction to programming. The unit focuses on contents of computer science that contribute to general education. This involves the understanding of fundamental scientific concepts such as algorithm, complexity, determinism, computation, automata, verification, testing and programming language as well as the way to embed them into a scientifically sound and didactically sustainable computer science course.

### Literature


### Prerequisites / notice

Lehrdiplom-Studierende müssen diese Lerneinheit zusammen mit dem Einführungspraktikum Informatik - 272-0201-00L - belegen.

### Mentored Work Subject Didactics Computer Science for Teaching Diploma and Teaching Diploma Computer Science as Minor Subject (20 credits)

<table>
<thead>
<tr>
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<th>Title</th>
<th>Objective</th>
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<tbody>
<tr>
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<td>Mentored Work Subject Didactics Computer Science</td>
<td>The objective is for the students:</td>
</tr>
<tr>
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<td>- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflect on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.</td>
</tr>
</tbody>
</table>

### Mentored Work Subject Didactics Computer Science for Teaching Diploma and for students upgrading TC to Teaching Diploma (20 credits)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Objective</th>
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</thead>
<tbody>
<tr>
<td>B</td>
<td>Mentored Work Subject Didactics Computer Science</td>
<td>The objective is for the students:</td>
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<td>- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflect on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.</td>
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<td></td>
<td>- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.</td>
</tr>
</tbody>
</table>
Thematische Schwerpunkte
Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

Lernformen

Literatur
Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

Prerequisites / notice
Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

Professional Training in Computer Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>271-0102-00L</td>
<td>Teaching Internship Including Examination Lessons in Computer Science</td>
<td>O</td>
<td>4 credits</td>
<td>9P</td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
</tbody>
</table>

Abstract
Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as assessed as Examination Lessons.

Objective
- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils’ work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Content

Die Themen für die beiden Prüfungslektionen am Schluss des Praktikums erfahren die Studierenden in der Regel eine Woche vor dem Prüfungstermin. Sie erstellen eine Vorbereitung gemäss Anleitung und reichen sie bis am Vortrag um 12 Uhr den beiden Prüfungsexperten (Fachdidaktiker/-in, Departementsvertreter/-in) ein. Die gehaltenen Lektionen werden kriteriumsbasiert beurteilt. Die Beurteilung umfasst auch die schriftliche Vorbereitung und eine mündliche Reflexion des Kandidaten/der Kandidatin über die gehaltenen Lektionen im Rahmen eines kurzen Kolloquiums.

Lecture notes
Dokument: schriftliche Vorbereitung für Prüfungslektionen.

Literature
Wird von der Praktikumslehrperson bestimmt.

Computer Science Teaching Diploma - Key for Type

<table>
<thead>
<tr>
<th>Key for Type</th>
<th>Description</th>
<th>E-</th>
<th>Z</th>
<th>Dr</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td></td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
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<td></td>
<td>Suitable for doctorate</td>
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Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
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<tbody>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<td>A</td>
<td>independent project</td>
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<td>U</td>
<td>exercise</td>
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<td>D</td>
<td>diploma thesis</td>
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<td>S</td>
<td>seminar</td>
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<td>R</td>
<td>revision course / private study</td>
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<td>K</td>
<td>colloquium</td>
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ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Computer Science Master

### Interfocus Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<tbody>
<tr>
<td>263-0006-00L</td>
<td>Algorithms Lab</td>
<td>O</td>
<td>6</td>
<td>4P+1A</td>
<td>A. Steger, E. Welzl, P. Widmayer</td>
</tr>
</tbody>
</table>

**Abstract**

Students learn how to solve algorithmic problems given by a textual description (understanding problem setting, finding appropriate modeling, choosing suitable algorithms, and implementing them). Knowledge of basic algorithms and data structures is assumed; more advanced material and usage of standard libraries for combinatorial algorithms are introduced in tutorials.

**Objective**

The objective of this course is to learn how to solve algorithmic problems given by a textual description. This includes appropriate problem modeling, choice of suitable (combinatorial) algorithms, and implementing them (using C/C++, STL, CGAL, and BGL).

**Literature**


<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturer(s)</th>
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<tr>
<td>263-0007-00L</td>
<td>Advanced Systems Lab</td>
<td>O</td>
<td>6</td>
<td>4P+1A</td>
<td>G. Alonso</td>
</tr>
</tbody>
</table>

**Abstract**

The goal of this course is to teach students how to evaluate the performance of complex computer and software systems. Accordingly, the methodology to carry out experiments and measurements is studied. Furthermore, the modeling of systems with the help of queueing network systems is explained.

**Objective**

The goal of this course is to teach students how to evaluate the performance of complex computer and software systems.

### Focus Courses

#### Focus Courses in Computational Science

#### Focus Core Courses Computational Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tr>
<td>252-0523-00L</td>
<td>Computational Biology</td>
<td>W</td>
<td>6</td>
<td>3V+2U</td>
<td>G. H. Gonnet</td>
</tr>
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</table>

**Abstract**

Study of computational techniques, algorithms and data structures used to solve problems in computational biology. Topics: basic biology, string alignment, phylogeny (distance, character, parsimony), molecular evolution, multiple sequence alignment, probabilistic and statistical models, Markov models, microarrays, dynamic programming, maximum likelihood and specialized DNA and protein analysis.

**Objective**

Familiarize the students with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensible to solve modeling problems under uncertainty. Key concepts are the generalization ability of models, Markov models, microarrays, dynamic programming, maximum likelihood and specialized DNA and protein analysis.

**Content**

- Study of fundamental concepts, models and computational methods for the modeling, simulation and analysis of biological networks. The aim of this course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.
- Study of computational techniques, algorithms and data structures used to solve problems in computational biology. Topics: basic biology, string alignment, phylogeny (distance, character, parsimony), molecular evolution, multiple sequence alignment, probabilistic and statistical models, Markov models, microarrays, dynamic programming, maximum likelihood and specialized DNA and protein analysis.

**Literature**


#### Focus Elective Courses Computational Science

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturer(s)</th>
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<tr>
<td>252-0535-00L</td>
<td>Machine Learning</td>
<td>W</td>
<td>6</td>
<td>3V+2U</td>
<td>J. M. Buhmann</td>
</tr>
</tbody>
</table>

**Abstract**

Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

**Objective**

Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensible to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.
The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:
- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher’s LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

Lecture notes
No lecture notes, but slides will be made available on the course webpage.

Literature

Prerequisites / notice
Solid basic knowledge in analysis, statistics and numerical methods for CSE. Experience in programming for solving the project tasks.
Literature


Prerequisites / notice

Prerequisites: Linear Algebra, Analysis, Computational Science.
The exercises are made with Matlab.

263-5150-00L Scientific Databases

Abstract

Scientific databases share many aspects with classical DBs, but have additional specific aspects. We will review Relational DBs, Object Oriented DBs, Knowledge DBs, textual DBs and the Semantic Web. All these topics will be studied from the point of view of the scientific applications (Bioinformatics, Physics, Chemistry, Health, Engineering) A toy SDB will be used for exercises.

Objective

The goals of this course are to:
(a) Familiarize the students with how existing DBs can be used for scientific applications.
(b) Recognize the areas where SciDBs differ and require additional features compared to classical DBs.
(c) Be able to understand more easily SciDBs, improve existing ones or design/create new ones.
(d) Familiarize the students with at least two examples of SciDBs.

Content

1) Introduction, Statement of the problem, course structure, exercises, why Scientific DBs (SDBs) do not fit exactly the classical DB area.
   Hierarchy: File systems, data bases, knowledge bases and variations.
   Efficiency issues and how they differ from classical DB.
2) Relational DB used for scientific data, pros/cons
   Introduction to RDB, limitations of the model, basics of SQL, handling of metadata, examples of scientific use of RDBs.
3) Object Oriented DB. Rich/structured objects are very appealing in SDB. OODB primitives and environments. OODB searching.
   Space and access time efficiency of OODBs.
4) Knowledge bases, key-value stores, ontologies, workflow-based architectures. WASA.
5) - MapReduce / Hadoop
6) - Storing and sharing mathematical objects, Open Math, its relation with OODB and Knowledge bases. Also the problem of chemical formula representation.
7) - SGML and XML, human-readable databases, genomic databases.
   Advantages of human-readable databases (the huge initial success of genomic databases).
8) - Semantic web, Resource Description Framework (RDF) triples, SparQL.
   An example of very flexible database for knowledge storage. Goals of the Semantic Web, discussion about its future.
9) - An ideal scenario (and the design of a toy system with most of the desired features for exploration and exercises).
11) - Functional testing, Verifiers, Consistency, Short-circuit testing, Recovery and Automatic recovery, Backup (incremental) methods.
12) - Performance and space issues, various uses of compression, concurrency control. Hardware issues, clusters, Cloud computing, Crowd-sourcing.
13) - Guest speaker: Ioannis Xenarios (UniProtKB/Swiss-Prot).

Literature

Several papers and online articles will be made available.
There is no single textbook for this course
A significant amount of material will be delivered in the lectures making lecture attendance highly recommended.

151-0104-00L Uncertainty Quantification for Engineering & Life Sciences

Number of participants limited to 60.

Abstract

Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

Objective

The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

Content

Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Lecture notes

The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.
Seminar Computational Science

### Course Details

**Number**: 252-5701-00L  
**Title**: Advanced Topics in Computer Graphics and Vision  
**ECTS**: 6 credits  
**Type**: Individual  
**Hours**: 2S  
**Lecturers**: M. Gross, M. Pollefeys, O. Sorkine Hornung  

**Abstract**: This seminar covers advanced topics in computer graphics, such as modeling, rendering, animation, real-time graphics, physical simulation, and computational photography. Each time the course is offered, a collection of research papers is selected and each student presents one paper to the class and leads a discussion about the paper and related topics.

**Objective**: The goal is to get an in-depth understanding of actual problems and research topics in the field of computer graphics as well as improve presentations and critical analysis skills.

**Content**: This seminar covers advanced topics in computer graphics, including both seminal research papers as well as the latest research results. Each time the course is offered, a collection of research papers are selected covering topics such as modeling, rendering, animation, real-time graphics, physical simulation, and computational photography. Each student presents one paper to the class and leads a discussion about the paper and related topics.

**Lecture notes**: no script  
**Literature**: Individual research papers are selected each term. See http://graphics.ethz.ch/ for the current list.

**Prerequisites**: Prerequisites: The courses “Computer Graphics I and II” (GDV I & II) are recommended, but not mandatory.

Focus Courses in Distributed Systems

### Focus Core Courses Distributed Systems

#### Course Details

**Number**: 252-3800-00L  
**Title**: Advanced Operating Systems  
**ECTS**: 6 credits  
**Type**: Individual  
**Hours**: 2V+2U+1A  
**Lecturers**: T. Roscoe  

**Abstract**: This course is intended to give students a thorough understanding of design and implementation issues for modern operating systems. We will cover key design issues in implementing an operating system, such as memory management, scheduling, protection, inter-process communication, device drivers, and file systems.

**Objective**: The goals of the course are, firstly, to give students a broader perspective on OS design than that provided by knowledge of Unix or Windows, building on the material in a standard undergraduate operating systems class, and secondly, to provide them with practical experience in dealing directly with the concurrency, resource management, and abstraction problems confronting OS designers and implementers.

**Content**: This course is intended to give students a thorough understanding of design and implementation issues for modern operating systems. We will cover key design issues in implementing an operating system, such as memory management, scheduling, protection, inter-process communication, device drivers, and file systems. We will pay particular attention to system structures that differ from traditional monolithic arrangements of Unix/Linux and Windows.

**Prerequisites**: The course consists of lectures, project work, and a written examination. Project work will be performed in small groups, where students will implement major components of a microkernel-based operating system. The final assessment will be a combination of project and examination grades.

**Number**: 252-1414-00L  
**Title**: System Security  
**ECTS**: 5 credits  
**Type**: Individual  
**Hours**: 2V+2U  
**Lecturers**: S. Capkun, A. Perrig  

**Abstract**: The first part of the lecture covers individual system's aspects starting with tamperproof or tamperresistant hardware in general over operating system related security mechanisms to application software systems, such as host based intrusion detection systems. In the second part, the focus is on system design and methodologies for large projects.

**Objective**: In this lecture, students learn about the security requirements and capabilities that are expected from modern hardware, operating systems and other software environments. An overview of available technologies, algorithms and standards is given, with which these requirements can be met.

**Content**: The first part of the lecture covers individual system's aspects starting with tamperproof or tamperresistant hardware in general over operating system related security mechanisms to application software systems such as host based intrusion detection systems. The main topics covered are: tamper resistant hardware, CPU support for security, protection mechanisms in the kernel, file system security (permissions / ACLs / network filesystem issues), IPC Security, mechanisms in more modern OS, such as Capabilities and Zones, Libraries and Software tools for security assurance, etc.

In the second part, the focus is on system design and methodologies for large projects. The main question answered is how to get a large secure system. Topics include: patch management, common software faults (buffer overflows, etc.), writing secure software (design, architecture, QA, testing), compiler-supported security, language-supported security (java...), logging and auditing (BSM audit, dtrace, ...), cryptographic support, TCG, secure file systems, dos/windows/ windowsXP security issues.

Along the lectures, model cases will be elaborated and evaluated in the exercises.

### Focus Elective Courses Distributed Systems

#### Course Details

**Number**: 252-0437-00L  
**Title**: Distributed Algorithms  
**ECTS**: 4 credits  
**Type**: Individual  
**Hours**: 3V  
**Lecturers**: F. Mattern  

**Abstract**: Models of distributed computations, time space diagrams, virtual time, logical clocks and causality, wave algorithms, parallel and distributed graph traversal, consistent snapshots, mutual exclusion, election and symmetry breaking, distributed termination detection, garbage collection in distributed systems, monitoring distributed systems, global predicates.

**Objective**: Become acquainted with models and algorithms for distributed systems.
Verteilte Algorithmen sind Verfahren, die dadurch charakterisiert sind, dass mehrere autonome Prozesse gleichzeitig Teile eines gemeinsamen Problems in kooperativer Weise bearbeiten und der dabei erforderliche Informationsaustausch ausschließlich über Nachrichten erfolgt. Derartige Algorithmen kommen im Rahmen verteilter Systeme zum Einsatz, bei denen kein gemeinsamer Speicher existiert und die Übertragungszeit von Nachrichten i.a. nicht vernachlässigt werden kann. Da dabei kein Prozess eine aktuelle konstante Sicht des globalen Zustands besitzt, führt dies zu interessanten Problemen. Im einzelnen werden u.a. folgende Themen behandelt:
- Modelle verteilter Berechnungen; Raum-Zeit Diagramme; Virtuelle Zeit; Logische Uhren und Kausalität; Wellenalgorithmen; Verteilte parallele Graphparallelität; Berechnung konsistenter Schnappschlüsse; Wechselfeldlicher Ausschluss; Elektron und Symmetriebrechung;
- Verteilte Terminierung; Garbage-Collection in verteilten Systemen; Beobachten verteilter Systeme; Berechnung globaler Prädikate.

Abdus Salam International Centre for Theoretical Physics, Trieste, Italy

252-0817-00L Distributed Systems Laboratory
In the Master Programme max. 10 credits can be accounted by Labs on top of the Interfocus Courses. These Labs will only count towards the Master Programme. Additional Labs will be listed on the Addendum.

Abstract
This course involves the participation in a substantial development and/or evaluation project involving distributed systems technology. There are projects available in a wide range of areas: from web services to ubiquitous computing including wireless networks, ad-hoc networks, RFID, and distributed applications on smartphones. There are projects available in a wide range of areas: from web services to ubiquitous computing including wireless networks, ad-hoc networks, and distributed application on smartphones. The goal of the project is for the students to gain hands-on-experience with real products and the latest technology in distributed systems.

Objective
Gain hands-on-experience with real products and the latest technology in distributed systems.

Content
This course involves the participation in a substantial development and/or evaluation project involving distributed systems technology. There are projects available in a wide range of areas: from web services to ubiquitous computing including wireless networks, ad-hoc networks, and distributed application on smartphones. The goal of the project is for the students to gain hands-on-experience with real products and the latest technology in distributed systems. There is no lecture associated to the course. For information of the course or projects available, please contact Prof. Mattern, Prof. Wattenhofer, Prof. Roscoe or Prof. G. Alonso.

Seminar Distributed Systems

Number Title Type ECTS Hours Lecturers
252-3001-00L Advanced Topics in Information Systems W 2 credits 2S M. Norrie

Abstract
This seminar course will discuss research topics in the area of information systems. We will read recent research papers on a selected topic, and present/discuss them in class.

Objective
The goal is to introduce students to current research, and to enable them to read, understand, and present scientific papers.

Content
This course involves the participation in a substantial development and/or evaluation project involving distributed systems technology. Each participant will be required to give a presentation of about 30 mins followed by a discussion on an assigned topic. In addition, each participant will be assigned as a buddy on another paper which means that they must read the paper and be prepared to start of the discussion on the paper with some comments and questions. Students also have to submit a 2-page summary of the paper that they present. Grading will depend on the quality of the talk, the report, and also active participation during the seminar.

Focus Courses in Information Security

Focus Core Courses Information Security

Number Title Type ECTS Hours Lecturers
252-0463-00L Security Engineering W 5 credits 2V+2U D. Basin

Abstract
Subject of the class are engineering techniques for developing secure systems. We examine concepts, methods and tools, applied within the different activities of the SW development process to improve security of the system. Topics: security requirements & risk analysis, system modeling & model-based development methods, implementation-level security, and evaluation criteria for secure systems.

Objective
Security engineering is an evolving discipline that unifies two important areas: software engineering and security. Software Engineering addresses the development and application of methods for systematically developing, operating, and maintaining, complex, high-quality software. Security, on the other hand, is concerned with assuring and verifying properties of a system that relate to confidentiality, integrity, and availability of data.

The goal of this class is to survey engineering techniques for developing secure systems. We will examine concepts, methods, and tools that can be applied within the different activities of the software development process, in order to improve the security of the resulting systems.

Topics covered include
- security requirements & risk analysis,
- system modeling and model-based development methods,
- implementation-level security, and
- evaluation criteria for the development of secure systems.
Security engineering is an evolving discipline that unifies two important areas: software engineering and security. Software Engineering addresses the development and application of methods for systematically developing, operating, and maintaining, complex, high-quality software.

Security, on the other hand, is concerned with assuring and verifying properties of a system that relate to confidentiality, integrity, and availability of data.

The goal of this class is to survey engineering techniques for developing secure systems. We will examine concepts, methods, and tools that can be applied within the different activities of the software development process, in order to improve the security of the resulting systems.

Topics covered include

* security requirements & risk analysis,
* system modeling and model-based development methods,
* implementation-level security, and
* evaluation criteria for the development of secure systems

Modules taught:

1. Introduction
   - Introduction of Infsec group and speakers
   - Security meets SW engineering: an introduction
   - The activities of SW engineering, and where security fits in
   - Overview of this class

2. Requirements Engineering: Security Requirements and some Analysis
   - overview: functional and non-functional requirements
   - use cases, misuse cases, sequence diagrams
   - safety and security
   - FMEA, FTA, attack trees

3. Modeling in the design activities
   - structure, behavior, and data flow
   - class diagrams, statecharts

4. Model-driven security for access control (design)
   - SecureUML as a language for access control
   - Combining Design Modeling Languages with SecureUML
   - Semantics, i.e., what does it all mean,
   - Generation
   - Examples and experience

5. Model-driven security (Part II)
   - Continuation of above topics

6. Security patterns (design and implementation)

7. Implementation-level security
   - Buffer overflows
   - Input checking
   - Injection attacks

8. Testing
   - overview
   - model-based testing
   - testing security properties

9. Risk analysis and management 1 (project management)
   - "risk": assets, threats, vulnerabilities, risk
   - risk assessment: quantitative and qualitative
   - safeguards
   - generic risk analysis procedure
   - The OCTAVE approach

10. Risk analysis: IT baseline protection
    - Overview
    - Example

11. Evaluation criteria
    - CMM
    - systems security engineering CMM
    - common criteria

12. Guest lecture
    - TBA

Literature

- Further relevant books and journal/conference articles will be announced in the lecture.

Prerequisites / notice

Prerequisite: Class on Information Security
Content

The first part of the lecture covers individual system's aspects starting with tamperproof or tamperresistant hardware in general over operating system related security mechanisms to application software systems such as host based intrusion detection systems. The main topics covered are: tamper resistant hardware, CPU support for security, protection mechanisms in the kernel, file system security (permissions / ACLs / network filesystem issues), IPC Security, mechanisms in more modern OS, such as Capabilities and Zones, Libraries and Software tools for security assurance, etc.

In the second part, the focus is on system design and methodologies for large projects. The main question answered is how to get a large secure system. Topics include: patch management, common software faults (buffer overflows, etc.), writing secure software (design, architecture, QA, testing), compiler-supported security, language-supported security (java...), logging and auditing (BSM audit, dtrace, ...), cryptographic support, TCG, secure file systems, dos/windows/ windowsXP security issues.

Along the lectures, model cases will be elaborated and evaluated in the exercises.

>>> Focus Elective Courses Information Security

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<thead>
<tr>
<th>Number</th>
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<th>Type</th>
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<tr>
<td>252-0811-00L</td>
<td>Applied Security Laboratory</td>
<td>W</td>
<td>8</td>
<td>7P</td>
<td>D. Basin</td>
</tr>
</tbody>
</table>

Abstract

Hands-on course on applied aspects of information security. Applied information security, operating system security. OS hardening, computer forensics, web application security, project work, design, implementation, and configuration of security mechanisms, risk analysis, system review.

Objective

The Applied Security Laboratory addresses four major topics: operating system security (hardening, vulnerability scanning, access control, logging), application security with an emphasis on web applications (web server setup, common web exploits, authentication, session handling, code security), computer forensics, and risk analysis and risk management.

Content

This course emphasizes applied aspects of Information Security. The students will study a number of topics in a hands-on fashion and carry out experiments in order to better understand the need for secure implementation and configuration of IT systems and to assess the effectiveness and impact of security measures. This part is based on a book and virtual machines that include example applications, questions, and answers.

The students will also complete an independent project: based on a set of functional requirements, they will design and implement a prototypical IT system. In addition, they will conduct a thorough security analysis and devise appropriate security measures for their systems. Finally, they will carry out a technical and conceptual review of another system. All project work will be performed in teams and must be properly documented.

Lecture notes

The course is based on the book "Applied Information Security - A Hands-on Approach". More information:
http://www.infsec.ethz.ch/appliedlabbook

Literature

Recommended reading includes:
* Various: OWASP Guide to Building Secure Web Applications, available online
* O'Reilly, Loukides: Unix Power Tools, O'Reilly & Associates.
* Frisch: Essential System Administration, O'Reilly & Associates.
* NIST: Risk Management Guide for Information Technology Systems, available online as PDF
* BSI: IT-Grundschutzhandbuch, available online

Prerequisites / notice

* The lab allows flexible working since there are only few mandatory meetings during the semester.
* The lab covers a variety of different techniques. Thus, participating students should have a solid foundation in the following areas: information security, operating system administration (especially Unix/Linux), and networking. Students are also expected to have a basic understanding of HTML, PHP, JavaScript, and MySQL because several examples are implemented in these languages.
* Students must be prepared to spend more than three hours per week to complete the lab assignments and the project. This applies particularly to students who do not meet the recommended requirements given above. Successful participants of the course receive 8 credits as compensation for their effort.
* All participants must sign the lab's charter and usage policy during the introduction lecture.

252-1411-00L Security of Wireless Networks

Abstract

Core Elements: Wireless communication channel, Wireless network architectures and protocols, Attacks on wireless networks, Protection techniques.

Objective

After this course, the students should be able to: describe and classify security goals and attacks in wireless networks; describe security architectures of the following wireless systems and networks: 802.11, GSM/UMTS, RFID, ad hoc/sensor networks; reason about security protocols for wireless network; implement mechanisms to secure 802.11 networks.

Content


263-4630-00L Computer-Aided Modelling and Reasoning

Abstract

The "computer-aided modelling and reasoning" lab is a hands-on course about using an interactive theorem prover to construct formal models of algorithms, protocols, and programming languages and to reason about their properties. The lab has two parts: The first introduces various modelling and proof techniques. The second part consists of a project in which the students apply these techniques to a variety of different applications.

Objective

The students learn to effectively use a theorem prover to create unambiguous models and rigorously analyse them. They learn how to write precise and concise specifications, to exploit the proof assistant as a tool for checking and analysing such models and for taming their complexity, and to extract certified executable implementations from such specifications.

Content

The "computer-aided modelling and reasoning" lab is a hands-on course about using an interactive theorem prover to construct formal models of algorithms, protocols, and programming languages and to reason about their properties. The focus is on applying logical methods to concrete problems supported by a theorem prover. The course will demonstrate the challenges of formal rigor, but also the benefits of machine support in modelling, proving and validating.

The lab will have two parts: The first part introduces basic and advanced modelling techniques (functional programs, inductive definitions, modules), the associated proof techniques (term rewriting, resolution, induction, proof automation), and compilation of the models to certified executable code. In the second part, the students work in teams of two on a project assignment in which they apply these techniques; they build a formal model and prove its desired properties. The project lies in the area of programming languages, model checking, or information security.
Seminar Information Security

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>252-4601-00L</td>
<td>Current Topics in Information Security</td>
<td>W</td>
<td>2 credits</td>
<td>3S</td>
<td>D. Basin, S. Capkun, A. Perrig</td>
</tr>
</tbody>
</table>

Abstract
The seminar covers various topics in information security: security protocols (models, specification & verification), trust management, access control, non-interference, side-channel attacks, identity-based cryptography, host-based attack detection, anomaly detection in backbone networks, key-management for sensor networks.

Objective
The main goals of the seminar are the independent study of scientific literature and assessment of its contributions as well as learning and practicing presentation techniques.

Content
The seminar covers various topics in information security, including network security, cryptography and security protocols. The participants are expected to read a scientific paper and present it in a 35-40 min talk. At the beginning of the semester a short introduction to presentation techniques will be given.

Selected Topics
- security protocols: models, specification & verification
- trust management, access control and non-interference
- side-channel attacks
- identity-based cryptography
- host-based attack detection
- anomaly detection in backbone networks
- key-management for sensor networks

Literature
The reading list will be published on the course web site.

Focus Courses Information Systems

Focus Core Courses Information Systems

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
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<tbody>
<tr>
<td>252-0535-00L</td>
<td>Machine Learning</td>
<td>W</td>
<td>6 credits</td>
<td>3V+2U</td>
<td>J. M. Buhmann</td>
</tr>
</tbody>
</table>

Abstract
Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

Objective
Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.

Content
The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:
- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher’s LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

Lecture notes
No lecture notes, but slides will be made available on the course webpage.

Literature
Prerequisites / notice

Solid basic knowledge in analysis, statistics and numerical methods for CSE. Experience in programming for solving the project tasks.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Security Engineering</th>
<th>Credits</th>
<th>Lectures</th>
<th>Tutorials</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0463-00L</td>
<td>W 5 credits 2V+2U D. Basin</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Abstract

Subject of the class are engineering techniques for developing secure systems. We examine concepts, methods and tools, applied within the different activities of the SW development process to improve security of the system. Topics: security requirements & risk analysis, system modeling & model-based development methods, implementation-level security, and evaluation criteria for secure systems.

Objective

Security engineering is an evolving discipline that unifies two important areas: software engineering and security. Software Engineering addresses the development and application of methods for systematically developing, operating, and maintaining, complex, high-quality software.

The goal of this class is to survey engineering techniques for developing secure systems. We will examine concepts, methods, and tools that can be applied within the different activities of the software development process, in order to improve the security of the resulting systems.

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Topics covered include

* security requirements & risk analysis,
* system modeling and model-based development methods,
* implementation-level security, and
* evaluation criteria for the development of secure systems

Content

Security engineering is an evolving discipline that unifies two important areas: software engineering and security. Software Engineering addresses the development and application of methods for systematically developing, operating, and maintaining, complex, high-quality software.

The goal of this class is to survey engineering techniques for developing secure systems. We will examine concepts, methods, and tools that can be applied within the different activities of the software development process, in order to improve the security of the resulting systems.

Topics covered include

* security requirements & risk analysis,
* system modeling and model-based development methods,
* implementation-level security, and
* evaluation criteria for the development of secure systems

Modules taught:

1. Introduction
   - Introduction of Infsec group and speakers
   - Security meets SW engineering: an introduction
   - The activities of SW engineering, and where security fits in
   - Overview of this class
2. Requirements Engineering: Security Requirements and some Analysis
   - overview: functional and non-functional requirements
   - use cases, misuse cases, sequence diagrams
   - safety and security
   - FMEA, FTA, attack trees
3. Modeling in the design activities
   - structure, behavior, and data flow
   - class diagrams, statecharts
4. Model-driven security for access control (design)
   - SecureUML as a language for access control
   - Combining Design Modeling Languages with SecureUML
   - Semantics, i.e., what does it all mean,
   - Generation
   - Examples and experience
5. Model-driven security (Part II)
   - Continuation of above topics
6. Security patterns (design and implementation)
7. Implementation-level security
   - Buffer overflows
   - Input checking
   - Injection attacks
8. Testing
   - overview
   - model-based testing
   - testing security properties
9. Risk analysis and management 1 (project management)
   - "risk": assets, threats, vulnerabilities, risk
   - risk assessment: quantitative and qualitative
   - safeguards
   - generic risk analysis procedure
   - The OCTAVE approach
10. Risk analysis: IT baseline protection
    - Overview
    - Example
11. Evaluation criteria
    - CMMI
    - systems security engineering CMM
    - common criteria
12. Guest lecture
    - TBA
The goal of this course is to give an overview of Big Data technologies. All aspects are covered: data formats and models, programming languages, optimization techniques, systems, and applications.

The course examines how traditional information system architectures and technologies have been adapted to support various forms of mobile and personal information systems. Topics to be covered include: databases of mobile objects; context-aware services; opportunistic information sharing; ambient information; pervasive display systems.

The courts exercises examine the impact of the different forms of mobility and collaboration that systems require nowadays and how these influence the design of systems at the database, the application and the user interface level. For example, traditional data management techniques have to be adapted to meet the requirements of such systems and cope with new connection, access and synchronisation issues. As mobile devices have increasingly become integrated into the users’ lives and are expected to support a range of activities in different environments, applications should be context-aware, adapting functionality, information delivery and the user interfaces to the current environment and task. Various forms of software and hardware sensors may be used to determine the current context, raising interesting issues for discussion. Finally, user mobility, and the varying and intermittent connectivity that it implies, gives rise to new forms of dynamic collaboration that require lightweight, but flexible, mechanisms for information synchronisation and consistency maintenance. Here, the interplay of mobile, personal and social context will receive special attention.

Scientific databases share many aspects with classical DBs, but have additional specific aspects. We will review Relational DBs, Object Oriented DBs, Knowledge DBs, textual DBs and the Semantic Web. All these topics will be studied from the point of view of the scientific applications (Bioinformatics, Physics, Chemistry, Health, Engineering). A toy SDB will be used for exercises.

The goals of this course are to:
(a) Familiarize the students with how existing DBs can be used for scientific applications.
(b) Recognize the areas where SciDBs differ and require additional features compared to classical DBs.
(c) Be able to understand more easily SciDBs, improve existing ones or design/create new ones.
(d) Familiarize the students with at least two examples of SciDBs.
1) Introduction, Statement of the problem, course structure, exercises, why Scientific DBs (SDBs) do not fit exactly the classical DB area. Efficiency issues and how they differ from classical DB.

2) Relational DB used for scientific data, pros/cons Introduction to RDB, limitations of the model, basics of SQL, handling of metadata, examples of scientific use of RDBs.

3) Object Oriented DB. Rich/structured objects are very appealing in SDB. OODB primitives and environments. OODB searching. Space and access time efficiency of OODBs.

4) Knowledge bases, key-value stores, ontologies, workflow-based architectures. WASA.

5) MapReduce / Hadoop

6) Storing and sharing mathematical objects, Open Math, its relation with OODB and Knowledge bases. Also the problem of chemical formula representation.


9) An ideal scenario (and the design of a toy system with most of the desired features for exploration and exercises).


12) Performance and space issues, various uses of compression, concurrency control. Hardware issues, clusters, Cloud computing, Crowd-sourcing.

13) Guest speaker: Ioannis Xenarios (UniProtKB/Swiss-Prot).

Literature
Several papers and online articles will be made available.
There is no single textbook for this course.
A significant amount of material will be delivered in the lectures making lecture attendance highly recommended.

263-5200-00L Data Mining: Learning from Large Data Sets W 4 credits 2V+1U A. Krause

Abstract
Many scientific and commercial applications require insights from massive, high-dimensional data sets. This course introduces principled, state-of-the-art techniques from statistics, algorithms and discrete and convex optimization for learning from such large data sets. The course both covers theoretical foundations and practical applications.

Objective
We will study principled, state-of-the-art techniques from statistics, algorithms and discrete and convex optimization for learning from such large data sets. The course will both cover theoretical foundations and practical applications.

Content
Topics covered:
- Dealing with large data (Data centers; Map-Reduce/Hadoop; Amazon Mechanical Turk)
- Fast nearest neighbor methods (Shingling, locality sensitive hashing)
- Online learning (Online optimization and regret minimization, online convex programming, applications to large-scale Support Vector Machines)
- Multi-armed bandits (exploration-exploitation tradeoffs, applications to online advertising and relevance feedback)
- Active learning (uncertainty sampling, pool-based methods, label complexity)
- Dimension reduction (random projections, nonlinear methods)
- Data streams (Sketches, coresets, applications to online clustering)
- Recommender systems

Prerequisites / notice
Prerequisites: Solid basic knowledge in statistics, algorithms and programming. Background in machine learning is helpful but not required.

263-5210-00L Probabilistic Artificial Intelligence W 4 credits 2V+1U A. Krause

Abstract
This course introduces core modeling techniques and algorithms from statistics, optimization, planning, and control and study applications in areas such as sensor networks, robotics, and the Internet.

Objective
How can we build systems that perform well in uncertain environments and unforeseen situations? How can we develop systems that exhibit "intelligent" behavior, without prescribing explicit rules? How can we build systems that learn from experience in order to improve their performance? We will study core modeling techniques and algorithms from statistics, optimization, planning, and control and study applications in areas such as sensor networks, robotics, and the Internet. The course is designed for upper-level undergraduate and graduate students.

Content
Topics covered:
- Search (BFS, DFS, A*), constraint satisfaction and optimization
- Tutorial in logic (propositional, first-order)
- Probability
- Bayesian Networks (models, exact and approximate inference, learning) - Temporal models (Hidden Markov Models, Dynamic Bayesian Networks)
- Probabilistic planning (MDPs, POMDPs)
- Reinforcement learning
- Combining logic and probability

Prerequisites / notice
Solid basic knowledge in statistics, algorithms and programming
Seminar Information Systems

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-3001-00L</td>
<td>Advanced Topics in Information Systems</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>M. Norrie</td>
</tr>
</tbody>
</table>

Number of participants limited to 16.

Abstract: This seminar course will discuss research topics in the area of information systems. We will read recent research papers on a selected topic, and present/discuss them in class.

Objective: The goal is to introduce students to current research, and to enable them to read, understand, and present scientific papers.

Content: Each participant will be required to give a presentation of about 30 mins followed by a discussion on an assigned topic. In addition, each participant will be assigned as a buddy on another paper which means that they must read the paper and be prepared to start of the discussion on the paper with some comments and questions. Students also have to submit a 2-page summary of the paper that they present. Grading will depend on the quality of the talk, the report, and also active participation during the seminar.

Focus Courses in Software Engineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>252-0237-00L</td>
<td>Concepts of Object-Oriented Programming</td>
<td>W</td>
<td>6 credits</td>
<td>3V+2U</td>
<td>P. Müller</td>
</tr>
</tbody>
</table>

Abstract: Course that focuses on an in-depth understanding of object-oriented programming and compares designs of object-oriented programming languages. Topics include different flavors of type systems, inheritance models, encapsulation in the presence of aliasing, object and class initialization, program correctness, reflection

Objective: After this course, students will:

- Have a deep understanding of advanced concepts of object-oriented programming and their support through various language features.
- Be able to learn new languages more rapidly.
- Be aware of many subtle problems of object-oriented programming and know how to avoid them.

Content: The main goal of this course is to convey a deep understanding of the key concepts of sequential object-oriented programming and their support in different programming languages. This is achieved by studying how important challenges are addressed through language features and programming idioms. In particular, the course discusses alternative language designs by contrasting solutions in languages such as C++, C#, Eiffel, Java, Python, and Scala. The course also introduces novel ideas from research languages that may influence the design of future mainstream languages.

The topics discussed in the course include among others:

- The pros and cons of different flavors of type systems (for instance, static vs. dynamic typing, nominal vs. structural, syntactic vs. behavioral typing)
- The key problems of single and multiple inheritance and how different languages address them
- Generics type systems, in particular, Java generics, C# generics, and C++ templates
- The situations in which object-oriented programming does not provide encapsulation, and how to avoid them
- The pitfalls of object initialization, exemplified by a research type system that prevents null pointer dereferencing
- How to maintain the consistency of data structures

Literature:

Will be announced in the lecture.

Prerequisites / notice:

- Prerequisites:
  - Mastering at least one object-oriented programming language (this course will NOT provide an introduction to object-oriented programming): programming experience

Focus Core Courses Software Engineering

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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>252-0239-00L</td>
<td>Software Verification</td>
<td>W</td>
<td>6 credits</td>
<td>3V+2U</td>
<td>B. Meyer, C. A. Furia, S. Nanz</td>
</tr>
</tbody>
</table>

Abstract: This course surveys some of the main approaches to software verification, including axiomatic semantics, abstract interpretation, model checking, and testing.

Objective: After successfully taking this course, students will have a theoretical and practical understanding of:

- The principles behind fundamental software verification techniques, including Hoare-style axiomatic semantics, abstract interpretation, model checking, and testing.
- Application of the principles to the construction of verification tools, in particular program provers.
- Research challenges in these areas.

Content: The idea of software verification has been around for decades, but only recently have the techniques become mature enough to be implemented and be applicable in practice. Progress has been made possible by the convergence of different techniques, originally developed in isolation.

This course embraces this diversity of approaches, by surveying some of the main ideas, techniques, and results in software verification. These include in particular:

- Axiomatic semantics, which provides a foundation of program correctness proofs by supplying a rigorous semantics of programs.
- Abstract interpretation, which provides a general framework to express and design static techniques for program analysis.
- Model checking, which provides efficient techniques for the exhaustive exploration of state-based models of programs and reactive systems.
- Testing, which provides the counterpart to exhaustive techniques by defining dynamic analyses to detect programming mistakes and correct them.

To demonstrate some of the techniques in practice, the course will offer a practical project requiring the application of verification tools to illustrative examples.
Literature

Axiomatic semantics:


Abstract interpretation:

* Neil D. Jones, Flemming Nielson: Abstract Interpretation: a Semantic-Based Tool for Program Analysis

Model checking and real-time:


Testing:


### Focus Elective Courses Software Engineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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</tr>
</thead>
<tbody>
<tr>
<td>252-0273-01L</td>
<td>Distributed Software Engineering Laboratory</td>
<td>W</td>
<td>8 credits</td>
<td>2V+2U+3A</td>
<td>B. Meyer, P. Kolb, D. M. Nordio</td>
</tr>
<tr>
<td>252-0286-00L</td>
<td>System Construction</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>F. O. Friedrich</td>
</tr>
</tbody>
</table>

Abstract

In the Master Programme max. 10 credits can be accounted by Labs on top of the Interfocus Courses. Additional Labs will be listed on the Addendum.

Abstract

The Distributed Software Engineering Laboratory introduces the software engineering principles and techniques appropriate for the increasingly prevalent style of modern software development, involving teams spread across teams, companies and countries.

Objective

Modern software development is increasingly "distributed": projects are developed by different groups collaborating across teams, companies, countries, timezones. This setup radically alters the assumptions underlying many of the traditional views of software engineering.

The Distributed Software Engineering Laboratory introduces the principles and techniques for this new paradigm. In line with the "distributed" nature of the topic, the project is performed in collaboration with student teams from other universities in various countries. This course provides students with a clear view of distributed software development, enabling them to participate successfully in distributed projects, and also helping them to devise their own career strategies in the context of the continued trend towards outsourcing.

Content

Basics of distributed development

The outsourcing phenomenon; country review.

Requirements engineering for distributed projects

Quality assurance for distributed projects.

Process models (especially CMMI) and agile methods

Supplier assessment and qualification.

Negotiating a contract for a distributed project.

Software project management for distributed projects.

Role of interfaces and other technical issues of distributed development.

A key part of the Laboratory is the course project, performed in groups involving teams from other universities. Students get to practice distributed development directly, experiencing issues and applying techniques presented in the course.

Lecture notes

The exercise sessions usually start at 9am.

Prerequisites / notice

The course page includes the full set of slides and links to supplementary documentation.

Prerequisites: Basic understanding of programming.
Each student will be asked to study some papers from the recent software engineering literature and review them. This is an exercise in critical review and analysis. Active participation is required (a presentation of a paper as well as participation in discussions).

The students learn to effectively use a theorem prover to create unambiguous models and rigorously analyse them. They learn how to write precise and concise specifications, to exploit the proof assistant as a tool for checking and analysing such models and for taming their complexity, and to extract certified executable implementations from such specifications.

The lecture intends to supplement more abstract views of software construction, and to contribute to a better understanding of "how it really works" behind the scenes.

The "computer-aided modelling and reasoning" lab is a hands-on course about using an interactive theorem prover to construct formal models of algorithms, protocols, and programming languages and to reason about their properties. The lab has two parts: The first introduces various modelling and proof techniques. The second part consists of a project in which the students apply these techniques.

The course is open to students of computer science, electrical engineering, and mechanical engineering background (although students from other departments will be considered).

In the Master Programme max. 10 credits can be accounted by Labs on top of the Interfocus Courses. Additional Labs will be listed on the Addendum.

This course is a hands-on laboratory course in which participants program Thymio II robot that will play in a competition. Students will learn software engineering skills and robotics concepts and apply them in practice.

Students will program Thymio II educational robot with a Carmine 1.09 RGBD camera as the sensor.

Combination of lectures and a semester-long project.

Limited to 18 students.

- Expected to work both individually and in teams of 2-3 students

The "computer-aided modelling and reasoning" lab is a hands-on course about using an interactive theorem prover to construct formal models of algorithms, protocols, and programming languages and to reason about their properties. The lab has two parts: The first introduces various modelling and proof techniques. The second part consists of a project in which the students apply these techniques.

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The course is open to students of computer science, electrical engineering, and mechanical engineering background (although students from other departments will be considered).

In the Master Programme max. 10 credits can be accounted by Labs on top of the Interfocus Courses. Additional Labs will be listed on the Addendum.

The lecture aims to provide a comprehensive view of the research topics in software engineering. This seminar is an opportunity to become familiar with current research in software engineering and more generally with the methods and challenges of scientific research.

Each student will be asked to study some papers from the recent software engineering literature and review them. This is an exercise in critical review and analysis. Active participation is required (a presentation of a paper as well as participation in discussions).
The aim of this seminar is to introduce students to recent research results in the area of programming languages and software engineering. To accomplish that, students will study and present research papers in the area as well as participate in paper discussions. The papers will span topics in both theory and practice, including papers on program verification, program analysis, testing, programming language design, and development tools.

Organizational note: the seminar will meet only when there is a scheduled presentation. Please consult the seminar's home page for information.

### Focus Courses in Theoretical Computer Science

#### Focus Core Courses Theoretical Computer Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0417-00L</td>
<td>Randomized Algorithms and Probabilistic Methods</td>
<td>W</td>
<td>7</td>
<td>3V+2U+1A</td>
<td>A. Steger</td>
</tr>
<tr>
<td>Abstract</td>
<td>Las Vegas &amp; Monte Carlo algorithms; inequalities of Markov, Chebyshev, Chernoff; negative correlation; Markov chains: convergence, rapidly mixing; generating functions; Examples include: min cut, median, balls and bins, routing in hypercubes, 3SAT, card shuffling, random walks</td>
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<tr>
<td>Objective</td>
<td>After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.</td>
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<tr>
<td>Content</td>
<td>Randomized Algorithms are algorithms that &quot;flip coins&quot; to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.</td>
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<tr>
<td>Lecture notes</td>
<td>Yes.</td>
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</thead>
<tbody>
<tr>
<td>252-0535-00L</td>
<td>Machine Learning</td>
<td>W</td>
<td>6</td>
<td>3V+2U</td>
<td>J. M. Buhmann</td>
</tr>
<tr>
<td>Abstract</td>
<td>Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.</td>
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<td>Objective</td>
<td>Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.</td>
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<tr>
<td>Content</td>
<td>The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.</td>
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<tr>
<td>Lecture notes</td>
<td>No lecture notes, but slides will be made available on the course webpage.</td>
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<tbody>
<tr>
<td>252-1407-00L</td>
<td>Algorithmic Game Theory</td>
<td>W</td>
<td>7</td>
<td>3V+2U+1A</td>
<td>P. Widmayer</td>
</tr>
<tr>
<td>Abstract</td>
<td>Game theory provides a formal model to study the behavior and interaction of self-interested users and programs in large-scale distributed computer systems without central control. The course discusses algorithmic aspects of game theory.</td>
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<tr>
<td>Objective</td>
<td>Learning the basic concepts of game theory and mechanism design, acquiring the computational paradigm of self-interested agents, and using these concepts in the computational and algorithmic setting.</td>
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<tr>
<td>Content</td>
<td>The Internet is a typical example of a large-scale distributed computer system without central control, with users that are typically only interested in their own good. For instance, they are interested in getting high bandwidth for themselves, but don't care about others, and the same is true for computational load or download rates. Game theory provides a particularly well-suited model for the behaviour and interaction of such selfish users and programs. Classical game theory dates back to the 1950s and typically does not consider algorithmic aspects at all. Only a few years back, algorithms and game theory have been considered together, in an attempt to reconcile selfish behavior of independent agents with the common good.</td>
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<tr>
<td>This course discusses algorithmic aspects of game-theoretic models, with a focus on recent algorithmic and mathematical developments. Rather than giving an overview of such developments, the course aims to study selected important topics in depth.</td>
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</table>
| Outline  | - Introduction to classical game theoretic concepts.  
- Existence of stable solutions (equilibria), algorithms for computing equilibria, computational complexity.  
- The cost difference between an optimum under central control and an equilibrium under selfish agents, known as the "price of anarchy".  
- Auction-like mechanisms and algorithms that "direct" the actions of selfish agents into a certain desired equilibrium situation.  
- Selected current research topics of Algorithmic Game Theory, such as Web-Search Based Keyword Auctions, or Information Cascading in Social Networks |

No lecture notes.
Complexity Theory classifies problems according to the resources required in order to solve them. In this course, we give an introduction to

**Lecturers**
- B. Gärtner, M. Hoffmann, E. Welzl

**Hours**
- 6 credits
- 2V+2U+1A

**Type**
- 3V+2U

**Prerequisites / notice**
- Audience: Although this is a Computer Science course, we encourage the participation from all students who are interested in this topic.

**Requirements:** You should enjoy precise mathematical reasoning. You need to have passed a course on algorithms and complexity. No knowledge of game theory is required.

### Focus Elective Courses Theoretical Computer Science

<table>
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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-1425-00L</td>
<td>Geometry: Combinatorics and Algorithms</td>
<td>W</td>
<td>6</td>
<td>2V+2U+1A</td>
<td>B. Gärtner, M. Hoffmann, E. Welzl</td>
</tr>
</tbody>
</table>

**Abstract**
- Geometric structures are useful in many areas, and there is a need to understand their structural properties, and to work with them algorithmically. The lecture addresses theoretical foundations concerning geometric structures. Central objects of interest are triangulations. We study combinatorial (Does a certain object exist?) and algorithmic questions (Can we find a certain object efficiently?)

**Objective**
- The goal is to make students familiar with fundamental concepts, techniques and results in combinatorial and computational geometry, so as to enable them to model, analyze, and solve theoretical and practical problems in the area and in various application domains. In particular, we want to prepare students for conducting independent research, for instance, within the scope of a thesis project.

**Content**
- Planar and geometric graphs, embeddings and their representation (Whitney's Theorem, canonical orderings, DCFL), polygon triangulations and the art gallery theorem, convexity in $\mathbb{R}^d$, planar convex hull algorithms (Jarvis Wrap, Graham Scan, Chan's Algorithm), point set triangulations, Delaunay triangulations (Lawson flips, lifting map, randomized incremental construction), Voronoi diagrams, the Crossing Lemma and incidence bounds, line arrangements (duality, Zone Theorem, ham-sandwich cuts), 3-SUM hardness, counting planar triangulations.

**Lecture notes**
- yes

**Literature**

**Prerequisites / notice**
- Prerequisites: The course assumes basic knowledge of discrete mathematics and algorithms, as supplied in the first semesters of Bachelor Studies at ETH.

**Outlook:** In the following spring semester there is a seminar "Geometry: Combinatorics and Algorithms" that builds on this course. There are ample possibilities for Semester-, Bachelor- and Master Thesis projects in the area.

<table>
<thead>
<tr>
<th>Number</th>
<th>Complexity Theory</th>
<th>W</th>
<th>6</th>
<th>3V+2U</th>
<th>T. Holenstein</th>
</tr>
</thead>
</table>

**Abstract**
- Complexity Theory classifies problems according to the resources required in order to solve them. In this course, we give an introduction to modern complexity theory. We introduce basic complexity classes (such as L, P, BPP, PH, NP, AM, PH, PSPACE, IP, EXP), and study circuit complexity.

**Objective**
- The student learns the fundamentals of Complexity Theory, as well as some of the more recent techniques. He not only understands the basic results and techniques used to prove them, but also has insight in some of the technically more advanced theorems.

**Content**
- Complexity Theory classifies problems according to the difficulty of solving them. In this course, we give an introduction to modern complexity theory. We introduce basic complexity classes (such as L, P, BPP, PH, PSPACE, IP, EXP), and study the known relationship to uniform complexity. We study circuit complexity, and its relationship to uniform complexity. We also will study some circuit lower bounds for constant depth circuits, as well as results which explain why it is difficult to improve these results.

**Literature**
- Several copies of both books are available in the Computer Science library.

**Prerequisites / notice**
- Prerequisites: The course assumes basic knowledge of discrete mathematics and algorithms, as supplied in the first semesters of Bachelor Studies at ETH.

**Outlook:** In the following spring semester there is a seminar "Geometry: Combinatorics and Algorithms" that builds on this course. There are ample possibilities for Semester-, Bachelor- and Master Thesis projects in the area.

<table>
<thead>
<tr>
<th>Number</th>
<th>Mathematical Optimization</th>
<th>W</th>
<th>11</th>
<th>4V+2U</th>
<th>R. Weismantel</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3901-00L</td>
<td>Mathematical Optimization</td>
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</tbody>
</table>

**Abstract**
- Mathematical treatment of diverse optimization techniques.

**Objective**
- Advanced optimization theory and algorithms.

**Content**
- 1. Linear optimization: The geometry of linear programming, the simplex method for solving linear programming problems, Farkas' Lemma and infeasibility certificates, duality theory of linear programming.
- 3. Integer optimization: Ties between linear and integer optimization, total unimodularity, complexity theory, cutting plane theory.
- 4. Combinatorial optimization: Network flow problems, structural results and algorithms for matroids, matchings and, more generally, independence systems.

### Seminar Theoretical Computer Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>252-4202-00L</td>
<td>Seminar in Theoretical Computer Science</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>E. Welzl, B. Gärtner, M. Hoffmann, J. Lengler, A. Steger, B. Sudakov</td>
</tr>
<tr>
<td>263-4203-00L</td>
<td>Geometry: Combinatorics and Algorithms</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>B. Gärtner, E. Welzl</td>
</tr>
</tbody>
</table>

**Abstract**
- Seminar in Theoretical Computer Science
- Presentation of recent publications in theoretical computer science, including results by diploma, masters and doctoral candidates.

**Objective**
- The goal is to introduce students to current research, and to enable them to read, understand, and present scientific papers.

**Notice**
- Does not take place this semester.

This seminar is held once a year and complements the courses Computational Geometry and Geometric Graphs: Combinatorics & Algorithms. Students of the seminar will present original research papers, some classic and some of them very recent. The seminar is a good preparation for a master, diploma, or semester thesis in the area.
This course covers some of the fundamental concepts of computer graphics, namely 3D object representations and generation of photorealistic images from digital representations of 3D scenes.

**Objective**

- getting an overview of the related literature;
- understanding and working out the background/motivation: why and where are the questions addressed relevant?
- understanding the contents of the paper in all details;
- selecting parts suitable for the presentation;
- presenting the selected parts in such a way that an audience with some basic background in geometry and graph theory can easily understand and appreciate it.

**Prerequisites / notice**

To attend the seminar, some basic knowledge in (discrete and computational) geometry and graphs and algorithms is required. Thus, previous participation in some of the courses “Graphs and Algorithms”, “Computational Geometry”, “Geometric Graphs: Combinatorics & Algorithms”, or similar courses is strongly encouraged. It is also possible to take this seminar in parallel to the lecture “Computational Geometry”.

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### Focus Courses in Visual Computing

#### Focus Core Courses Visual Computing

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>252-0535-00L</td>
<td>Machine Learning</td>
<td>W</td>
<td>6 credits</td>
<td>3V+2U</td>
<td>J. M. Buhmann</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the students' knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.</td>
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<tr>
<td><strong>Content</strong></td>
<td>The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data. Topics covered in the lecture include:</td>
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<td>- Bayesian theory of optimal decisions</td>
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<td>- Maximum likelihood and Bayesian parameter inference</td>
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<td>- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)</td>
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<td></td>
<td>- Ensemble methods: Bagging and Boosting</td>
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<td></td>
<td>- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off</td>
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<td></td>
<td>- Non-parametric density estimation: Parzen windows, nearest neighbour</td>
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<td></td>
<td>- Dimension reduction: principal component analysis (PCA) and beyond</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>No lecture notes, but slides will be made available on the course webpage.</td>
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</table>

**Prerequisites / notice**

Solid basic knowledge in analysis, statistics and numerical methods for CSE. Experience in programming for solving the project tasks.

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>This course covers some of the fundamental concepts of computer graphics, namely 3D object representations and generation of photorealistic images from digital representations of 3D scenes.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>At the end of the course the students will be able to build a rendering system. The students will study the basic principles of rendering and image synthesis. In addition, the course is intended to stimulate the students' curiosity to explore the field of computer graphics in subsequent courses or on their own.</td>
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<tr>
<td><strong>Content</strong></td>
<td>This course covers fundamental concepts of modern computer graphics. Students will learn about 3D object representations and the details of how to generate photorealistic images from digital representations of 3D scenes. Starting with an introduction to 3D shape modeling, the representation, texture mapping and ray-tracing, we will move on to acceleration structures, the physics of light transport, appearance modeling and global illumination principles and algorithms. We will end with an overview of modern image-based image synthesis techniques, covering topics such as lightfields and depth-image based rendering.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>No lecture notes, but slides will be made available on the course webpage.</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Fundamentals of calculus and linear algebra, basic concepts of algorithms and data structures, programming skills in C++, Visual Computing course recommended. The programming assignments will be in C++. This will not be taught in the class.</td>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>263-5902-00L</td>
<td>Computer Vision</td>
<td>W</td>
<td>6 credits</td>
<td>3V+1U+1A</td>
<td>M. Pollefeys, L. Van Gool</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>The goal of this course is to provide students with a good understanding of computer vision and image analysis techniques. The main concepts and techniques will be studied in depth and practical algorithms and approaches will be discussed and explored through the exercises.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>The objectives of this course are:</td>
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<tr>
<td></td>
<td>1. To introduce the fundamental problems of computer vision.</td>
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<td>2. To introduce the main concepts and techniques used to solve these.</td>
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<td>3. To enable participants to implement solutions for reasonably complex problems.</td>
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<td>4. To enable participants to make sense of the computer vision literature.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Camera models and calibration, invariant features, Multiple-view geometry, Model fitting, Stereo Matching, Segmentation, 2D Shape matching, Shape from Silhouettes, Optical flow, Structure from motion, Tracking, Object recognition, Object category recognition</td>
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<td><strong>Prerequisites / notice</strong></td>
<td>It is recommended that students have taken the Visual Computing lecture or a similar course introducing basic image processing concepts before taking this course.</td>
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</table>
Focus Elective Courses Visual Computing

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>252-0546-00L</td>
<td>Physically-Based Simulation in Computer Graphics</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>B. Solenthaler, B. Thomaszewski</td>
</tr>
<tr>
<td>Abstract</td>
<td>This lecture provides an introduction to physically-based animation in computer graphics and gives an overview of fundamental methods and algorithms. The practical exercises include three assignments which are to be solved in small groups. In an additional course project, topics from the lecture will be implemented into a 3D game or a comparable application.</td>
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<tr>
<td>Objective</td>
<td>This lecture provides an introduction to physically-based animation in computer graphics and gives an overview of fundamental methods and algorithms. The practical exercises include three assignments which are to be solved in small groups. In an additional course project, topics from the lecture will be implemented into a 3D game or a comparable application.</td>
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<tr>
<td>Content</td>
<td>The lecture covers topics in physically-based modeling, such as particle systems, mass-spring models, finite difference and finite element methods. These approaches are used to represent and simulate deformable objects or fluids with applications in animated movies, 3D games and medical systems. Furthermore, the lecture covers topics such as rigid body dynamics, collision detection, and character animation.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Fundamentals of calculus and physics, basic concepts of algorithms and data structures, basic programming skills in C++. Knowledge on numerical mathematics as well as ordinary and partial differential equations is an asset, but not required.</td>
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<tr>
<td>252-5703-00L</td>
<td>Multimedia Communications</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>A. Smolic</td>
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<tr>
<td>Abstract</td>
<td>After a summary of fundamentals in signal processing and information theory, an introduction to processing and coding of different types of multimedia is given.</td>
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<tr>
<td>Objective</td>
<td>Understanding principles of multimedia communications and getting an illustrative overview of available and emerging technology.</td>
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<tr>
<td>Content</td>
<td>After a summary of fundamentals in signal processing and information theory, an introduction to processing and coding of different types of multimedia is given. This starts with speech (PCM, vocoder, CELP etc.), continues over audio (MP3, AAC etc.), still images (JPEG etc.), video (MPEG-2, MPEG-4, H.264/AVC, HEVC etc.), and interactive graphics (MPEG-4), to emerging and future multimedia content such as 3D video, free viewpoint video, high dynamic range video. Algorithms as well as human perception will be addressed.</td>
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<tr>
<td>Content</td>
<td>- Fundamentals of information theory</td>
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<td>- Fundamentals of signal processing and coding</td>
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<td></td>
<td>- Speech processing and coding</td>
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<td>- Audio processing and coding</td>
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<td>- Still image processing and coding</td>
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<td>- Video processing and coding</td>
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<td></td>
<td>- Emerging multimedia (3D video, free viewpoint video, HDR, HFR)</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: Solid basic knowledge in statistics, algorithms and programming. Background in machine learning is helpful but not required.</td>
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<tr>
<td>263-5200-00L</td>
<td>Data Mining: Learning from Large Data Sets</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>A. Krause</td>
</tr>
<tr>
<td>Abstract</td>
<td>Many scientific and commercial applications require insights from massive, high-dimensional data sets. This course introduces principled, state-of-the-art techniques from statistics, algorithms and discrete and convex optimization for learning from such large data sets. The course also covers theoretical foundations and practical applications.</td>
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<tr>
<td>Objective</td>
<td>Many scientific and commercial applications require us to obtain insights from massive, high-dimensional data sets. In this graduate-level course, we will study principled, state-of-the-art techniques from statistics, algorithms and discrete and convex optimization for learning from such large data sets. The course will also cover theoretical foundations and practical applications.</td>
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<tr>
<td>Content</td>
<td>Topics covered:</td>
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<tr>
<td></td>
<td>- Dealing with large data (Data centers; Map-Reduce/Hadoop; Amazon Mechanical Turk)</td>
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<td></td>
<td>- Fast nearest neighbor methods (Shingling, locality sensitive hashing)</td>
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<td></td>
<td>- Online learning (Online optimization and regret minimization, online convex programming, applications to large-scale Support Vector Machines)</td>
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<td></td>
<td>- Multi-armed bandits (exploration-exploitation tradeoffs, applications to online advertising and relevance feedback)</td>
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<td>- Active learning (uncertainty sampling, pool-based methods, label complexity)</td>
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<td>- Dimension reduction (random projections, nonlinear methods)</td>
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<td>- Data streams (Sketches, coresets, applications to online clustering)</td>
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<td></td>
<td>- Recommender systems</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: Solid basic knowledge in statistics, algorithms and programming. Background in machine learning is helpful but not required.</td>
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<tr>
<td>263-5210-00L</td>
<td>Probabilistic Artificial Intelligence</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>A. Krause</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course introduces core modeling techniques and algorithms from statistics, optimization, planning, and control and study applications in areas such as sensor networks, robotics, and the Internet.</td>
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<tr>
<td>Objective</td>
<td>How can we build systems that perform well in uncertain environments and unforeseen situations? How can we develop systems that exhibit &quot;intelligent&quot; behavior, without prescribing explicit rules? How can we design systems that learn from experience in order to improve their performance? We will study core modeling techniques and algorithms from statistics, optimization, planning, and control and study applications in areas such as sensor networks, robotics, and the Internet. The course is designed for upper-level undergraduate and graduate students.</td>
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<tr>
<td>Content</td>
<td>Topics covered:</td>
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<tr>
<td></td>
<td>- Search (BFS, DFS, A*), constraint satisfaction and optimization</td>
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<td></td>
<td>- Tutorial in logic (propositional, first-order)</td>
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<td>- Probability</td>
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<td></td>
<td>- Bayesian Networks (models, exact and approximate inference, learning) - Temporal models (Hidden Markov Models, Dynamic Bayesian Networks)</td>
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<td>- Probabilistic palning (MDPs, POMDPs)</td>
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<td></td>
<td>- Reinforcement learning</td>
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<td></td>
<td>- Combining logic and probability</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: Solid basic knowledge in statistics, algorithms and programming</td>
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<tr>
<td>252-0527-00L</td>
<td>Probabilistic Graphical Models for Image Analysis</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>Does not take place this semester.</td>
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<tr>
<td>Objective</td>
<td>This course will focus on the algorithms for inference and learning with statistical models. We use a framework called probabilistic graphical models which include Bayesian Networks and Markov Random Fields.</td>
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<tr>
<td>Literature</td>
<td>We will use examples from traditional vision problems such as image registration and image segmentation, as well as recent problems such as object recognition.</td>
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<tr>
<td>Students</td>
<td>Students will be introduced to probabilistic graphical models and will learn how to apply them to problems in image analysis and understanding. The focus will be to study various algorithms for inference and parameter learning.</td>
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<tr>
<td>Literature</td>
<td>Will be announced during the lecture.</td>
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</tbody>
</table>
### Course Descriptions

#### Advanced Topics in Machine Learning

**Abstract**
In this seminar, recent papers of the pattern recognition and machine learning literature are presented and discussed. Possible topics cover statistical models in computer vision, graphical models and machine learning.

**Objective**
The seminar "Advanced Topics in Machine Learning" familiarizes students with recent developments in pattern recognition and machine learning. Original articles have to be presented and critically reviewed. The students will learn how to structure a scientific presentation in English which covers the key ideas of a scientific paper. An important goal of the seminar presentation is to summarize the essential ideas of the paper in sufficient depth while omitting details which are not essential for the understanding of the work. The presentation style will play an important role and should reach the level of professional scientific presentations.

**Content**
The seminar will cover a number of recent papers which have emerged as important contributions to the pattern recognition and machine learning literature. The topics will vary from year to year but they are centered on methodological issues in machine learning like new learning algorithms, ensemble methods or new statistical models for machine learning applications. Frequently, papers are selected from computer vision or bioinformatics - two fields, which relies more and more on machine learning methodology and statistical models.

**Literature**
The papers will be presented in the first session of the seminar.

#### Advanced Topics in Computer Graphics and Vision

**Abstract**
This seminar covers advanced topics in computer graphics, such as modeling, rendering, animation, real-time graphics, physical simulation, and computational photography. Each time the course is offered, a collection of research papers is selected and each student presents one paper to the class and leads a discussion about the paper and related topics.

**Objective**
The goal is to get an in-depth understanding of actual problems and research topics in the field of computer graphics as well as improve presentations and critical analysis skills.

**Content**
This seminar covers advanced topics in computer graphics, including both seminal research papers as well as the latest research results. Each time the course is offered, a collection of research papers are selected covering topics such as modeling, rendering, animation, real-time graphics, physical simulation, and computational photography. Each student presents one paper to the class and leads a discussion about the paper and related topics.

**Lecture notes**
No script

**Literature**
Individual research papers are selected each term. See http://graphics.ethz.ch/ for the current list.

**Prerequisites / notice**
Prerequisites: Individual research papers are selected each term. See http://graphics.ethz.ch/ for the current list.

### Computer Science Elective Courses

The Elective Computer Science Courses can be selected from all Master level courses offered by D-INFK.

#### Wireless and Mobile Computing for Entertainment Applications

**Abstract**
This course gives a detailed overview about the 802 standards and summarizes the state of the art for WLANs, WPANs, and WMANs, including new topics such as mesh networks, cognitive radio, and visible light communications. The course combines lectures with a set of assignments in which students are asked to work with a simple JAVA simulation software.

**Objective**
The objective of the course is to learn about the general principles of wireless communications, including physics, frequency spectrum regulation, and standards. Further, the most up-to-date standards and protocols used for wireless LAN IEEE 802.11, Bluetooth and Wi-Fi, mesh networks, sensor networks, cellular networks, visible light communication, and cognitive radios, are analyzed and evaluated.

**Content**
Students develop their own add-on mobile computing algorithms to improve the behavior of the systems, using a Java-based event-driven simulator. We also hand out embedded systems that can be used for experiments for optical communication.

**Literature**

**Prerequisites / notice**
Students should have interest in wireless communication, and should be familiar with JAVA programming.

#### Smart Energy

**Abstract**
The lecture covers the role of ICT for sustainable energy usage. Concepts of the emerging smart grid are outlined and approaches to motivate sustainable consumer choices are explained. The lecture combines technologies from ubiquitous computing and traditional ICT with insights from socio-psychological concepts and illustrates them with examples from actual applications.

**Objective**
Participants become familiar with the challenges related to sustainable energy usage, understand the principles of a smart grid infrastructure and its applications, know the role of ubiquitous computing technologies, can explain the challenges regarding security and privacy, can reflect the basics cues to induce changes in consumer behavior, develop a general understanding of the effects of a smart grid infrastructure on energy efficiency, and know how to apply the learning to related design projects.

**Content**
- Background on energy generation and consumption; characteristics, potential, and limitations of renewable energy sources
- Introduction to energy economics
- Smart grid and smart metering infrastructures, virtual power plants, security challenges
- Demand management and home automation using ubiquitous computing technologies
- Changing consumer behavior with smart ICT
- Benefits challenges of a smart energy system

**Literature**
Will be provided during the course, though a good starting point is "ICT for green: how computers can help us to conserve energy" from Friedemann Mattern, Thosten Staake, and Markus Weiss (available at http://www.vs.inf.ethz.ch/publ/papers/ICT-for-Green.pdf).
This course covers all aspects of delivering strong presentations. I explain common mistakes, what works and what does not, and why.

The course deals with advanced topics in GIS: GIS project lifecycle, Managing GIS, Legal issues, GIS assets & constraints; Geospatial

<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
<th>The lecture includes interactive exercises, case studies and practical examples.</th>
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</thead>
<tbody>
<tr>
<td><strong>263-0600-00L</strong></td>
<td>Research in Computer Science ■</td>
</tr>
<tr>
<td><strong>W</strong></td>
<td>5 credits</td>
</tr>
<tr>
<td><strong>11A</strong></td>
<td>Professors</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Independent project work under the supervision of a Computer Science Professor.</td>
</tr>
<tr>
<td><strong>Objective</strong></td>
<td>Independent project work under the supervision of a Computer Science Professor.</td>
</tr>
<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Only students who fulfill one of the following requirements are allowed to begin a research project:</td>
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<tr>
<td></td>
<td>a) 1 lab (interfocus course) and 1 focus course</td>
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<td></td>
<td>b) 2 core focus courses</td>
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<td></td>
<td>c) 2 labs (interfocus courses)</td>
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</tbody>
</table>

A task description must be submitted to the Student Administration Office at the beginning of the work.

| **227-0778-00L**              | Hardware/Software Codesign                                                    |
| **W**                         | 6 credits                                                                      |
| **2V+2U**                     | L. Thiele                                                                      |
| **Abstract**                  | The course provides advanced knowledge in the design of complex computer systems, in particular embedded systems. Models and methods are discussed that are fundamental for systems that consist of software and hardware components. |
| **Objective**                 | The course provides advanced knowledge in the design of complex computer systems, in particular embedded systems. Models and methods are discussed that are fundamental for systems that consist of software and hardware components. |
| **Content**                   | The course covers the following subjects: (a) Models for describing hardware and software components (specification), (b) Hardware-Software Interfaces (instruction set, hardware and software components, reconfigurable computing, heterogeneous computer architectures, System-on-Chip), (c) Application specific instruction sets, code generation and retargetable compilation, (d) Performance analysis and estimation techniques, (e) System design (hardware-software partitioning and design space exploration). |
| **Lecture notes**             | Material for exercises, copies of transparencies.                             |

| **Prerequisites / notice**    | Prerequisites for the course is a basic knowledge in the following areas: computer architecture, digital design, software design, embedded systems |
| **103-0237-00L**              | GIS III                                                                        |
| **W**                         | 5 credits                                                                      |
| **3G**                        | P. Kiefer, S. Scheider                                                         |
| **Abstract**                  | The course deals with advanced topics in GIS: GIS project lifecycle, Managing GIS, Legal issues, GIS assets & constraints; Geospatial Web Services; technical basics, architecture, functions, interoperability, standards, mashups, portals, applications; Geostatistics; Sensor Web Enablement; Human-Computer Interaction; Cognitive Issues in GIS. |
| **Objective**                 | Students will get a detailed overview of advanced GIS topics. They will go through all steps of setting up a Web-GIS application in the labs and perform other practical tasks relating to Sensor Web Enablement, Human-Computer Interaction, Geostatistics, and Web Processing Services. |
| **Lecture notes**             | no script                                                                      |

**Election Courses**

Students can individually choose from the entire Master course offerings from ETH Zurich, EPF Lausanne, the University of Zurich and - with the consent of the mentor - from all other Swiss universities.

For further details, refer to Art. 31 of the Regulations 2009 for the Master Program in Computer Science.

**Internship**

Wherever possible I illustrate by example and present the material in a way to make it immediately applicable. The goal is to provide the knowledge that enables the participants, whether beginner or experienced presenter, to further improve their presentation skills and hence their impact whenever they step in front of an audience.

Then I discuss structure and content as well as a set of fundamental principles from graphic design that make slides communicate effectively. These principles also apply to the presentation and visualization of data which is covered in some detail. Finally, I give some useful tips on the use of PowerPoint that simplify the creation of strong presentations.

**Compulsory Electives in Humanities, Social and Political Sciences**

Recommended GESS compulsory elective courses (Type B) for D-INFK:

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

**Master Thesis**
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tbody>
<tr>
<td>263-0800-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30 credits</td>
<td>64D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

**Abstract**

Independent project work supervised by a Computer Science professor. Duration 6 months.

**Objective**

Independent project work supervised by a Computer Science professor.

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### Computer Science Master - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

### Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
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</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
### Integrated Building Systems Master

#### Main Courses

##### Fundamental Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0010-00L</td>
<td>Chemistry</td>
<td>W</td>
<td>3</td>
<td>2V+1U</td>
<td>A. de Mello, K. Elvira</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>This is a general chemistry course aimed at first year undergraduate students in the Department of Mechanical and Process Engineering (D-MAVT).</td>
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<td><strong>Objective</strong></td>
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<td></td>
<td>The aims of the course are as follows:</td>
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<tr>
<td></td>
<td>1) To provide a thorough understanding of the basic principles of chemistry and its application.</td>
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<td></td>
<td>2) To develop an understanding of the atomic and molecular nature of matter and of the chemical reactions that describe their transformations.</td>
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<td>3) To emphasize areas considered most relevant in an engineering context.</td>
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<td></td>
<td><strong>Content</strong></td>
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<td></td>
<td>Electronic structure of atoms, chemical bonding, molecular shape and bonding theory, gases, thermodynamics, chemical thermodynamics, chemical kinetics, equilibria, solutions and intermolecular forces, redox and electrochemistry.</td>
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<tr>
<td></td>
<td><strong>Literature</strong></td>
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<td></td>
<td>The course is based on &quot;Chemistry the Central Science&quot; by Brown, LeMay, Bursten, Murphy and Woodward. Pearson. 12th Edition (international edition).</td>
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<table>
<thead>
<tr>
<th>051-0757-00L</th>
<th>Building Process I</th>
<th>W</th>
<th>2</th>
<th>2G</th>
<th>S. Menz</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>The building process is the main focus of this lecture series. The process is understood as a sequence of criteria in time.</td>
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<td></td>
<td><strong>Objective</strong></td>
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<td></td>
<td>Alongside a discussion of the basic principles, trends and terminologies, a closer look will be taken at each topic using case studies that investigate current structures as well as those relevant in terms of architecture and urban design. Active participation as well as interdisciplinary and process-oriented thinking on the part of students is a prerequisite.</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
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<tr>
<td></td>
<td>The building process is the main focus of this lecture series. The process is understood as a sequence of criteria in time. These criteria are divided into acquisition and building legislation, building economics and facility management, the people involved and their work, construction and planning organization. Process thinking and a glance at our foreign neighbours complete the series.</td>
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<td></td>
<td><strong>Literature</strong></td>
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<tr>
<td></td>
<td>The building process is the main focus of this lecture series. The process is understood as a sequence of criteria in time. These criteria are divided into acquisition and building legislation, building economics and facility management, the people involved and their work, construction and planning organization. Process thinking and a glance at our foreign neighbours complete the series.</td>
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<tr>
<td></td>
<td><strong>Lecture notes</strong></td>
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<tr>
<td></td>
<td>Sacha Menz (Hrsg.), Drei Bücher über den Bauprozess, vdf Hochschulverlag an der ETH Zürich, 2009</td>
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<tr>
<td></td>
<td><strong>Literature</strong></td>
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<tr>
<td></td>
<td>Literatureempfehlungen unter <a href="http://www.bauprozess.arch.ethz.ch">www.bauprozess.arch.ethz.ch</a>.</td>
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<table>
<thead>
<tr>
<th>066-0411-00L</th>
<th>Structural Design I</th>
<th>W</th>
<th>2</th>
<th>2V</th>
<th>P. Block, J. Schwartz</th>
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<tbody>
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<td></td>
<td><strong>Abstract</strong></td>
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<td>The course is an introduction to structural design using graphical methods and structural models, with a focus on a creative approach rather than repetitive calculations. Cable and membrane structures, arch and shell structures and combined arch and cable systems will be used to demonstrate these methods.</td>
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<td></td>
<td><strong>Objective</strong></td>
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<td>The objective is to encourage students to develop an intuitive understanding of the relationship between the shape of a structure, the load it needs to carry and the forces in it.</td>
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<td></td>
<td><strong>Content</strong></td>
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<td>To achieve this, the teaching is based on graphic statics, which allow the visualization of internal and external forces in structural systems, therefore illustrating the relationship between shape (form) and stress (force) in load bearing elements. This understanding is directly applied to the students' design projects, in which issues of statics and design overlap.</td>
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<td></td>
<td><strong>Lecture notes</strong></td>
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<tr>
<td></td>
<td>Slides will be distributed by e-mail every week.</td>
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<tr>
<td></td>
<td><strong>Literature</strong></td>
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<td></td>
<td>&quot;Faustformel Tragwerkseuweur&quot; (Philippe Block, Christoph Gengangel, Stefan Peters, DVA Deutsche Verlags-Anstalt 2013, ISBN: 978-3-421-03904-0)</td>
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<table>
<thead>
<tr>
<th>151-1633-00L</th>
<th>Energy Conversion</th>
<th>W</th>
<th>4</th>
<th>3G</th>
<th>H. G. Park</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
<td></td>
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<tr>
<td></td>
<td>Fundamentals of Thermal Sciences in association with Energy Conversion</td>
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<td></td>
<td><strong>Objective</strong></td>
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<td></td>
<td>To become acquainted and familiarized with basic principles of fundamental thermal sciences (Thermodynamics, Heat Transfer, etc.) as well as their linkage to energy conversion technologies.</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
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<tr>
<td></td>
<td>Thermodynamics (first and second laws), Heat Transfer (conduction/convection/radiation), Technical Applications</td>
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<td></td>
<td><strong>Lecture notes</strong></td>
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<tr>
<td></td>
<td>Slides will be distributed by e-mail every week.</td>
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<tr>
<td></td>
<td><strong>Literature</strong></td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>1. Introduction to Thermodynamics and Heat Transfer, 2nd ed. by Cengel, Y. A., McGraw Hill;</td>
<td></td>
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<tr>
<td></td>
<td>2. Fundamentals of Engineering Thermodynamics, 6th ed. by Moran &amp; Shapiro, Wiley</td>
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<tr>
<td></td>
<td><strong>Prerequisites / notice</strong></td>
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<tr>
<td></td>
<td>This course is intended for students outside of D-MAVT.</td>
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<table>
<thead>
<tr>
<th>401-0203-00L</th>
<th>Mathematics</th>
<th>W</th>
<th>4</th>
<th>2V+1U</th>
<th>C. Busch</th>
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<tbody>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>This course gives an introduction to the following subjects: linear algebra (systems of linear equations, matrices), calculus, multivariable calculus, differential equations.</td>
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<tr>
<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>Basic mathematical knowledge for engineers. Mathematics as a tool to solve engineering problems.</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
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<tr>
<td></td>
<td><strong>Literature</strong></td>
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<tr>
<td></td>
<td>Tom M. Apostol, Calculus, Volume 1, One-Variable Calculus with an Introduction to Linear Algebra, 2nd Edition, Wiley</td>
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<tr>
<td></td>
<td>Tom M. Apostol, Multi-Variable Calculus and Linear Algebra with Applications, 2nd Edition, Wiley</td>
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</table>
This course focuses on the analysis of innovation as a pervasive process that cuts across organizational and functional boundaries. It looks
at the sources of innovation, at the tools and techniques that organizations deploy to routinely innovate, and the strategic implications of
technical change.

### Prerequisites /
- Master the most common methods and tools organizations deploy to innovate
- Understand the core concepts necessary to analyze how innovation happens

### Literature
- J. Carmeliet
- A. Steinfeld

### Content
- Scenarios for world energy demand and CO2 emissions, implications for climate. Methods for the assessment of energy chains.
- Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaic electricity, solar chemistry). Wind and ocean energy, heat pumps, geothermal energy, energy from waste. CO2 sequestration.
- Renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals.

### Lecture notes
Lecture notes will be distributed during the course.

### Prerequisites / notice
Fundamentals of chemistry and physics are a prerequisite for this course.

### Topics
Topics are available to carry out a Project Work (Semesterarbeit) on the contents of this course.
This course looks at technology and innovation management as a process. Continuously, organizations are faced with a fundamental decision: they have to allocate resources between well-known tasks that reliably generate positive results; or explore new ways of doing things, new technologies, products and services. The latter is a high risk choice. Its rewards can be high, but the chances of success is small.

How do firms organize to take these decisions? What kind of management skills are necessary to take them? What kind of tools and methods are deployed to sustain managerial decision-making in highly volatile environments? These are the central questions on which this course focuses, relying on a combination of lectures, case-based discussion, guest speakers, simulations and group work.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0503-00L</td>
<td>Principles of Microeconomics</td>
<td>3</td>
<td>W</td>
<td>M. Filippini</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course introduces basic principles, problems and approaches of microeconomics. The course includes the following main topics: Basic principles of demand and supply, market and state in a modern economy, externalities, cost analysis, consumer behaviour, economies of scale and economies of scope, perfect competition, monopoly, oligopoly, monopolistic competition, mathematical treatment of some basic concepts.</td>
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<tr>
<td>Literature</td>
<td>Slides will be available on the TIMGROUP website.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>No specific background in economics or management is required.</td>
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<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Urban physics: wind, wind comfort, pollutant dispersion, natural ventilation, driving rain, heat islands, climate change and weather conditions, urban acoustics and energy use in the urban context. - Basic knowledge of the global climate and the local microclimate around buildings - Impact of urban environment on wind, ventilation, rain, pollutants, acoustics and energy, and their relation to comfort, durability, air quality and energy demand - Application of urban physics concepts in urban design - Climate Change. The Global Picture: global energy balance, global climate models, the IPCC process. Towards regional climate scenarios: role of spatial resolution, overview of approaches, hydrostatic RCMs, cloud-resolving RCMs - Urban micro climate and comfort: urban heat island effect, wind flow and radiation in the built environment, convective heat transport modelling, heat balance and ventilation of urban spaces - impact of morphology, outdoor wind comfort, outdoor thermal comfort, - Urban energy and urban design. Energy performance of building quarters and cities, decentralized urban energy production and storage technologies, district heating networks, optimization of energy consumption at district level, effect of the micro climate, urban heat islands, and climate change on the energy performance of buildings and building blocks. - Wind driving rain (WDR): WDR phenomena, WDR experimental and modeling, wind blocking effect, applications and moisture durability - Pollutant dispersion, pollutant cycle: emission, transport and deposition, air quality - Urban acoustics, noise propagation through the urban environment, meteorological effects, urban acoustic modeling, noise reduction measures, urban vegetation</td>
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<tr>
<td>Literature</td>
<td>All material is provided via the website of the chair (<a href="http://www.carmeliet.arch.ethz.ch/Education/">www.carmeliet.arch.ethz.ch/Education/</a>).</td>
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<tr>
<td>Prerequisites / notice</td>
<td>All material is provided via the website of the chair (<a href="http://www.carmeliet.arch.ethz.ch/Education/">www.carmeliet.arch.ethz.ch/Education/</a>).</td>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>066-0423-00L</td>
<td>Application of CFD in Buildings</td>
<td>3</td>
<td>V</td>
<td>D. Lakehal</td>
</tr>
<tr>
<td>Abstract</td>
<td>Fundamentals, Applications and Project works in the area of CFD in buildings. Understanding: Basic principles of fluid flow &amp; heat transfer - Basic concepts of CFD - Validation and verification, practical guidelines Application and project works of CFD in buildings including the fields of: - Building aerodynamics - Steady vs. unsteady wind loads on urban structures - Air pollution and contaminant dispersion - Indoor ventilation - CFD for renewable energy in the urban physics: Wind loads on roof-mounted solar photovoltaic arrays, coupled solar-wind energy generation applications, etc.</td>
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<tr>
<td>Notice</td>
<td>The number of participants is limited and enrolment is only possible in agreement with the chair.</td>
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</table>

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Content

I. Fundamentals
- Basic principles of fluid flow & heat transfer
- Laminar versus turbulent flow
- Forced vs. natural convection
- Basic concepts of CFD
- Discretization, stability & convergence, space and time-marching schemes, etc.
- Turbulence modelling
- Near-wall treatment
- Validation and verification, practical guidelines

II. Applications
CFD for:
- Building aerodynamics
- Steady vs. unsteady wind loads on urban structures
- Air pollution and contaminant dispersion
- Indoor ventilation
- CFD for renewable energy in the urban physics: Wind loads on roof-mounted solar photovoltaic arrays, coupled solar-wind energy generation applications, etc.

III. Project work
- Geometry and grid generation (from CAD to domain meshing)
- Exp. wind engineering
- Boundary conditions, solver settings and solution
- Data Post-processing
- Validation and error estimation
- Hands-on-Training
- Presentation

▌▌ Specialised Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0235-00L</td>
<td>Thermodynamics of Novel Energy Conversion Technologies</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>D. Poulikakos</td>
</tr>
</tbody>
</table>

Abstract
In the framework of this course we will look at a broad spectrum of novel energy conversion processes which are not based on the heat-power-conversion. Especially the production of electrical energy without using mechanical work will be covered.

Objective
This course deals with novel energy conversion and storage systems such as fuel cells and micro-fuel cells, batteries, hydrogen production and storage, plasmonics and photovoltaics. The focus of the course is on the physics and basic understanding of those systems as well as their real-world applications.

Content
Part 1: Fundamentals:
- Thermodynamic overview and exergy analysis;
- Thermodynamics of multi-component-systems (mixtures) and phase equilibrium;
- Electrochemistry;
Part 2: Novel energy conversion and storage systems:
- batteries and accumulators;
- fuel cells and micro fuel cells (fundamentals, fabrication, modelling, and applications);
- hydrogen production and storage, Fuel reforming;
- Plasmonics and photovoltaics.

Lecture notes available (ca. 200 pages in English)

Prerequisites / notice
The course will be given in English:
1. Weekly exercises, each includes 1 or 2 questions which should be solved and returned at the specified due dates. Exercises count as 15% of the final grade.
2. One programming mini-project which should be finished at the specified due date. It counts as 5% of the final grade.
4. Final exam: Written exam during the regular examination session. It counts as 80% of the final grade.

151-0113-00L    | Applied Fluid Dynamics                          | W    | 4 credits | 2V+1U | J.P. Kunsch        |

Abstract
Applied Fluid Dynamics
The methods of fluid dynamics play an important role in the description of a chain of events, involving the release, spreading and dilution of dangerous fluids in the environment.
Tunnel ventilation systems and strategies are studied, which must meet severe requirements during normal operation and in emergency situations (tunnel fires etc.).

Objective
Generally applicable methods in fluid dynamics and gas dynamics are illustrated and practiced using selected current examples.

Content
Often experts fall back on the methodology of fluid dynamics when involved in the construction of environmentally friendly processing and incineration facilities, as well as when choosing safe transport and storage options for dangerous materials. As a result of accidents, but also in normal operations, dangerous gases and liquids may escape and be transported further by wind or flowing water. There are many possible forms that the resulting damage may take, including fire and explosion when flammable substances are mixed. The topics covered include: Emissions of liquids and gases from containers and pipelines, evaporation from pools and vaporization of gases kept under pressure, the spread and dilution of waste gas plumes in the wind, deflagration and detonation of inflammable gases, fireballs in gases held under pressure, pollution and exhaust gases in tunnels (tunnel fires etc.)

Lecture notes not available

Prerequisites / notice
Requirements: successful attendance at lectures "Fluiddynamik I und II", "Thermodynamik I und II"

151-0185-00L    | Radiation Heat Transfer                        | W    | 4 credits | 2V+1U | A. Steinfeld, A. Z'Graggen |

Abstract
Advanced course in radiation heat transfer
Fundamentals of radiative heat transfer for high-temperature applications. Examples are combustion and solar thermal/thermochemical processes, and other applications in the field of energy conversion and material processing.

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Lecture notes
Copy of the slides presented.

Literature

151-0103-00L Fluid Dynamics II W 3 credits 2V+1U P. Jenny

Abstract
Two-dimensional irrotational (potential) flows: stream function and potential, singularity method, unsteady flow, aerodynamic concepts.

Objective
Expand basic knowledge of fluid dynamics.

Content
Vorticity dynamics: vorticity and circulation, vorticity equation, vortex theorems of Helmholtz and Kelvin.

Lecture notes
Lecture notes are available (in German).

Literature
Relevant chapters (corresponding to lecture notes) from the textbook


Prerequisites /
Analysis I/II, Knowledge of Fluid Dynamics I, thermodynamics of ideal gas

401-0647-00L Introduction to Mathematical Optimization O 5 credits 2V+1U R. Zenklusen

Abstract
Introduction to basic techniques and problems of mathematical optimization.

Objective
The goal is to get a good understanding of some of the most important mathematical optimization techniques used to solve linear programs and basic combinatorial optimization problems.

Content
Topics covered in this course include:
- Linear programming (simplex method, duality theory, shadow prices, ...).
- Basic combinatorial optimization problems (spanning trees, network flows, knapsack problem, ...).

Literature
Information about relevant literature will be given in the lecture.

Prerequisites /
Analysis I/II, Knowledge of Fluid Dynamics I, thermodynamics of ideal gas

227-0477-00L Acoustics I W 6 credits 4G K. Heutsch

Abstract
Introduction to the fundamentals of acoustics in the area of sound field calculations, measurement of acoustical events, outdoor sound propagation and room acoustics of large and small enclosures.

Objective
Introduction to acoustics. Understanding of basic acoustical mechanisms. Survey of the technical literature. Illustration of measurement techniques in the laboratory.

Content
Fundamentals of acoustics, measuring and analyzing of acoustical events, anatomy and properties of the ear. Outdoor sound propagation, absorption and transmission of sound, room acoustics of large and small enclosures, architectural acoustics, noise and noise control, calculation of sound fields.

Lecture notes
Yes

101-0579-00L Infrastructure Maintenance Processes W 3 credits 2G B. T. Adey

Abstract
This course provides an introduction to:
- how to model the changes in infrastructure objects over time,
- how to monitor these changes and assess the benefits of monitoring,
- how to intervene to improve infrastructure performance and assess the benefits of interventions, and
- how to model the changes in stakeholders interests over time.

Objective
Deterioration
- manifest and latent processes,
- modeling
Monitoring
- non-destructive and destructive techniques,
- evaluation of benefits of monitoring
Intervention
- types of intervention,
- evaluation of benefits of intervention
Benefits
- modeling of stakeholder benefits over time

Lecture notes
All necessary materials (e.g. transparencies and hand-outs) will be handed out at the beginning of each class.

Literature
Appropriate reading material will be assigned when necessary.

101-0577-00L An Introduction to Sustainable Development in the Built Environment W 3 credits 2G G. Habert

Abstract
This year the UN Conference in Paris will shape future world objectives to tackle climate change.

This course provides an introduction to the notion of sustainable development when applied to our built environment.
At the end of the semester, the students have an understanding of the term of sustainable development, its history, the current political and scientific discourses and its relevance for our built environment.

In order to address current challenges of climate change mitigation and resource depletion, students will learn a holistic approach of sustainable development. Ecological, economical and social constraints will be presented and students will learn about methods for argumentation and tools for assessment (i.e. life cycle assessment).

For this purpose an overview of sustainable development is presented with an introduction to the history of sustainability and its today definition as well as the role of cities, urbanisation and material resources (i.e. energy, construction material) in social economic and environment aspects.

The course aims to promote an integral view and understanding of sustainability and describing different spheres (social/cultural, ecological, economical, and institutional) that influence our built environment.

Students will acquire critical knowledge and understand the role of involved stakeholders, their motivations and constraints, learn how to evaluate challenges, identify deficits and define strategies to promote a more sustainable construction.

After the course students should be able to define the relevance of specific local, regional or territorial aspects to achieve coherent and applicable solutions toward sustainable development.

The course offers an environmental, socio-economic and socio-technical perspective focussing on buildings, cities and their transition to resilience with sustainable development. Students will learn on theory and application of current scientific pathways towards sustainable development.

The following topics give an overview of the themes that are to be worked on during the lecture.

- Overview on the history and emergence of sustainable development
- Overview on the current understanding and definition of sustainable development

- Case Study 1: Sustainable construction, the role of construction industry (national/international)
- Case Study 2: Cities, forms of settlements
- Case Study 3: Material resources, scenarios, energy, construction materials, urban metabolism
- Case Study 4: Buildings, heating/cooling, consumers, prosumers and other stakeholder, cooperations

- Method 1: Life cycle assessment (planning, construction, operation/use, deconstruction)
- Method 2: Economics for sustainable construction
- Method 3: Construction, flexibility, modularity

- Synthesis 1: Change Climate mitigation and adaptation in cities
- Synthesis 2: Transition to sustainable development

A list of the basic literature will be offered on a specific online platform, that could be used by all students attending the lectures.

<table>
<thead>
<tr>
<th>Lecture notes</th>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>All relevant information will be online available before the lectures. For each lecture slides of the lecture will be provided.</td>
<td>A list of the basic literature will be offered on a specific online platform, that could be used by all students attending the lectures.</td>
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</table>

### 102-1227-15L Advanced Life Cycle Assessment (HS15) ★

**Objective**

To improve ones understanding of life cycle assessment, and the broader issues in modeling, improving, and understanding sustainability assessments.

**Content**

The first hour of class is an interactive student presentation with discussion and class participation; each student is expected to present once, either alone or with one other student. The second half of class is devoted to a practical exercise of the concepts introduced and examined in the first half.

**Literature**

Everyone is expected to read one or two scientific articles or manuscripts each week, to be provided by the instructor.

**Prerequisites / notice**

Students should be familiar with either life cycle assessment, environmental science, or economic modeling. This seminar is intended to be primarily for Ph.D. students.

<table>
<thead>
<tr>
<th>102-1227-15L</th>
<th>Advanced Life Cycle Assessment (HS15) ★</th>
<th>W</th>
<th>1 credit</th>
<th>1S</th>
<th>C. L. Mutel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>A seminar on current topic in life cycle assessment. In the fall of 2015, the focus is on assessment of complex systems. We will look a number of topics, including input/output tables, optimization, and linking LCA with physical or economic models.</td>
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<tr>
<td>Objective</td>
<td>To improve ones understanding of life cycle assessment, and the broader issues in modeling, improving, and understanding sustainability assessments.</td>
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<tr>
<td>Content</td>
<td>The first hour of class is an interactive student presentation with discussion and class participation; each student is expected to present once, either alone or with one other student. The second half of class is devoted to a practical exercise of the concepts introduced and examined in the first half.</td>
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<tr>
<td>Literature</td>
<td>Everyone is expected to read one or two scientific articles or manuscripts each week, to be provided by the instructor.</td>
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<tr>
<td>Prerequisites</td>
<td>Students should be familiar with either life cycle assessment, environmental science, or economic modeling. This seminar is intended to be primarily for Ph.D. students.</td>
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</table>

### 101-0417-00L Transport Planning Methods

**Objective**

- Knowledge of methods and algorithms commonly used in transport planning
- Ability to independently develop a transport model able to solve / answer the given problem / questions
- Understanding of algorithms and their implementations commonly used in transport planning

**Content**

The course provides the necessary knowledge to develop models supporting the solution of given planning problems. This is done by dividing the forecasting problem into sub-problems. The course is composed of a lecture part, providing the theoretical knowledge, and a applied part, in which students develop their own models.

To cope with the forecasting problem it is first divided into sub-problems. Then, these are solved using various algorithms like iterative proportional fitting, shortest path algorithms and the method of successive averages.

The course is composed of a lecture part, providing the theoretical knowledge, and a applied part, in which students create their own models. This part takes place in form of a tutorial and consists in the development of a computer program. The programming part is closely guided and particularly suitable for students with little programming experience.

**Lecture notes**

The slides of the lecture are provided electronically.

**Literature**


<table>
<thead>
<tr>
<th>101-0417-00L</th>
<th>Transport Planning Methods</th>
<th>W</th>
<th>6 credits</th>
<th>4G</th>
<th>K. W. Axhausen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>The course provides the necessary knowledge to develop models supporting the solution of given planning problems. This is done by dividing the forecasting problem into sub-problems. The course is composed of a lecture part, providing the theoretical knowledge, and a applied part, in which students develop their own models.</td>
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</tbody>
</table>
| Objective     | - Knowledge of methods and algorithms commonly used in transport planning
- Ability to independently develop a transport model able to solve / answer the given problem / questions
- Understanding of algorithms and their implementations commonly used in transport planning |   |          |    |               |
| Content       | The course provides the necessary knowledge to develop models supporting the solution of given planning problems. This is done by dividing the forecasting problem into sub-problems. Then, these are solved using various algorithms like iterative proportional fitting, shortest path algorithms and the method of successive averages. The course is composed of a lecture part, providing the theoretical knowledge, and a applied part, in which students create their own models. This part takes place in form of a tutorial and consists in the development of a computer program. The programming part is closely guided and particularly suitable for students with little programming experience. |   |          |    |               |
| Lecture notes | The slides of the lecture are provided electronically. |   |          |    |               |

### 101-0414-AAL Transport Planning (Transportation I)

**Objective**

The lecture course discusses the basic concepts, approaches and methods of transport planning in both their theoretical and practical contexts.

**Content**

The course introduces the basic theories and methods of transport planning.

**Literature**


Prerequisites / notice
- Lecture and exercise lessons in english

**402-0809-01L** Introduction to Computational Physics (for Civil Engineers)

<table>
<thead>
<tr>
<th>Content</th>
<th>W 4 credits</th>
<th>2V+U</th>
<th>H. J. Herrmann</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>This course offers an introduction to computer simulation methods for physics problems and their implementation on PCs and supercomputers: classical equations of motion, partial differential equations (wave equation, diffusion equation, Maxwell's equation), Monte Carlo simulations, percolation, phase transitions.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Lecture and exercise lessons in english</td>
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</tbody>
</table>

**402-0809-00L** Introduction to Computational Physics

<table>
<thead>
<tr>
<th>Content</th>
<th>W 8 credits</th>
<th>2V+2U</th>
<th>H. J. Herrmann</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>This course offers an introduction to computer simulation methods for physics problems and their implementation on PCs and supercomputers: classical equations of motion, partial differential equations (wave equation, diffusion equation, Maxwell's equation), Monte Carlo simulations, percolation, phase transitions.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Lecture and exercise lessons in english, exams in German or in English</td>
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</table>

**063-1357-15L** Digital Urban Simulation

<table>
<thead>
<tr>
<th>Content</th>
<th>W 4 credits</th>
<th>4G</th>
<th>R. König</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>In this teaching unit architectural and urban design are analyzed by current computational methods. Based on these analyses the effects of plannings can be simulated and understood. An important focus of this course is the interpretation of the analysis and simulation results and the application of these correspondent methods in early planning phases.</td>
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<tr>
<td>Objective</td>
<td>The students learn how the design and planning of cities can be evidence based by using scientific methods. The teaching unit convey knowledge in state-of-the-art and emerging spatial analysis and simulation methods and equip students with skills in modern software systems. The course consists of lectures, associated exercises and workshops, as well as of one integral project work.</td>
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<tr>
<td>Content</td>
<td>In a series of theory lectures we explore how the design and planning of cities can be evidence based by using scientific methods. By various exercises the students are equipped with skills in modern software systems. In an integral project work knowledge in state-of-the-art and emerging spatial analysis and simulation methods is deepened. Based on the imparted methods the effects of planning and design interventions can be simulated and understood. An important focus of this course is the interpretation of the analysis and simulation results and the application of these correspondent methods in early planning phases.</td>
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</table>

**101-0517-01L** Project Management: Pre-tender to Contract Execution

<table>
<thead>
<tr>
<th>Content</th>
<th>W 3 credits</th>
<th>2G</th>
<th>to be announced</th>
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<tbody>
<tr>
<td>Abstract</td>
<td>This course will provide a comprehensive overview and understanding of the techniques, processes, tools and terminology to manage the Project Triangle (time, cost, quality) and to organize, analyze, control and report a complex project from Pre-Tender stage to Contract execution. This is part 1 of a 3 part course, see notice below.</td>
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<tr>
<td>Objective</td>
<td>Upon successful completion of this course students will have the understanding of the Project Management duties and responsibilities from the Pre-Tender stage of a project to Contract Execution.</td>
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</tbody>
</table>
| Content | - Project scope definition and project organization 
- Technical specification proposals 
- Work Breakdown Structure 
- Estimating 
- Schedule development 
- Interface management 
- Resource and cost integration 
- Risk and opportunity identification and quantification 
- Contract review and analysis 
- Project life cycle 
- Contract Execution - Project Manager Check List | | |
| Lecture notes | The slides will either be distributed at the beginning of the class, or made available online (via Moodle) prior to class. A copy of the appropriate chapter of the script, the assignment and any other assigned reading materials will be available via Moodle. | | |
| Literature | Appropriate reading material (e.g., chapters out of certain textbooks or trade articles) will be assigned when necessary and made available via Moodle. | | |
The reduction of CO2 emissions is the only option for keeping future climate change within reasonable bounds. In this course, we will study structural reliability and risk analysis. Structural reliability aims at quantifying the probability of failure of systems due to uncertainties in their design, manufacturing, and environmental conditions. Risk analysis combines this information with the consequences of failure in view of optimal decision making. The course presents the underlying probabilistic modelling and computational methods for reliability and risk assessment.

The goal of this course is to provide the students with a thorough understanding of the key concepts behind structural reliability and risk analysis. After this course the students will have refreshed their knowledge of probability theory and statistics to model uncertainties in view of engineering applications. They will be able to analyze the reliability of a structure and to use risk assessment methods for decision making under uncertain conditions. They will be aware of the state-of-the-art computational methods and software in this field.

Engineers are confronted every day to decision making under limited amount of information and uncertain conditions. When designing new structures and systems, the design codes such as SIA or Euro-codes usually provide a framework that guarantees safety and reliability. However the level of safety is not quantified explicitly, which does not allow the analyst to properly choose between design variants and evaluate a total cost in case of failure. In contrast, the framework of risk analysis allows one to incorporate the uncertainty in decision making.

The first part of the course is a reminder on probability theory that is used as a main tool for reliability and risk analysis. Classical concepts such as random variables and vectors, dependence and correlation are recalled. Basic statistical inference methods used for building a probabilistic model from the available data, e.g. the maximum likelihood method, are presented.

The second part is related to structural reliability analysis, i.e. methods that allow one to compute probabilities of failure of a given system with respect to prescribed criteria. The framework of reliability analysis is first set up. Reliability indices are introduced together with the first order-second moment method (FORM) and the first order reliability method (FORM). Methods based on Monte Carlo simulation are then reviewed and illustrated through various examples. By-products of reliability analysis such as sensitivity measures and partial safety coefficients are derived and their links to structural design codes is shown. The reliability of structural systems is also introduced as well as the methods used to reassess existing structures based on new information.

The third part of the course addresses risk assessment methods. Techniques for the identification of hazard scenarios and their representation by fault trees and event trees are described. Risk is defined with respect to the concept of expected utility in the framework of decision making. Elements of Bayesian decision making, i.e. pre-, post- and pre-post risk assessment methods are presented. Bayesian networks are introduced as a generic numerical tool for solving such problems. The course also includes a tutorial using a software dedicated to real world structural reliability analysis.

Students gain insight into the next generation of design processes for architects and urban designers, and into concepts of the Information Architecture of SMART CITIES, including the influence of Big Data. They learn about the expanded roles of information and of architecture: information and simulation in architecture as means to make the invisible visible, and architecture as a metaphor and ordering system to structure the immense amounts of data of the Information Society. The seminar is highly interactive and discusses visionary case studies in Europe and Asia and new techniques in Big Data informed smart urban design. Apart from learning about and experiencing Information Architecture and SMART CITIES, the course also introduces research and management skills that will distinguish the future ETH architect.

An iBook and the edX Massive Open Online Course (MOOC) Future Cities support the course.

Students gain insight into the next generation of design processes for architects and urban designers, and into concepts of the Information Architecture of SMART CITIES, including the influence of Big Data. They learn about the expanded roles of information and of architecture: information and simulation in architecture as means to make the invisible visible, and architecture as a metaphor and ordering system to structure the immense amounts of data of the Information Society. The seminar is highly interactive and discusses visionary case studies in Europe and Asia and new techniques in Big Data informed smart urban design. Apart from learning about and experiencing Information Architecture and SMART CITIES, the course also introduces research and management skills that will distinguish the future ETH architect.

An iBook and the edX Massive Open Online Course (MOOC) Future Cities support the course.

We examine patterns of crowd-flows in an extraordinary urbanisation phenomena: festivals. The course participants will learn how to program simulations using Processing/Java. Previous programming knowledge is not necessary. Furthermore they will gain insights into other analysis methods and learn about their significance, strengths and weaknesses.

We will look at those patterns from two sides. One being the view of a planner asking to find bottlenecks or the ideal place for amenities such as booths, toilets etc. Another being the view of visitors. We will program different behaviours that should compete against each other in order to compare their different strategies. As a case study we will use the Caliente Festival in Zurich.

For deepening the learnt in a seminar thesis we offer to optimise the created simulations to make them available in interactive planning workshops. Additionally they could be converted into interactive web apps.

Carbon Mitigation

The reduction of CO2 emissions is the only option for keeping future climate change within reasonable bounds. In this course, we will discuss a portfolio of options involving the alteration of natural carbon sinks and carbon sequestration. The course includes introductory lectures, presentations from guest speakers from industry and the public sector, and final presentations by the students.
The goal of this course is to investigate, as a group, a particular set of carbon mitigation/sequestration options and to evaluate their potential, their cost, and their consequences.

From the large number of carbon sequestration/mitigation options, a few options will be selected and then investigated in detail by the students. The results of this research will then be presented to the other students, the involved faculty, and discussed in detail by the whole group.

Will be identified based on the chosen topic.

Exam: No final exam. Pass/No-Pass is assigned based on the quality of the presentation and ensuing discussion.

<table>
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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>066-0425-00L</td>
<td>Integrated Design MBS</td>
<td>W</td>
<td>6</td>
<td>2V+2U</td>
<td>A. Schlüter</td>
</tr>
</tbody>
</table>

During the integrated design studio students work on a contemporary integrated design project (urban and/or building scale) executing an integrated design process to achieve synergistic solutions.

The integrated design studio enables students to identify site specific energy demand and potentials, develop integrated energy and climate systems on both the urban and building scale and evaluate their interactions and impact on building design and operation.

During the integrated design studio students work on a contemporary integrated design project (urban and/or building scale) executing an integrated design process from the analysis of site potentials, the identification of demands, the development of an urban scale energy concept and a matching building energy- and HVAC-systems concept. Input lectures from academics and professionals will highlight specific topics relevant to the task. The projects will be presented by the student groups and discussed with internal and external reviewers at midterm and at the final presentations.

Skripts are specific to the design task and distributed at the beginning of the course.

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<tr>
<th>Number</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>066-0431-00L</td>
<td>Semester Project MBS</td>
<td>O</td>
<td>6</td>
<td>13A</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

You can choose the mentoring professor of your semester project MBS:

- Jan CARMEJET
- Stefano BRUSONI
- Mario FONTANA
- Guillaume HABERT
- John LYGEROS
- Marco MAZZOTTI
- Amo SCHLÜTER
- Roy SMITH

The semester project focuses on solving specific research questions in the field of integrated building systems.

The semester project is designed to train students in solving specific research questions in the field of integrated building systems. The goal is to apply acquired knowledge which is gained throughout the first year of the master's program. The semester project is advised by a professor who is affiliated with one of the partner departments of the Master program "Integrated building systems".

The semester project is designed to train students in solving specific research questions in the field of integrated building systems. The goal is to apply acquired knowledge which is gained throughout the first year of the master's program. The semester project is advised by a professor who is affiliated with one of the partner departments of the Master program "Integrated building systems".

Recommended GESS compulsory elective courses (Type B) for D-ARCH.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/Zurich

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<tr>
<th>Number</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>051-0412-AAL</td>
<td>Structural Design I / Structural Design II</td>
<td>E-</td>
<td>8</td>
<td>17R</td>
<td>P. Block, J. Schwartz</td>
</tr>
</tbody>
</table>

Enrolment only for MSc students who need this course as additional admission requirement.

Introduction to the design of structures, by means of graphic statics and structural models, focusing on cable, membrane, as well as arched and shell structures.

Determination of internal forces and description of structural behavior of mixed arches and cable structures, of truss systems, beams, slabs and frames using method of graphical statics.

Using graphical methods, students are taught to understand and generate the flow of forces through a structural system in relation to its form, and to dimension its components.

Awareness of the most important structural systems. Understanding of the interplay of load and form. Estimation of the inner forces and dimensioning of elements.
Content

Structural Design I:
The students learn to determine the internal forces and understand the structural behavior of cable, arch, and combined arch-cable structures, but are also introduced to three-dimensional membrane and shell structures. By means of graphical design methods, such as graphic statics, students are taught to analyse the flow of forces through structural systems in relation to their form and to dimension the components of the systems.

Structural Design II:
Determination of internal forces and description of structural behaviour of mixed arches and cable structures, of truss systems, beams, slabs, panels and frames using method of graphical statics as well as dimensioning of these structural systems. Structural behaviour of columns. Discussion of reference buildings and illustration of interplay of structural system and architectural intention.

Lecture notes
on eQuilibrium
http://www.block.arch.ethz.ch/equilibrium

and
http://www.schwartz.arch.ethz.ch/

"Faustformel Tragwerkentwurf"
(Philipp Block, Christoph Gengangel, Stefan Peters, DVA Deutsche Verlags-Anstalt 2013, ISBN: 978-3-421-03904-0)

Weiteres Lernmaterial:
"Form and Forces: Designing Efficient, Expressive Structures"

<table>
<thead>
<tr>
<th>151-1633-AAL</th>
<th>Energy Conversion</th>
<th>E-</th>
<th>4 credits</th>
<th>9R</th>
<th>H. G. Park</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Fundamentals of Thermal Sciences in association with Energy Conversion</td>
<td></td>
<td></td>
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<tr>
<td>Objective</td>
<td>To become acquainted and familiarized with basic principles of fundamental thermal sciences (Thermodynamics, Heat Transfer, etc.) as well as their linkage to energy conversion technologies.</td>
<td></td>
<td></td>
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<tr>
<td>Content</td>
<td>Thermodynamics (first and second laws), Heat Transfer (conduction/convection/radiation), Technical Applications</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Slides will be distributed by e-mail every week.</td>
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</tbody>
</table>

Prerequisites / notice
This course is intended for students outside of D-MAVT.

Integrated Building Systems Master - Key for Type

O Compulsory
W+ Eligible for credits and recommended
W Eligible for credits

E- Recommended, not eligible for credits
Z Courses outside the curriculum
Dr Suitable for doctorate

Key for Hours

V lecture
G lecture with exercise
U exercise
S seminar
K colloquium

P practical/laboratory course
A independent project
D diploma thesis
R revision course / private study

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Compulsory Subjects First Year Examinations

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>529-0011-04L</td>
<td>Practical Course General Chemistry</td>
<td>O</td>
<td>8 credits</td>
<td>12P</td>
<td>H. V. Schönberg, E. C. Meister</td>
</tr>
</tbody>
</table>

#### Abstract
Qualitative analysis (determination of cations and anions), acid-base-equilibria (pH-values, titrations, buffer), precipitation equilibria (gravimetry, potentiometry, conductivity), redox reactions (syntheses, redox-titrations, galvanic elements), metal complexes (syntheses, complexometric titration) analysis of measured values, states of aggregation (vapour pressure, conductivity, calorimetry)

#### Objective
Qualitative analysis (simple cation and anion separation process, determination of cations and anions), acid-base-equilibria (strengths of acids and bases, pH- and pKa-values, titrations, buffer systems, Kjeldahl determination), precipitation equilibria (gravimetry, potentiometry, conductivity), oxidation state and redox behaviour (syntheses), redox-titrations, galvanic elements), metal complexes (syntheses of complexes, ligand exchange reactions, complexometric titration) analysis of measured values (measuring error, average value, error analysis), states of aggregation (vapour pressure), characteristics of electrolytes (conductivity measurements), thermodynamics (calorimetry)

#### Content
The general aim for the students of the practical course in general chemistry is an introduction in the scientific work and to get familiar with simple experimental procedures in a chemical laboratory. In general, first experiences with the principal reaction behaviour of a variety of different substances will be made. The chemical characteristics of these will be elucidated by a series of quantitative experiments alongside with the corresponding qualitative analyses. In order to get an overview of classes of substances as well as some general phenomena in chemistry suitable experiments have been chosen. In the second part of the practical course, i.e. physical chemistry, the behaviour of substances in their states of aggregation as well as changes of selected physical values will be recorded and discussed.

#### Additional First Year Compulsory Subjects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>529-0011-01L</td>
<td>General Chemistry (Physical Chemistry) I</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>F. Merkt</td>
</tr>
</tbody>
</table>

#### Abstract
Atomic structure and structure of matter: atomic theory, elementary particles, atomic nuclei, radioactivity, nuclear reactions. Atomic orbitals and energy levels: ionisation energies, atomic spectroscopy, term values and symbols. Quantum mechanical atom model: wave-particle duality, the uncertainty principle, Schrödinger’s equation, the hydrogen atom, construction of the periodic table of the elements. Chemical bonding: ionic bonding, covalent bonding, molecular orbitals. Equations of state: ideal gases

#### Objective
Mastering basic concepts of Linear Algebra

#### Additional First Year Electives

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<tr>
<th>Number</th>
<th>Title</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-1511-00L</td>
<td>Linear Algebra I</td>
<td>O</td>
<td>7 credits</td>
<td>4V+2U</td>
<td>E. Kowalski</td>
</tr>
</tbody>
</table>

#### Abstract
Introduction to the theory of vector spaces for mathematicians and physicists including solutions of linear equations, linear transformations, determinants, eigenvalues and eigenvectors, bilinear forms, canonical forms for matrices, and selected applications, part I.

#### Objective
The ability to work with the basics of calculus in a mathematically rigorous way.

#### Content
The general aim for the students of the practical course in general chemistry is an introduction in the scientific work and to get familiar with simple experimental procedures in a chemical laboratory. In general, first experiences with the principal reaction behaviour of a variety of different substances will be made. The chemical characteristics of these will be elucidated by a series of quantitative experiments alongside with the corresponding qualitative analyses. In order to get an overview of classes of substances as well as some general phenomena in chemistry suitable experiments have been chosen. In the second part of the practical course, i.e. physical chemistry, the behaviour of substances in their states of aggregation as well as changes of selected physical values will be recorded and discussed.

#### Lectures

<table>
<thead>
<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0011-02L</td>
<td>General Chemistry (Inorganic Chemistry) I</td>
<td>W</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>A. Togni</td>
</tr>
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</table>
3. Semester

Compulsory Subjects Examination Block

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>529-0422-00L</td>
<td>Physical Chemistry II: Introduction to Chemical Reaction Kinetics</td>
<td>O</td>
<td>4</td>
<td>3V+1U</td>
<td>H. J. Wörner</td>
</tr>
<tr>
<td>402-2883-00L</td>
<td>Physics III</td>
<td>O</td>
<td>7</td>
<td>4V+2U</td>
<td>A. Wallraf</td>
</tr>
</tbody>
</table>

Electives

For the Bachelor in Interdisciplinary Sciences students can in principle choose from all subjects taught at the Bachelor level at ETH Zurich.

At the beginning of the 2. year an individual study program is established for every student in discussion with the Director of Studies in interdisciplinary sciences. For details see Programme Regulations 2010.

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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
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</thead>
<tbody>
<tr>
<td>252-0021-00L</td>
<td>Introduction to Programming</td>
<td>W</td>
<td>7</td>
<td>4V+2U</td>
<td>B. Meyer</td>
</tr>
</tbody>
</table>

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 792 of 1434
Objective
Many people can write programs. The "Introduction to Programming" course goes beyond that basic goal: it teaches the fundamental concepts and skills necessary to perform programming at a professional level. As a result of successfully completing the course, students master the fundamental control structures, data structures, reasoning patterns and programming language mechanisms characterizing modern programming, as well as the fundamental rules of producing high-quality software. They have the necessary programming background for later courses introducing programming skills in specialized application areas.

Content
Basics of object-oriented programming. Objects and classes. Pre- and postconditions, class invariants. Design by Contract. Fundamental control structures. Assignment and References. Basic hardware concepts. Fundamental data structures and algorithms. Recursion. Inheritance and deferred classes, introduction into event-driven design and concurrent programming. Basic concepts of Software Engineering such as the software process, specification and documentation, reuse and quality assurance.

Lecture notes
The lecture slides are available for download on the course page.

Literature
Bertrand Meyer: Touch of Class: Learning to Program Well Using Objects and Contracts, Springer Verlag, 2009; new printing, 2012. This is the official textbook for the course. See http://www.polybuchhandlung.ch/100/con_liste.asp

Prerequisites / notice
The course uses an "Outside-In" approach enabling students, right from the beginning, to use an advanced graphical library and produce significant applications. Students then learn step by step how the library is built, as a source of imitation and inspiration.

The course covers not only basic concepts of programming but also some advanced topics seldom encountered in introductory courses, such as recursion, undecidability, event-driven programming, multiple inheritance and others.

252-0847-00L Computer Science W 5 credits 2V+2U B. Gärtner
Abstract
This lecture is an introduction to programming based on the language C++. We cover fundamental types, control statements, functions, arrays, and classes. The concepts will be motivated and illustrated through algorithms and applications.

Objective
The goal of this lecture is an algorithmically oriented introduction to programming.

Content
This lecture is an introduction to programming based on the language C++. We cover fundamental types, control statements, functions, arrays, and classes. The concepts will be motivated and illustrated through algorithms and applications.

Lecture notes
Lecture notes in English and Handouts in German will be distributed electronically along with the course.

Literature

327-0103-00L Introduction to Materials Science W 3 credits 3G L. Heyderman, M. Niederberger, P. Uggowitzer
Abstract
Fundamental knowledge and understanding of the atomistic and macroscopic concepts of material science.

Objective
Basic concepts in materials science.

Contents:
Atomic structure
Crystallography
Mechanical and thermal properties
Phase diagrams
Structural materials
Magnetic and optical properties of materials
Materials selection criteria

Literature
James F. Shackelford
Introduction to Materials Science for Engineers

327-0301-00L Materials Science I W 3 credits 3G J. F. Löfler, A. R. Studart, P. Uggowitzer
Abstract
Basic concepts of metal physics, ceramics, polymers and their technology.

Objective
Based on the lecture 'Introduction to Materials Science' this lecture aims to give a detailed understanding of important aspects of materials science, with special emphasis on metallic and ceramic materials.

Content
Thermodynamics and phase diagrams, crystal interfaces and microstructure, diffusional transformations in solids, and diffusionless transformations will be presented for metallic alloys. The basics of the ionic and covalent chemical bonds, the bond energy, the crystalline structure, four important structural ceramics, and the properties of glasses and glass ceramics will be presented for ceramic materials.

Lecture notes
For metals see:
http://www.metphys.mat.ethz.ch/education/courses/mat_wiss1/details

For ceramics see:
http://www.complex.mat.ethz.ch/education/lectures.html
The course provides an introduction to solid state physics, covering several topics that are later discussed in more detail in other more advanced courses. The topics include:

- Metals:

- Ceramics:
  - diversified CEN ISO standards given in the lectures
  - Barsoum MW: Fundamentals of Ceramics


- Silicon-Based Structural Ceramics (Ceramic Transactions), Stephen C. Danforth (Editor), Brian W. Sheldon, American Ceramic Society, 2003


- Phase relationships in the zirconia-yttria system, HGM Scott - Journal of Materials Science, 1975, Springer


- "Formation of beta-Si sub 3 N sub 4 solid solutions in the system Si, Al, O, N by reaction sintering--sintering of an Si sub 3 N sub 4 AlN, Al sub 2 O sub 3 mixture" Boskovic, L J; Gauckler, L J, La Ceramica (Florence). Vol 33, no. N-2, pp. 18-22. 1980.


- In the first part of the lecture the lectures are obtained for metals. In the second part the basics of ceramics will be presented.

- The lecture will be generally in German.

**Prerequisites / notice**

401-2303-00L **Complex Analysis**

**Abstract**
Complex functions of one variable, Cauchy-Riemann equations, Cauchy theorem and integral formula, singularities, residue theorem, index of closed curves, conformal mappings, Riemann mapping theorem.

**Objective**
Working Knowledge with functions of one complex variables; in particular applications of the residue theorem

**Literature**

- Th. Gamelin: Complex Analysis. Springer 2001

401-2333-00L **Methods of Mathematical Physics I**

**Abstract**

**Objective**
Introduction to single-particle quantum mechanics. Familiarity with basic ideas and concepts (quantisation, operator formalism, Dirac-notation, symmetries, perturbation theory) and generic examples and applications (bound states, tunneling, scattering states, in one- and three-dimensional settings). Ability to solve simple problems.

**Content**
Keywords: Schrödinger equation, basic formalism of quantum mechanics (states, operators, commutators, measuring process), symmetries (translations, rotations), quantum mechanics in one dimension, dimensionally symmetric problems in three dimensions, scattering theory, density matrices, Schrödinger-, Heisenberg-, Dirac-pictures, time reversal, perturbation theory, variational techniques, spin, addition of angular momenta, relation between QM and classical physics.

**Lecture notes**
Deutsch

402-0225-00L **Introduction to Solid State Physics**

**Abstract**
The course provides an introduction to solid state physics, covering several topics that are later discussed in more detail in other more specialized lectures. The central topics are: solids and their lattice structures; light waves, lattice dynamics, electronic properties of insulators, metals, semiconductors, transport properties, magnetism, superconductivity.

**Objective**
Introduction to Solid State Physics.

**Content**
The course provides an introduction to solid state physics, covering several topics that are later discussed in more detail in other more specialized lectures. The central topics are: solids and their lattice structures; light waves, lattice dynamics, electronic properties of insulators, metals, superconductors; bandstructure and n-type doping; magnetism, superconductivity.

**Lecture notes**
A Manuscript is distributed.

**Literature**

- Itach & Lüth, Festkörperrphysik
- C. Kittel, Festkörperphysik
- Ashcroft & Mermin, Festkörperrphysik
- Känzig, Kondensierte Materie
At the end of the lecture the student should understand four key phenomena of electron transport in semiconductor nanostructures:

1. The integer quantum Hall effect
2. Conductance quantization in quantum point contacts
3. the Aharonov-Bohm effect
4. Coulomb blockade in quantum dots

The course provides an overview of fundamental concepts and physical processes in astrophysics with the dual goals of: i) illustrating physical principles through a variety of astrophysical applications; and ii) providing an overview of research topics in astrophysics.

The course is taught in English. The course is suitable for all physics students beyond the bachelor of science degree. Basic knowledge of solid state physics is recommended. Very ambitioned students in the third year may be able to follow. The lecture can be chosen as part of the PhD-program.

Prerequisites / notice


Data: 06.02.2019 13:00

Autumn Semester 2015

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Lecture notes 

Content 

Objective 

Abstract 

529-0051-00L 

Analytical Chemistry I

Introduction into the most important spectroscopical methods and their applications to gain structural information.

Knowledge about the necessary theoretical background of spectroscopical methods and their practical applications.

Application oriented basics of organic and inorganic instrumental analysis and of the empirical employment of structure elucidation methods:

Mass spectrometry: Ionization methods, mass separation, isotope signals, rules of fragmentation, rearrangements.

NMR spectroscopy: Experimental basics, chemical shift, spin-spin coupling.

IR spectroscopy: Revisiting topics like harmonic oscillator, normal vibrations, coupled oscillating systems (in accordance to the basics of the related lecture in physical chemistry); sample preparation, acquisition techniques, law of Lambert and Beer, interpretation of IR spectra.

Raman spectroscopy.

UV/VIS spectroscopy: Basics, interpretation of electron spectra. Circular dichroism (CD) and optical rotation dispersion (ORD).


Script will be for the production price


Exercises are integrated in the lectures. In addition, attendance in the lecture 529-0289-00 "Instrumental analysis of organic compounds" (4th semester) is recommended.

551-0105-00L 

Fundamentals of Biology IA

The course provides an introduction to the basics of molecular- and cell biology and genetics.

Introduction to modern biology and to principal biological concepts.

The course is divided into several chapters:

1. Basic principles of Evolution.
2. Chemistry of Life: Water; Carbon and molecular diversity; biomolecules
3. The cell: structure; membrane structure and function, cell cycle
4. Metabolism: Respiration; Photosynthesis; Fermentation
5. Inheritance: meiosis and sexual reproduction; Mendelian genetics; chromosomal basis of inheritance, molecular basis of inheritance, from gene to protein, regulation of gene expression; genomes and their evolution

None

The text-book "Biology" (Campbell, Reece) (10th edition) is the basis of the course.

The structure of the course is largely identical with that of the text-book.

Certain sections of the text-book must be studied by self-instruction.

529-0121-00L 

Inorganic Chemistry I

Complexes of the transition metals: structure, bonding, spectroscopic properties, and synthesis.

Introduction to the binding theory in complexes of the transition metals. Interpretation of structure, bonding, and spectroscopic properties. General synthetic strategies.

The chemical bond (overview). Symmetry and group theory. The chemical bond of coordination compounds (Valence Bond Theory, Crystal Field Theory, Molecular Orbital Theory (sigma- and pi-bonding); pi-Accepting ligands (CO, NO, olefins, dioxygen, dihydrogen, phosphines and phosphites). Electronic spectra of coordination compounds (Tanabe-Sugano diagrams). Coordination numbers and isomers in complexes. Dynamic phenomena (stereochemical nonrigidity). Complexes and kinetics.

Can be bought at the HCI-shop


529-0221-00L 

Organic Chemistry I

Chemical reactivity and classes of compounds. Eliminations, fragmentations, chemistry of aldehydes and ketones (hydrates, acetals, imines, enamines, nucleophilic addition of organometallic compounds, reactions with phosphorus and sulfur ylides; reactions of enolates as nucleophiles) and of carboxylic acid derivatives. Aldol reactions.

A basic repertoire of synthetic methods including important reactions of aldehydes, ketones, carboxylic acids and carboxylic acid derivatives, as well as eliminations and fragmentations. Particular emphasis is placed on the understanding of reaction mechanisms and the correlation between structure and reactivity. A deeper understanding of the concepts presented during the lecture is reached by solving basic problems and discussed one week later in the exercise class. The topics covered range from different complexes. Dynamic phenomena (stereochemical nonrigidity). Complexes and kinetics.

A pdf file of the printed lecture notes is provided online. Supplementary material may be provided online.

No set textbooks. Optional literature will be proposed at the beginning of the class and in the lecture notes.

701-0023-00L 

Atmosphere

Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

Understanding of basic physical and chemical processes in the atmosphere. Understanding of mechanisms of interactions between: weather - climate, atmosphere - ocean - continents, troposphere - stratosphere. Understanding of environmentally relevant structures and processes on vastly differing scales. Basis for the modelling of complex interrelations in the atmosphere.

Written information will be supplied


701-0245-00L 

Introduction to Evolutionary Biology

This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions. These topics are important for understanding of a number of evolutionary problems in the basic and applied sciences.
Content
This lecture imparts the mathematical basis necessary for the development and application of atmospheric dynamics. Based on these theoretical principles, the following aspects are discussed: the energetics of the global circulation, the basic synoptic- and meso-scale flow phenomena, in particular the dynamics of extratropical cyclones, and the influence of mountains on the atmospheric flow.

Objective
- explain up-to-date meteorological observation techniques and the basic methods of theoretical atmospheric dynamics
- to discuss the mathematical basis of atmospheric dynamics, based on selected atmospheric flow phenomena
- to explain the basic dynamics of the global circulation and of synoptic- and meso-scale flow features
- to explain how mountains influence the atmospheric flow on different scales

Content
Satellite observations; analysis of vertical soundings; geostrophic and thermal wind; cyclones at mid-latitude; global circulation; north-atlantic oscillation; atmospheric blocking situtations; Eulerian and Lagrangian perspective; potential vorticity; Alpine dynamics (storms, orographic wind); planetary boundary layer

Lecture notes
Lecture notes and slides

Literature
Textbook:
Scott Freeman and Jon Herron

Prerequisites / notice
The exam is based on lecture and textbook.

701-0401-00L Hydrosphere

Abstract
Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.

Objective
Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.

Content
Topics of the course.
Physical properties of water (i.e. density and equation of state)
- global water resources
- energy (thermal & kinetic), gas exchange
- vertical stratification, large scale transport
- turbulence and mixing
- mixing and exchange processes in rivers
Groundwater and its dynamics
- ground water as part of the terrestrial water cycle
- ground water hydraulics, Darcy's law
- aquifers and their properties
- hydrochemistry and tracer
- ground water use
Case studies
- 1. Water as resource, 2. Water and climate

Lecture notes
In addition to the suggested literature handouts are distributed.

Literature
Suggested literature.

Prerequisites / notice
The case studies and the analysis of the questions and problems are integral part of the course.

701-0423-00L Chemistry of Aquatic Systems

Abstract
This course gives an introduction to chemical processes in aquatic systems and shows applications to various systems. The following topics are treated: acid-base reactions and carbonate system, solubility of solids and weathering, redox reactions, complexation of metals, reactions at the solid/water interface, applications to lakes, rivers and groundwater.

Objective
Understanding of chemical processes in aquatic systems. Qualitative application of chemical equilibria to processes in natural waters.

Content
Introduction to the chemistry of aquatic systems. Regulation of the composition of natural waters by chemical, geochemical and biological processes. Quantitative application of chemical equilibria to processes in natural waters. The following topics are treated: acid-base reactions, carbonate system; solubility of solid phases and weathering; complexation of metals and metal cycling in natural waters; redox reactions; reactions at the interface solid phase-water; applications to lakes, rivers, groundwater.

701-0461-00L Numerical Methods in Environmental Sciences

Abstract
This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

Objective
This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

Content
Classification of numerical problems, introduction to finite-difference methods, time integration schemes, non-linearity, conservative numerical techniques, an overview of spectral and finite-element methods. Examples and exercises from a diverse cross-section of Environmental Science.

Three obligatory exercises, each two hours in length, are integrated into the lecture. The implementation language is Matlab (previous experience not necessary: a Matlab introduction is given). Example programs and graphics tools are supplied.

Lecture notes
Is provided (CHF 10.- per copy).

Literature
List of literature is provided.

701-0473-00L Weather Systems

Abstract
This lecture introduces the theoretical principles and the observational and analytical methods of atmospheric dynamics. Based on these principles, the following aspects are discussed: the energetics of the global circulation, the basic synoptic- and meso-scale flow phenomena, in particular the dynamics of extratropical cyclones, and the influence of mountains on the atmospheric flow.

Objective
The students are able to
- explain up-to-date meteorological observation techniques and the basic methods of theoretical atmospheric dynamics
- to discuss the mathematical basis of atmospheric dynamics, based on selected atmospheric flow phenomena
- to explain the basic dynamics of the global circulation and of synoptic- and meso-scale flow features
- to explain how mountains influence the atmospheric flow on different scales

Content
Satellite observations; analysis of vertical soundings; geostrophic and thermal wind; cyclones at mid-latitude; global circulation; north-atlantic oscillation; atmospheric blocking situtations; Eulerian and Lagrangian perspective; potential vorticity; Alpine dynamics (storms, orographic wind); planetary boundary layer

Lecture notes
Lecture notes and slides

Literature
Academic Press

John M. Wallace and Peter V. Hobbs

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Autumn Semester 2015
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Die Behandlung der Themen erfolgt auf der Basis des Lehrbuchs Brock, *Biology of Microorganisms*.

This course covers the basics of atmospheric physics, which consist of: cloud and precipitation formation, thermodynamics, aerosol physics, radiation as well as the impact of aerosols and clouds on climate and artificial weather modification.

Content

- to explain the mechanisms of cloud and precipitation formation using knowledge of humidity processes and thermodynamics.
- to evaluate the significance of clouds and aerosol particles for climate and artificial weather modification.

Lecture notes

Powerpoints slides and script will be made available.

Literature


Prerequisites / notice

50% of the time we use the concept of "flipped classroom" (en.wikipedia.org/wiki/Flipped_classroom), which we introduce at the beginning.

We offer a lab tour, in which we demonstrate with some instruments how some of the processes, that are discussed in the lectures, are measured.

There is a additional tutorial right after each lecture to give you the chance to ask further questions and discuss the exercises. The participation is recommended but voluntary.

---

**Microbiology**

**Objective**

Teaching of basic knowledge in microbiology with main focus on Microbial Cell Structure and Function, Molecular Genetics, Microbial Growth, Metabolic Diversity, Phylogeny and Taxonomy, Prokaryotic Diversity, Human-Microbe Interactions, Biotechnology.

**Content**


**Lecture notes**

Lecture notes can be purchased during the first lecture (15.- SFr)

**Literature**


---

**Laboratory Courses, Semester Papers, Proseminars, Field Trips**

Further Laboratory Courses arising upon specific written request by the students and permission by the Director of studies.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0011-04L</td>
<td>Practical Course General Chemistry</td>
<td>O</td>
<td>8 credits</td>
<td>12P</td>
<td>H. V. Schönberg, E. C. Meister</td>
</tr>
<tr>
<td>529-0129-00L</td>
<td>Inorganic and Organic Chemistry II</td>
<td>W</td>
<td>11 credits</td>
<td>16P</td>
<td>A. Mezzetti, A. Togni</td>
</tr>
</tbody>
</table>

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Data: 06.02.2019 13:00  Autumn Semester 2015  Page 798 of 1434
Inorganic chemistry part: Synthesis and analysis of elemento-organic compounds, metal complexes, and organometallic compounds. Introduction to Schlenk techniques, solid state synthesis, and kinetics. Introduction in the chemistry library: literature data banks and collections of spectra.

Organic synthesis with organometallic compounds and catalysts: Experiments in the framework of a selected specialised project. Possible projects: Rh catalysed asymmetric hydrogenation of enamides, Mn catalysed epoxidation of olefins, Cu catalysed Diels-Alder reactions, synthesis of organo-boron compounds and Pd catalysed coupling with halides, Ru catalysed transfer hydrogenation.

A manual is distributed in the teaching laboratory. Certain sections of the text-book must be studied by self-instruction. From gene to protein, regulation of gene expression; genomes and their evolution

In a semester project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic.

In a research project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic. Research projects are carried out in a core or optional subject area as chosen by the student.

Students are accustomed to scientific work and they get to know one specific research field.

Students are accustomed to scientific work and they get to know one specific research field.

The text-book “Biology” (Campbell, Reece) (10th edition) is the basis of the course.

The structure of the course is largely identical with that of the text-book.

The ability to work with the basics of calculus in a mathematically rigorous way.

The ability to work with the basics of calculus in a mathematically rigorous way.

The ability to work with the basics of calculus in a mathematically rigorous way.

The ability to work with the basics of calculus in a mathematically rigorous way.
Discuss fundamentals of computer architecture, languages, algorithms and programming with an eye to their application in the area of computer science.

**Literature**
- K. Koepfer: Analysis I, Springer-Verlag
- R. Courant: Introduction to Calculus and Analysis, Springer-Verlag
- V. Zorich: Mathematical Analysis I, Springer Verlag 2009
  
  
- H. Heuser: Lehrbuch der Analysis. Teubner Verlag
- W. Walter: Analysis 1. Springer Verlag
- O. Forster: Analysis I. Vieweg Verlag

J. Appell: Analysis in Beispielen und Gegenbeispielen. Springer Verlag http://www.springerlink.com/content/q67803/?p=091fa376ade4fcb8b21451e2e4e0a&pi=4

**Course 401-0231-10L**
*Analysis I*

**Abstract**
Calculus of one variable: Real and complex numbers, vectors, functions, limits, sequences, series, power series, differentiation and integration in one variable, Real to ordinary differential equations.

**Objective**
Einführung in die Grundlagen der Analysis

**Lecture notes**
Christian Blatter: Ingenieur-Analyse (Kapitel 1-3)

**Course 529-0001-00L**
*Introduction to Computer Science*

**Abstract**
Introduction to UNIX, data representation, introduction to C++ programming, errors, algorithms, computer architecture, sorting and searching, databases, numerical algorithms, types of algorithms, simulation, data communication & networks, chemical structures, operating systems, programming languages, software engineering.

**Objective**
Discuss fundamentals of computer architecture, languages, algorithms and programming with an eye to their application in the area of chemistry, biology and material science.

**Content**
Minimal introduction to UNIX, Data representation and processing, algorithms and programming in C++, Errors, programming guidelines, efficiency, computer architecture, algorithms for sorting and searching, databases, numerical algorithms, types of algorithms, simulation, data communication & networks, chemical structures, operating systems, programming languages, style, software engineering.

**Lecture notes**
Available (in English), distributed at first lecture

**Literature**
See: www.csms.ethz.ch/education/lnfoll

**Prerequisites / notice**
Since the exercises on the computer do convey and test essentially different skills as those being conveyed during the lectures and tested at the written exam, the results of the exercises are taken into account when evaluating the results of the exam.

**Literature**
For more information about the lecture: www.csms.ethz.ch/education/lnfoll

**Course 529-0001-02L**
*General Chemistry (Inorganic Chemistry) I*

**Abstract**
Introduction to the chemistry of ionic equilibria: Acids and bases, redox reactions, formation of coordination complexes and precipitation reactions.

**Objective**
Understanding and describing ionic equilibria from both a qualitative and a quantitative perspective

**Content**
Chemical equilibrium and equilibrium constants, mono- and polyprotic acids and bases in aqueous solution, calculation of equilibrium concentrations, acid functions, Lewis acids, acids in non-aqueous solvents, redox reactions and equilibrium, Galvanic cells, electrode potentials, Nernst equation, coordination chemistry, stepwise formation of metal complexes, solubility potentials, Nernst equation, coordination chemistry, stepwise formation of metal complexes, solubility

**Lecture notes**
Copies of the course slides as well as other documents will be provided as pdf files via the ILIAS platform (myStudies)

**Literature**

**Course 529-0001-03L**
*General Chemistry (Organic Chemistry) I*

**Abstract**
Introduction to Organic Chemistry. Classical structure theory, stereochemistry, chemical bonds and bonding, symmetry, nomenclature, organic thermochemistry, conformational analysis, basics of chemical reactions.

**Objective**
Introduction to the structures of organic compounds as well as the structural and energetic basis of organic chemistry.

**Content**
Introduction to the history of organic chemistry, introduction to nomenclature, learning of classical structures and stereochemistry; isomerism, Fischer projections, CIP rules, point groups, molecular symmetry and chirality, topical, chemical bonding: Lewis bonding model and resonance theory in organic chemistry, description of linear and cyclic conjugated molecules, aromaticity, Huckel rules, organic thermochemistry, learning of organic chemistry reactions, intermolecular interactions.

**Lecture notes**
Unterlagen werden als PDF über die ILIAS-Plattform zur Verfügung gestellt

**Literature**

**Course 529-0001-01L**
*General Chemistry (Physical Chemistry) I*

**Abstract**
Atomic structure and structure of matter; Atomic orbitals and energy levels; Quantum mechanical atom model; Chemical bonding; Equations of state.

**Objective**
Introduction to Physical Chemistry

**Content**
Atomic structure and structure of matter; atomic theory, elementary particles, atomic nuclei, radioactivity, nuclear reactions. Atomic orbitals and energy levels: ionisation energies, atomic spectroscopy, term values and symbols, Quantum mechanical atom model: wave-particle duality, the uncertainty principle, Schrödinger’s equation, the hydrogen atom, construction of the periodic table of the elements. Chemical bonding: ionic bonding, covalent bonding, molecular orbitals. Equations of state: ideal gases

**Lecture notes**
See homepage of the lecture.

**Literature**
See homepage of the lecture.

**Prerequisites / notice**
Voraussetzungen: Maturastoff. Insbesondere Integral- und Differenirechnung.

### Additional First Year Compulsory Subjects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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</thead>
<tbody>
<tr>
<td>529-0011-04L</td>
<td>Practical Course General Chemistry</td>
<td>O</td>
<td>8</td>
<td>12P</td>
<td>H. V. Schönberg, E. C. Meister</td>
</tr>
</tbody>
</table>

Information about the practical course will be given on the first day.

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 800 of 1434
Abstract
Qualitative analysis (determination of cations and anions), acid-base-equilibria (pH-values, titrations, buffer), precipitation equilibria (gravimetry, potentiometry, conductivity), redox reactions (syntheses, redox-titrations, galvanic elements), metal complexes (syntheses, complexometric titration)

analysis of measured values, states of aggregation (vapour pressure, conductivity, calorimetry)

Objective
Qualitative analysis (simple cation and anion separation process, determination of cations and anions), acid-base-equilibria (strengths of acids and bases, pH- and pKa-values, titrations, buffer systems, Kjeldahl determination), precipitation equilibria (gravimetry, potentiometry, conductivity), oxidation state and redox behaviour (syntheses), redox-titrations, galvanic elements), metal complexes (syntheses of complexes, ligand exchange reactions, complexometric titration)

analysis of measured values (measuring error, average value, error analysis), states of aggregation (vapour pressure), characteristics of electrolytes (conductivity measurements), thermodynamics (calorimetry)

Content
The general aim for the students of the practical course in general chemistry is an introduction in the scientific work and to get familiar with simple experimental procedures in a chemical laboratory. In general, first experiences with the principal reaction behaviour of a variety of different substances will be made. The chemical characteristics of these will be elucidated by a series of quantitative experiments alongside with the corresponding qualitative analyses. In order to get an overview of classes of substances as well as some general phenomena in chemistry suitable experiments have been chosen. In the second part of the practical course, i.e. physical chemistry, the behaviour of substances in their states of aggregation as well as changes of selected physical values will be recorded and discussed.

Lecture notes
http://www.gruetzmacher.ethz.ch/education/labcourses

Prerequisites /
Compulsory: online enrolment latest one week prior start of the semester

3. Semester (Biochemical-Physical Direction)

Compulsory Subjects Examination Block

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0373-00L</td>
<td>Mathematics III: Partial Differential Equations</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>F. Da Lio</td>
</tr>
</tbody>
</table>

Abstract

Objective
The main objective is that the students get a basic knowledge of the classical tools to solve explicitly linear partial differential equations.

Content
## Examples of partial differential equations
- Classification of PDEs
- Superposition principle

## One-dimensional wave equation
- D'Alembert's formula
- Duhamel's principle

## Fourier series
- Representation of piecewise continuous functions via Fourier series
- Examples and applications

## Separation of variables
- Resolution of wave and heat equation
- Homogeneous and inhomogeneous boundary conditions, Dirichlet and Neumann boundary conditions

## Laplace equation
- Resolution of the Laplace equation on rectangle, disk and annulus
- Poisson formula
- Mean value theorem and maximum principle

## Fourier transform
- Derivation and Definition
- Inverse Fourier transformation and inversion formula
- Interpretation and properties of the Fourier transform
- Resolution of the heat equation

## Laplace transform
- Definition, motivation and properties
- Inverse Laplace transform of rational functions
- Application to ordinary differential equations

Lecture notes
There are available some Lecture Notes in English and also in German of the Professor. These can be found following the links provided under the tab 'Lernmaterialien'.

Literature
2) Y. Pinchover and J. Rubinstein, An Introduction to Partial Differential Equations, Cambridge University Press
3) E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons (only Chapters 1,2,6,11)

Prerequisites /
It is required a minimal background of: 1) multivariables functions (Riemann integrals in two or three variables, change of variables in the integrals through the Jacobian, partial derivatives, differentiability, Jacobian) 2) numerical and functional sequences and series, basic knowledge of ordinary differential equations.

401-0353-00L Analysis III W 4 credits 2V+1U  P. S. Jossen

Abstract
In this lecture we treat problems in applied analysis. The focus lies on the simplest cases of three fundamental types of partial differential equations of second order: the Laplace equation, the heat equation and the wave equation.

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Content
1.) Klassifizierung von PDE's
- linear, quasilinear, nicht-linear
- elliptisch, parabolisch, hyperbolisch

2.) Quasilineare PDE
- Methode der Charakteristiken (Beispiele)

3.) Elliptische PDE
- Bsp: Laplace-Gleichung
- Harmonische Funktionen, Maximumsprinzip, Mittelwerts-Formel.
- Methode der Variablenseparation.

4.) Parabolische PDE
- Bsp: Wärmeleitungsgleichung
- Bsp: Inverse Wärmeleitungsgleichung
- Methode der Variablenseparation

5.) Hyperbolische PDE
- Bsp: Wellengleichung
- Formel von d'Alambert in (1+1)-Dimensionen
- Methode der Variablenseparation

6.) Green'sche Funktionen
- Rechnen mit der Dirac-Deltafunktion
- Idee der Green'schen Funktionen (Beispiele)

7.) Ausblick auf numerische Methoden
- 5-Punkt-Diskretisierung des Laplace-Operators (Beispiele)

Literature

Zusätzliche Literatur:
Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, Kap. 8, 11, 16 (sehr gutes Buch, als Referenz zu benutzen)
Norbert Hungerbühler, "Einführung in die partiellen Differentialgleichungen", vdf Hochschulverlag AG an der ETH Zürich.

G. Felder:Partielle Differenzialgleichungen.
http://www.math.ethz.ch/u/felder/Teaching/PDG

Prerequisites / notice
Prerequisites: Analysis I and II, Fourier series (Komplexe Analyse)

<table>
<thead>
<tr>
<th>402-0043-00L</th>
<th>Physics I</th>
<th>W</th>
<th>4 credits</th>
<th>3V+1U</th>
<th>M. R. Meyer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Introduction to the concepts and tools in physics with the help of demonstration experiments: mechanics of point-like and ridged bodies, periodic motion and mechanical waves.</td>
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<tr>
<td>Objective</td>
<td>The concepts and tools in physics, as well as the methods of an experimental science are taught. The student should learn to identify, communicate and solve physical problems in his/her own field of science.</td>
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<tr>
<td>Content</td>
<td>Mechanics (motion, Newton's laws, work and energy, conservation of momentum, rotation, gravitation, fluids) Periodic Motion and Waves (periodic motion, mechanical waves, acoustics).</td>
<td></td>
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<tr>
<td>Lecture notes</td>
<td>The lecture follows the book &quot;Physics&quot; by Paul A. Tipler.</td>
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</table>

<table>
<thead>
<tr>
<th>402-1701-00L</th>
<th>Physics I</th>
<th>W</th>
<th>7 credits</th>
<th>4V+2U</th>
<th>G. Dissertori</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>This course gives a first introduction to Physics. The emphasis is on classical mechanics, together with an introduction to thermodynamics.</td>
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<tr>
<td>Objective</td>
<td>Acquire knowledge of the basic principles regarding the physics of classical mechanics and thermodynamics. Skills in solving physics problems.</td>
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<table>
<thead>
<tr>
<th>529-0422-00L</th>
<th>Physical Chemistry II: Introduction to Chemical Reaction Kinetics</th>
<th>O</th>
<th>4 credits</th>
<th>3V+1U</th>
<th>H. J. Wörner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>Introduction to Chemical Reaction Kinetics</td>
<td></td>
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<tr>
<td>Prerequisites / notice</td>
<td>- Mathematik I und II</td>
<td></td>
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<td></td>
<td>- Allgemeine Chemie I und II</td>
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<tr>
<td></td>
<td>- Physikalische Chemie I</td>
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<table>
<thead>
<tr>
<th>529-0221-00L</th>
<th>Organic Chemistry I</th>
<th>O</th>
<th>3 credits</th>
<th>2V+1U</th>
<th>F. Diederich, C. Schaack</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Chemical reactivity and classes of compounds. Eliminations, fragmentations, chemistry of aldehydes and ketones (hydrates, acetals, imines, enamines, nucleophilic addition of organometallic compounds, reactions with phosphorus and sulfur ylides; reactions of enolates as nucleophiles) and of carboxylic acid derivatives. Aldol reactions.</td>
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<tr>
<td>Objective</td>
<td>Acquisition of a basic repertoire of synthetic methods including important reactions of aldehydes, ketones, carboxylic acids and carboxylic acid derivatives, as well as eliminations and fragmentations. Particular emphasis is placed on the understanding of reaction mechanisms and the correlation between structure and reactivity. A deeper understanding of the concepts presented during the lecture is reached by solving the problems handed out each time and discussed one week later in the exercise class.</td>
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</tbody>
</table>
Electives

Im Bachelor-Studienang Angerechnet können die Studierenden prinzipiell alle Lehrveranstaltungen wählen, die in einem Bachelor-Studienang der ETH angeboten werden.


<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
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</tr>
</thead>
<tbody>
<tr>
<td>529-0051-00</td>
<td>Analytical Chemistry I</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>D. Günther, M.O. Ebert, R. Zenobi</td>
</tr>
<tr>
<td>529-0121-00</td>
<td>Inorganic Chemistry I</td>
<td>W</td>
<td>3</td>
<td>2V+1U</td>
<td>A. Mezzetti</td>
</tr>
<tr>
<td>252-0847-00L</td>
<td>Computer Science</td>
<td>W</td>
<td>5</td>
<td>2V+2U</td>
<td>B. Gärtner</td>
</tr>
<tr>
<td>551-0103-00L</td>
<td>Fundamentals of Biology II: Cell Biology</td>
<td>W</td>
<td>5</td>
<td>5V</td>
<td>E. Hafen, U. Kutay, J. Matos, G. Schertler, U. Suter, S. Werner</td>
</tr>
</tbody>
</table>

Prerequisites / notice

Exercises are integrated in the lectures. In addition, attendance in the lecture 529-0289-00 "Instrumental analysis of organic compounds" (4th semester) is recommended.

Exercises are integrated in the lectures. In addition, attendance in the lecture 529-0289-00 "Instrumental analysis of organic compounds" (4th semester) is recommended.

Exercises are integrated in the lectures. In addition, attendance in the lecture 529-0289-00 "Instrumental analysis of organic compounds" (4th semester) is recommended.
**Introduction to Bioinformatics: Concepts and Applications**

**W. Gruissem, K. Bärenfaller, A. Callisch, G. Capitani, J. Fütterer, M. Robinson, A. Wagner**

**Abstract**
Storage, handling and analysis of large datasets have become essential in biological research. The course will introduce students to a number of applications of bioinformatics in biology. Freely accessible software tools and databases will be explained and explored in theory and praxis.

**Objective**
Introduction to Bioinformatics I: Concepts and Applications (formerly Bioinformatics I) will provide students with the theoretical background of approaches to store and retrieve information from large databases. Concepts will be developed how DNA sequence information can be used to understand phylogenetic relationships, how RNA sequence relates to structure, and how protein sequence information can be used for genome annotation and to predict protein folding and structure. Students will be introduced to quantitative methods for measuring gene expression and how this information can be used to model gene networks. Methods will be discussed to construct protein interaction maps and how this information can be used to simulate dynamic molecular networks.

In addition to the theoretical background, the students will develop hands-on experiences with the bioinformatics methods through guided exercises. The course provides students from different backgrounds with basic training in bioinformatics approaches that have impact on biological, chemical and physics experimentation. Bioinformatics approaches draw significant expertise from mathematics, statistics and computational science.

Although "Introduction to Bioinformatics I" will focus on theory and praxis of bioinformatics approaches, the course provides an important foundation for the course "Introduction to Bioinformatics II: Fundamentals of computer science, modeling and algorithms" that will be offered in the following semester.

**Content**
Bioinformatics I will cover the following topics:

- Storage, handling and analysis of large datasets
- DNA sequence prediction
- Gene expression analysis
- Protein sequence and structure databases
- WWW for bioinformatics
- Protein sequence comparisons
- Proteomics and de novo protein sequencing
- Protein structure prediction
- Cellular and protein interaction networks
- Molecular dynamics simulation

### 401-0373-00L Mathematics III: Partial Differential Equations

**W. Da Lio**

**Abstract**

**Objective**
The main objective is that the students get a basic knowledge of the classical tools to solve explicitly linear partial differential equations.

**Content**

#### Examples of partial differential equations
- Classification of PDEs
- Superposition principle

#### One-dimensional wave equation
- D'Alembert's formula
- Duhamel's principle

#### Fourier series
- Representation of piecewise continuous functions via Fourier series
- Examples and applications

#### Separation of variables
- Resolution of wave and heat equation
- Homogeneous and inhomogeneous boundary conditions, Dirichlet and Neumann boundary conditions

#### Laplace equation
- Resolution of the Laplace equation on rectangle, disk and annulus
- Poisson formula
- Mean value theorem and maximum principle

#### Fourier transform
- Derivation and Definition
- Inverse Fourier transformation and inversion formula
- Interpretation and properties of the Fourier transform
- Resolution of the heat equation

#### Laplace transform
- Definition, motivation and properties
- Inverse Laplace transform of rational functions
- Application to ordinary differential equations

**Lecture notes**
There are available some Lecture Notes in English and also in German of the Professor. These can be found following the links provided under the tab 'Lernmaterialien'.

**Literature**
2) Y. Pinchover and J. Rubinstein, An Introduction to Partial Differential Equations, Cambridge University Press
3) E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons (only Chapters 1,2,6,11)

**Prerequisites / notice**
It is required a minimal background of: 1) multivariables functions (Riemann integrals in two or three variables, change of variables in the integrals through the Jacobian, partial derivatives, differentiability, Jacobian) 2) numerical and functional sequences and series, basic knowledge of ordinary differential equations.
Objective
Mastering basic concepts of Linear Algebra

401-2303-00L Complex Analysis W 6 credits 3V+2U R. Pandharipande
Abstract
Complex functions of one variable, Cauchy-Riemann equations, Cauchy theorem and integral formula, singularities, residue theorem, index of closed curves, analytic continuation, special functions, conformal mappings, Riemann mapping theorem.
Objective
Working Knowledge with functions of one complex variables; in particular applications of the residue theorem
Literature
Th. Gamelin: Complex Analysis. Springer 2001

D. Salamon: "Funktionentheorie". Birkhauser, 2011. (In German)
B. Paalka: "An introduction to complex function theory."
R.Remmert: Theory of Complex Functions. Springer Verlag

402-2203-01L Classical Mechanics W 7 credits 4V+2U C. Anastasiou
Abstract
A conceptual introduction to theoretical physics: Newtonian mechanics, central force problem, oscillations, Lagrangian mechanics, symmetries and conservation laws, spinning top, relativistic space-time structure, particles in an electromagnetic field, Hamiltonian mechanics, canonical transformations, integrable systems, Hamilton-Jacobi equation.
Objective
Working Knowledge with functions of one complex variables; in particular applications of the residue theorem
Literature

401-2333-00L Methods of Mathematical Physics I W 6 credits 3V+2U G. Felder
Abstract

402-2883-00L Physics III W 7 credits 4V+2U A. Wallraf
Abstract
Introductory course on quantum and atomic physics including optics and statistical physics.
Objective
A basic introduction to quantum and atomic physics, including basics of optics and equilibrium statistical physics. The course will focus on the relation of these topics to experimental methods and observations.
Content
Evidence for Quantum Mechanics: atoms, photons, photo-electric effect, Rutherford scattering, Compton scattering, de-Broglie waves.
Quantum mechanics: wavefunctions, operators, Schrodinger's equation, infinite and finite square well potentials, harmonic oscillator, hydrogen atoms, spin.
Atomic structure: Perturbation to basic structure, including Zeeman effect, spin-orbit coupling, many-electron atoms. X-ray spectra, optical selection rules, emission and absorption of radiation, including lasers.
Optics: Fermat's principle, lenses, imaging systems, diffraction, interference, relation between geometrical and wave descriptions, interferometers, spectrometers.
Statistical mechanics: probability distributions, macro and macrostates, Boltzmann distribution, ensembles, equipartition theorem, blackbody spectrum, including Planck distribution

402-0263-00L Astrophysics I W 10 credits 3V+2U A. Refregier
Abstract
This introductory course will develop basic concepts in astrophysics as applied to the understanding of the physics of planets, stars, galaxies, and the Universe.
Objective
The course provides an overview of fundamental concepts and physical processes in astrophysics with the dual goals of: i) illustrating physical principles through a variety of astrophysical applications; and ii) providing an overview of research topics in astrophysics.

752-4001-00L Microbiology W 2 credits 2V M. Ackermann, M. Schuppler, J. Vorholt-Zambelli
Abstract
Teaching of basic knowledge in microbiology with main focus on Microbial Cell Structure and Function, Molecular Genetics, Microbial Growth, Metabolic Diversity, Phylogeny and Taxonomy, Prokaryotic Diversity, Human-Microbe Interactions, Biotechnology.
Objective
Teaching of basic knowledge in microbiology.
Content
Lecture notes
Die Behandlung der Themen erfolgt auf der Basis des Lehrbuchs Brock, Biology of Microorganisms

701-0243-01L Biology III: Essentials of Ecology W 3 credits 2V S. Güsewell, C. Vorburger
Abstract
This lecture presents an introduction to ecology. It includes basic ecological concepts and the most important levels of complexity in ecological research. Ecological concepts are exemplified by using aquatic and terrestrial systems; corresponding methodological approaches are demonstrated. In a more applied part of the lecture threats to biodiversity and the appropriate management are discussed.
Objective
The objective of this lecture is to teach basic ecological concepts and the different levels of complexity in ecological research: the individual, the population, the community and the ecosystem level. The students should learn ecological concepts at these different levels in the context of concrete examples from terrestrial and aquatic ecology. Corresponding methods for studying the systems will be presented.
A further aim of the lecture is that students achieve an understanding of biodiversity, why it is threatened and how it can be managed.
This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions.

**Abstract**

This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions. The topics covered range from different forms of selection, phylogenetic analysis, population genetics, life history theory, the evolution of sex, social evolution to human evolution. These topics are important for the understanding of a number of evolutionary problems in the basic and applied sciences.

**Content**

Topics likely to be covered in this course include research methods in evolutionary biology, adaptation, evolution of sex, evolutionary transitions, human evolution, infectious disease evolution, life history evolution, macroevolution, mechanisms of evolution, phylogenetic analysis, population dynamics, population genetics, social evolution, speciation and types of selection.

**Literature**

Textbook: Evolutionary Analysis
Scott Freeman and Jon Herron

**Prerequisites / notice**

The exam is based on lecture and textbook.

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**701-0245-00L**

**Introduction to Evolutionary Biology**

- **W** 2 credits
- **2V**

**Objective**

This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions. The topics covered range from different forms of selection, phylogenetic analysis, population genetics, life history theory, the evolution of sex, social evolution to human evolution. These topics are important for the understanding of a number of evolutionary problems in the basic and applied sciences.

**Content**

Topics likely to be covered in this course include research methods in evolutionary biology, adaptation, evolution of sex, evolutionary transitions, human evolution, infectious disease evolution, life history evolution, macroevolution, mechanisms of evolution, phylogenetic analysis, population dynamics, population genetics, social evolution, speciation and types of selection.

**Prerequisites / notice**

The exam is based on lecture and textbook.

---

**701-0023-00L**

**Atmosphere**

- **W** 3 credits
- **2V**

**Objective**

Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

**Content**

Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

**Literature**


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**701-0501-00L**

**Pedosphere**

- **W** 3 credits
- **2V**

**Objective**

Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

**Content**

Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

**Literature**


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**701-0401-00L**

**Hydrosphere**

- **W** 3 credits
- **2V**

**Objective**

Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.

**Literature**

- Aktuelle Naturschutzprobleme und -massnahmen
- Biodiversität: Variation, Ursachen, Gefährdung und Erhaltung
- Ökosysteme: Kompartimente, Stoff- und Energieflüsse
- Lebensgemeinschaften: Struktur, Stabilität, Sukzession
- Naturwissenschaften: Allgemeine Ökologie
- Naturschutzbiologie
- Aquatische Ökologie
- Pedosphere
- Aquatische Ökologie:

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**Lecture notes**

Unterlagen, Vorlesungsfolien und relevante Literatur sind in der Lehrdokumentenablage abrufbar. Die Unterlagen für die nächste Vorlesung stehen jeweils spätestens am Freitagmorgen zur Verfügung.
Topics of the course.
Physical properties of water (i.e. density and equation of state)
- global water resources
Exchange at boundaries
- energy (thermal & kinetic), gas exchange
Mixing and transport processes in open waters
- vertical stratification, large scale transport
- turbulence and mixing
- mixing and exchange processes in rivers
Groundwater and its dynamics
- ground water as part of the terrestrial water cycle
- ground water hydraulics, Darcy's law
- aquifers and their properties
- hydrochemistry and tracer
- ground water use
Case studies
- 1. Water as resource, 2. Water and climate

Lecture notes
in addition to the suggested literature handouts are distributed.

Literature
Suggested literature.

Prerequisites / notice
The case studies and the analysis of the questions and problems are integral part of the course.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0255-00L</td>
<td>Biochemistry</td>
</tr>
<tr>
<td>701-0423-00L</td>
<td>Chemistry of Aquatic Systems</td>
</tr>
<tr>
<td>701-0461-00L</td>
<td>Numerical Methods in Environmental Sciences</td>
</tr>
<tr>
<td>252-0021-00L</td>
<td>Introduction to Programming</td>
</tr>
</tbody>
</table>

**Biochemistry**

**Abstract**
Building on the biology courses in the 1st and 2nd semesters, this course covers basic biochemical knowledge in the areas of enzymology and metabolism. Those completing the course are able to describe and understand fundamental cellular metabolic processes.

**Objective**
Students are able to understand
- the structure and function of biological macromolecules
- the kinetic bases of enzyme reactions
- thermodynamic and mechanistic basics of relevant metabolic processes

Students are able to describe the relevant metabolic reactions in detail

**Content**
Introduction, basics, composition of cells, biochemical units, repetition of relevant organic chemistry
Structure and function of proteins
Carbohydrates
Lipids an biological membranes
Enzymes and enzyme kinetics
Catalytic strategies
Metabolism: Basic concepts and design. Repetition of basic thermodynamics
Glycolysis, fermentation
The citric acid cycle
Oxidative phosphorylation
Fatty acid metabolism

**Chemistry of Aquatic Systems**

**Abstract**
This course gives an introduction to chemical processes in aquatic systems and shows applications to various systems. The following topics are treated: acid-base reactions and carbonate system, solubility of solids and weathering, redox reactions, complexation of metals, reactions at the solid/water interface, applications to lakes, rivers and groundwater.

**Objective**
Understanding of chemical processes in aquatic systems. Quantitative application of chemical equilibria to processes in natural waters. Evaluation of analytical data from aquatic systems.

**Content**
Introduction to the chemistry of aquatic systems. Regulation of the composition of natural waters by chemical, geochemical and biological processes. Quantitative application of chemical equilibria to processes in natural waters. The following topics are treated: acid-base reactions, carbonate system; solubility of solid phases and weathering; complexation of metals and metal cycling in natural waters; redox reactions; reactions at the interface solid phase-water; applications to lakes, rivers, groundwater.

**Numerical Methods in Environmental Sciences**

**Abstract**
This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

**Objective**
This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

**Content**
Classification of numerical problems, introduction to finite-difference methods, time integration schemes, non-linearity, conservative numerical techniques, an overview of spectral and finite-element methods. Examples and exercises aimed at the realization of simple models.

**Introduction to Programming**

**Abstract**
Introduction to fundamental concepts of modern programming and operational skills for developing high-quality programs, including large programs as in industry. The course introduces software engineering principles with an object-oriented approach based on Design by Contract as present in Eiffel. For the second time we offer a supporting MOOC (online) version with more exercises and a hint system.
Objective

Many people can write programs. The "Introduction to Programming" course goes beyond that basic goal: it teaches the fundamental concepts and skills necessary to perform programming at a professional level. As a result of successfully completing the course, students master the fundamental control structures, data structures, reasoning patterns and programming language mechanisms characterizing modern programming, as well as the fundamental rules of producing high-quality software. They have the necessary programming background for later courses introducing programming skills in specialized application areas.

Content

Basics of object-oriented programming. Objects and classes. Pre- and postconditions, class invariants, Design by Contract. Fundamental control structures. Assignment and References. Basic hardware concepts. Fundamental data structures and algorithms. Recursion. Inheritance and deferred classes, introduction into event-driven design and concurrent programming. Basic concepts of Software Engineering such as the software process, specification and documentation, reuse and quality assurance.

Lecture notes

Textbook: "Touch of Class" (see under "Literatur")

The lecture slides are available for download on the course page.

Literature

Bertrand Meyer: Touch of Class: Learning to Program Well Using Objects and Contracts, Springer Verlag, 2009; new printing, 2012. This is the official textbook for the course. See http://www.polybuchhandlung.ch/100/con_liste.asp

Prerequisites / notice

The course uses an "Outside-In" approach enabling students, right from the beginning, to use an advanced graphical library and produce significant applications. Students then learn step by step how the library is built, as a source of imitation and inspiration.

The course covers not only basic concepts of programming but also some advanced topics seldom encountered in introductory courses, such as recursion, undecidability, event-driven programming, multiple inheritance and others.

5. Semester (Biochemical-Physical Direction)

Laboratory Courses, Semester Papers, Proseminars, Field Trips

Laboratory Courses arising upon specific written request by the students and permission by the Director of studies.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0450-00L</td>
<td>Semester Project</td>
<td>W</td>
<td>18 credits</td>
<td>18A</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Abstract

In a semester project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic.

Objective

Students are accustomed to scientific work and they get to know one specific research field.

Bachelor's Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0400-00L</td>
<td>Bachelor's Thesis</td>
<td>O</td>
<td>15 credits</td>
<td>15D</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Abstract

It completes the Bachelor program and consists of a scientific project carried out independently.

Objective

Encourages students to show independence, to produce scientifically structured work and to apply engineering working methods.

Second and Third Year Additional Subjects

For the Bachelor in Interdisciplinary Sciences students can in principle choose from all subjects taught at the Bachelor level at ETH Zurich.

At the beginning of the 2. year an individual study program is established for every student in discussion with the Director of Studies in interdisciplinary sciences. For details see Programme Regulations 2010.

Other Electives ETH

Further combinations of Compulsory elective subjects arising upon specific written request by the students and permission by the Director of studies.

Course Catalogue of ETH

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-CHAB.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Interdisciplinary Sciences Bachelor - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Interdisciplinary Sciences Master

For the Master in Interdisciplinary Sciences students can in principle choose from all subjects taught at the Master level at ETH Zurich.

At the beginning of the Master studies an individual study program is established for every student in discussion with the Director of Studies in interdisciplinary sciences. For details see Programme Regulations 2007.

▶ Majors

The students can choose from all Majors as provided by the following list: http://www.chab.ethz.ch/lehre/in_msc/index_EN

Furthermore it is also possible to create an individual Majors as specified in Art. 19 paragraph 3 of the Programme Regulations.

Selection of courses of ETH, according individual curriculum.

▶ General Courses

Selection of courses of ETH, according individual curriculum.

▶ Proseminars, Laboratory Courses, Research Projects and Sem. Papers

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0020-00L</td>
<td>Research Project</td>
<td>W</td>
<td>20 credits</td>
<td>20A</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Abstract
In a research project students extend their knowledge in a particular field, get acquainted with the scientific way of working, and learn to work on an actual research topic. Research projects are carried out in a core or optional subject area as chosen by the student.

Objective
Students are accustomed to scientific work and they get to know one specific research field.

▶ Compulsory Electives in Humanities, Social and Political Sciences

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Recommended GESS compulsory elective courses (Type B) for D-CHAB.

▶ Master Thesis

If more than 20 credits are acquired by the Master Thesis, select a course of the ETH course cataloque with similar content to the specific major of your study program. Registration by the study administration (HCI H201).

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-1000-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>20 credits</td>
<td>43D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract
In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is usually carried out in a core or optional subject area as chosen by the student.

Objective
In the Master Thesis students prove their ability to independent, structured and scientific working.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-1000-30L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30 credits</td>
<td>64D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract
In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is usually carried out in a core or optional subject area as chosen by the student.

Objective
In the Master Thesis students prove their ability to independent, structured and scientific working.

Interdisciplinary Sciences Master - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>W+</td>
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</tr>
<tr>
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<td>Eligible for credits</td>
</tr>
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### Key for Hours

<table>
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<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**

- European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
### Chemistry I

**Number:** 529-2001-02L  
**Title:** Chemistry I  
**Type:** O  
**ECTS:** 4 credits  
**Hours:** 2V+2U  
**Lecturers:** W. Uhlig, J. E. E. Buschmann, S. Canonica, P. Funck, E. C. Meister, R. Verel

**Abstract:**  
General Chemistry I: Chemical bond and molecular structure, chemical thermodynamics, chemical equilibrium.

**Objective:**  
Introduction to general and inorganic chemistry. Basics of the composition and the change of the material world. Introduction to the thermodynamically controlled physico-chemical processes. Macroscopic phenomena and their explanation through atomic and molecular properties. Using the theories to solve qualitatively and quantitatively chemical and ecologically relevant problems.

**Content:**  
1. Stoichiometry  
2. Atoms and Elements (Quantenmechanical Model of the Atom)  
3. Chemical Bonding  
4. Thermodynamics  
5. Chemical Kinetics  
6. Chemical Equilibrium (Acids and Bases, Solubility Equilibria)

**Lecture notes:** ca. 360 Seiten mit vielen Figuren und durchgerechneten Beispielen.

**Literature:**  
- Further reading: Brown, LeMay, Bursten CHEMIE (deutsch)
- Housecroft and Constable, CHEMISTRY (englisch)
- Oxtoby, Gillis, Nachtrieb, MODERN CHEMISTRY (englisch)

### Mathematics I

**Number:** 401-0251-00L  
**Title:** Mathematics I  
**Type:** O  
**ECTS:** 6 credits  
**Hours:** 4V+2U  
**Lecturers:** A. Cannas da Silva

**Abstract:**  
This course covers mathematical concepts and techniques necessary to model, solve and discuss scientific problems - notably through ordinary differential equations.

**Objective:**  
Mathematics is of ever increasing importance to the Natural Sciences and Engineering. The key is the so-called mathematical modelling cycle, i.e. the translation of problems from outside of mathematics into mathematics, the study of the mathematical problems (often with the help of high level mathematical software packages) and the interpretation of the results in the original environment.

The goal of Mathematics I and II is to provide the mathematical foundations relevant for this paradigm. Differential equations are by far the most important tool for modelling and are therefore a main focus of both of these courses.

**Content:**  
1. Single-Variable Calculus:  
   - review of differentiation, linearisation, Taylor polynomials, maxima and minima, antiderivative, fundamental theorem of calculus, integration methods, improper integrals.
   - systems of linear equations, Gauss-Jordan elimination, matrices, determinants, eigenvalues and eigenvectors, cartesian and polar forms for complex numbers, complex powers, complex roots, fundamental theorem of algebra.
   - separable ordinary differential equations (ODEs), integration by substitution, 1st and 2nd order linear ODEs, homogeneous systems of linear ODEs with constant coefficients, introduction to 2-dimensional dynamical systems.

**Literature:**  
- Bretscher, O.: Linear Algebra with Applications (Pearson Prentice Hall).

**Prerequisites / notice:**  
Prerequisites: familiarity with the basic notions from Calculus, in particular those of function and derivative.

**Assistance:**  
Mondays 12-13, Tuesdays 17-19, Wednesdays 17-19, in Room HG E 41.

### General Biology I

**Number:** 551-0001-00L  
**Title:** General Biology I  
**Type:** O  
**ECTS:** 3 credits  
**Hours:** 3V  
**Lecturers:** U. Sauer, A. Widmer

**Abstract:**  
Basics of structure, formation and function of cells and biomacromolecules, principles of metabolism, as well as basic classical and molecular genetics and evolutionary biology. First in a series of two lectures given over two semesters for students of agricultural and food sciences, as well as of environmental sciences.

**Objective:**  
The understanding of some basic principles of biology: the hierarchy of the structural levels of biological organisation, with particular emphasis on the cell and its functions, as well as metabolism, inheritance and evolution.
The structure and function of biomacromolecules; basics of metabolism; cell biology; membrane structure and function; basic energetics of cellular processes; respiration, photosynthesis; cell cycle, meiosis and sexual life cycles; Mendelian and molecular genetics; animal reproduction and behavior; sensory and motor mechanisms; population biology and evolution; principles of phylogeny.

The Campbell Chapters 1-4 (10th edition) under the heading “The role of chemistry in biology” are expected. We will treat the following Campbell chapters:

5 Biochemistry Biological Macromolecules and Lipids
7 Cell biology Cell Structure and Function
8 Cell biology Cell Membranes
10 Cell biology Cellular Respiration: An Introduction to Metabolism
10 Cell biology Cellular Respiration
11 Cell biology Photosynthesis
12 Cell Biology Mitosis
13 The Genetic Basis of Life Sexual Life Cycles and Meiosis
14 The Genetic Basis of Life Mendelian Genetics
15 The Genetic Basis of Life Linkage and Chromosomes
20 The Genetic Basis of Life The Evolution of Genomes
21 Evolution How Evolution Works
22 Evolution Phylogenetic Reconstruction
23 Evolution Microevolution
24 Evolution Species and Speciation
25 Evolution Macroevolution

Lecture notes no script
Prerequisites / notice The lecture is the first in a series of two lectures given over two semesters for students with biology as a basic subject.


Abstract
This lecture presents an introduction to ecology. It includes basic ecological concepts and the most important levels of complexity in ecological research. Ecological concepts are exemplified by using aquatic and terrestrial systems; corresponding methodological approaches are demonstrated. In a more applied part of the lecture threats to biodiversity and the appropriate management are discussed.

Objective
The objective of this lecture is to teach basic ecological concepts and the different levels of complexity in ecological research: the individual, the population, the community and the ecosystem level.

Content
- Übersicht der aquatischen und terrestrischen Lebensräume mit ihren Bewohnern
- Einfluss von Umweltfaktoren (Temperatur, Strahlung, Wasser, Nährstoffe etc.) auf Organismen; Anpassung an bestimmte Umweltbedingungen
- Populationsdynamik: Ursachen, Beschreibung, Vorhersage und Regulation
- Interaktionen zwischen Arten (Konkurrenz, Koexistenz, Prädation, Parasitismus, Nahrungsnetze)
- Lebensgemeinschaften: Struktur, Stabilität, Sukzession
- Ökosysteme: Kompartimente, Stoff- und Energieflüsse
- Biodiversität: Variation, Ursachen, Gefährdung und Erhaltung
- Aktuelle Naturschutzprobleme und -massnahmen
- Evolutionäre Ökologie: Methodik, Spezialisierung, Koevolution

Lecture notes Unterlagen, Vorlesungsmaterial und relevante Literatur sind in der Lehrdokumentenablage abrufbar. Die Unterlagen für die nächste Vorlesung stehen jeweils spätestens am Freitagmorgen zur Verfügung.

Literature
Generelle Ökologie:
Aquatische Ökologie:
Lampert & Sommer 1999. Limnökologie. Thieme, 2. Aufl., ca. Fr. 55.-;
Bohle 1995. Limnische Systeme. Springer, ca. Fr. 50.-
Naturschutzbiologie:

701-0025-00L Earth and Natural Production Systems O 5 credits 4V C. Schär, E. Fossard, C. Garcia, M. Sonneveld, B. Wehrli, S. Willett

Abstract
The lecture provides a science-based exploration of key aspects of our planet: from its formation, to its properties and resources (minerals, soils, climate, water, vegetation), to agricultural production.

Objective
Overview and understanding of key aspects of planet earth and its role for agricultural production, including consideration of current challenges such as climate change, water crises, deforestation, north-south conflict and biodiversity.

Content
Origin of the planetary system, composition of the earth and the atmosphere, formation of continents and oceans, biogeochemical cycles, plate tectonics and earthquakes, erosion, climate, water cycle, surface waters, vegetation, forests and crops, food production including related worldwide ecological and economical interactions.

Lecture notes Scripts provided by each teaching person.
Prerequisites / notice Further information: https://moodle-app2.let.ethz.ch/course/info.php?id=1682

701-0757-00L Principles of Economics O 3 credits 2G R. Schubert

Abstract
This course covers the bases for understanding micro- and macroeconomic issues and theories. Participants are given the tools to argue in economic and political terms and to evaluate the corresponding measures. Group and individual exercises during the course ensure that the knowledge gained.

Objective
Students are able to
- describe fundamental micro- and macroeconomic issues and theories.
- apply suitable economic arguments to a given theme.
- evaluate economic measures.

Content
Supply and demand behaviour of firm and households; market equilibrium and taxation; national income and indicators; inflation; unemployment; growth; macroeconomics policies

Lecture notes available on electronic platform
### Additional First Year Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>252-0839-00L</td>
<td>Informatics</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>L. E. Fässler, H.J. Böckenhauer, M. Dahinden, D. Korn</td>
</tr>
<tr>
<td></td>
<td>Abstract: Students learn to apply selected concepts and tools from computer science for working on interdisciplinary projects. The following topics are covered: publishing over the internet, processing and visualizing time series, visualizing multi-dimensional data, managing data with lists and tables and with relational databases, introduction to macro programming, universal methods for algorithm design.</td>
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<td>Objective: The students learn to</td>
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<td></td>
<td>- choose and apply appropriate tools from computer science,</td>
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<td></td>
<td>- process and analyze real-world data from their subject of study,</td>
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<td>- handle the complexity of real-world data,</td>
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<td>- know universal methods for algorithm design.</td>
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<tr>
<td>751-0801-00L</td>
<td>Biology I: Laboratory Exercises</td>
<td>O</td>
<td>1</td>
<td>2U</td>
<td>E. B. Truernit</td>
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<tr>
<td></td>
<td>Objective: Capability of preparing biological specimen, microscopy and documentation. Understanding the correlation between plant structure and function at the level of organs, tissues and cells.</td>
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<td>Measuring object sizes with the microscope. Preparation of specimen for light microscopy. Plant tissue staining techniques. Special features of plant cells: Plastids, vacuole, cell wall. Anatomy of seed plants: From cells to organs. Anatomy and function of various plant tissues (epidermis, vascular tissue, wood, etc.). Anatomy and function of different plant organs (root, stem, leaf, flower, fruit, seed). Anatomical adaptations to different environments.</td>
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<td>Lecture notes: Handouts</td>
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<td></td>
<td>Literature: For further reading (not obligatory): Gerhard Wanner; Mikroskopisch- Botanisches Praktikum, Georg Thieme Verlag, Stuttgart.</td>
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<td>Prerequisites / notice: Groups of a maximum of 30 students.</td>
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<tr>
<td>529-0030-00L</td>
<td>Laboratory Course: Elementary Chemical Techniques</td>
<td>O</td>
<td>3</td>
<td>6P</td>
<td>N. Kobert, M. Morbidelli</td>
</tr>
<tr>
<td></td>
<td>Abstract: This practical course provides an introduction to elementary laboratory techniques. The experiments cover a wide range of techniques, including analytical and synthetic techniques (e.g. investigation of soil and water samples or the preparation of simple compounds). Furthermore, the handling of gaseous substances is practised.</td>
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<td>Objective: This course is intended to provide an overview of experimental chemical methods. The handling of chemicals and proper laboratory techniques represent the main learning targets. Furthermore, the description and recording of laboratory processes is an essential part of this course.</td>
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</table>
The classification and analysis of natural and artificial compounds is a key subject of this course. It provides an introduction to elementary laboratory techniques, and the experiments cover a wide range of analytic and synthetic tasks:

Selected samples (e.g. soil and water) will be analysed with various methods, such as titrations, spectroscopy or ion chromatography. The chemistry of aqueous solutions (acid-base equilibria and solvation or precipitation processes) is studied.

Furthermore, the preparation and handling of environmentally relevant gaseous species like carbon dioxide or nitrogen oxides is a central subject of the Praktikum.

Lecture notes
The script will be published on the web.
Details will be provided on the first day of the semester.

Literature
A thorough study of all script materials is requested before the course starts.

751-0001-00L Introduction to the Study Program E- 0 credits 1V Lecturers
Abstract
Technical and organizational guidance to Freshmen.
Objective
Support to Freshmen in Agricultural Science and Food Sciences
Content
Information on:
Program structure, regulations, bachelor thesis, project work, practice and the importance of first year basics.
Organization: department, institutes, professorships and research, students' associations.

3. Semester

Basic Courses II: Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>402-0063-00L</td>
<td>Physics II</td>
<td>O</td>
<td>5</td>
<td>3V+1U</td>
<td>A. Vaterlaus</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to the &quot;way of thinking&quot; and the methodology in Physics, with the help of demonstration experiments. The Chapters treated are Electromagnetism, Refraction and Diffraction of Waves, Elements of Quantum Mechanics with applications to Spectroscopy, Thermodynamics, Phase Transitions, Transport Phenomena. Whenever possible, examples relevant to the students' main field of study are given.</td>
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<tr>
<td>Objective</td>
<td>Introduction to the scientific methodology. The student should develop his/her capability to turn physical observations into mathematical models, and to solve the latter.</td>
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<tr>
<td>Content</td>
<td>Elektromagnetismus, Elektromagnetische Wellen, Wellenoptik, Strahlenoptik, Quantenoptik, Quantenmechanik, Thermische Eigenschaften, Transportphänomen, Wärmestrahlung</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Skript wird verteilt.</td>
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</tr>
</tbody>
</table>
| Literature   | Friedhelm Kuypers
Physik für Ingenieure und Naturwissenschaftler
Band 2 Elektrizität, Optik, Wellen
Verlag Wiley-VCH, 2003, Fr. 77.- |
|              | Douglas C. Giancoli
Physik
3. erweiterte Auflage
Pearson Studium |
|              | Hans J. Paus
Physik in Experimenten und Beispielen
Carl Hanser Verlag, München, 2002, 1068 S. |
|              | Paul A. Tipler
Physik
Spektrum Akademischer Verlag, 1998, 1522 S., ca Fr. 120.- |
|              | David Halliday
Robert Resnick
Jearl Walker
Physik
Wiley-VCH, 2003, 1388 S., Fr. 87.- (bis 31.12.03) |
|              | dazu gratis Online Ressourcen (z.B. Simulationen): www.halliday.de |
| 701-0071-00L | Mathematics III: Systems Analysis O 4 credits 2V+1U N. Gruber, P. Landschützer |
| Abstract     | The objective of the systems analysis course is to deepen and illustrate the mathematical concepts on the basis of a series of very concrete examples. Topics covered include: linear box models with one or several variables, non-linear box models with one or several variables, time-discrete models, and continuous models in time and space. |
| Objective    | Learning and applying of concepts (models) and quantitative methods to address concrete problems of environmental relevance. Understanding and applying the systems-analytic approach, i.e., Recognizing the core of the problem - simplification - quantitative approach - prediction. |
| Content      | Content of lectures:
http://www.up.ethz.ch/education/system_analysis/index_DE |
| Lecture notes| Homework:
http://www.up.ethz.ch/education/system_analysis/SA2/index_DE |
| Literature   | Overhead slides:
http://www.up.ethz.ch/education/system_analysis/index_DE |
| 752-4001-00L | Microbiology           O 2 credits 2V M. Ackermann, M. Schuppler, J. Vorholt-Zambelli |
| Abstract     | Teaching of basic knowledge in microbiology with main focus on Microbial Cell Structure and Function, Molecular Genetics, Microbial Growth, Metabolic Diversity, Phylogeny and Taxonomy, Prokaryotic Diversity, Human-Microbe Interactions, Biotechnology. |
| Objective    | Teaching of basic knowledge in microbiology. |
| Content      | Der Schwerpunkt liegt auf den Themen: Bakterielle Zellbiologie, Molekulare Genetik, Wachstumspathophysiologie, Biochemische Diversität, Phylogenie und Taxonomie, Prokaryotische Vielfalt, Interaktion zwischen Menschen und Mikroorganismen sowie Biotechnologie. |
| Lecture notes| Wird von den jeweiligen Dozenten ausgegeben. |
Die Behandlung der Themen erfolgt auf der Basis des Lehrbuchs Brock, Biology of Microorganisms

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0255-00L</td>
<td>Biochemistry</td>
<td>O</td>
<td>2 credits</td>
<td>2V</td>
<td>H.P. Kohler</td>
</tr>
<tr>
<td>Abstract</td>
<td>Building on the biology courses in the 1st and 2nd semesters, this course covers basic biochemical knowledge in the areas of enzymology and metabolism. Those completing the course are able to describe and understand fundamental cellular metabolic processes.</td>
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<tr>
<td>Objective</td>
<td>Students are able to understand - the structure and function of biological macromolecules - the kinetic bases of enzyme reactions - thermodynamic and mechanistic basics of relevant metabolic processes Students are able to describe the relevant metabolic reactions in detail</td>
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<tr>
<td>Content</td>
<td>Program</td>
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<tr>
<td>Literature</td>
<td>H. P. Kohler</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Basic knowledge in biology and chemistry is a precondition.</td>
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</tbody>
</table>

752-6305-00L  Physiology and Anatomy I  O    2 credits  2V  W. Langhans

Abstract: Imparts a basic understanding of physiology and anatomy in man, focusing on the interrelations between morphology and function of the human organism. This is fostered by discussing all subjects from a functional point of view. One major topic of the lecture is food intake and digestion with its correlated chemosensory, endocrine and metabolic processes.

Objective: At the end of the course the students understand the basic functions of the organ systems and functionally important morphological features. One focus of the course is on aspects related to nutrition and overweight including the resulting diseases.

701-0225-00L  Organic Chemistry  O    2 credits  2V  K. McNeill

Abstract: Introduction to isomerism. Reaction mechanisms in organic chemistry (substitutions, additions, eliminations condensations) Biosynthesis of Terpenes.

Objective: The students are able to differentiate between structural and stereoisomers. The students know the basic reaction mechanisms in organic chemistry. They are able to understand and formulate simple biochemical reactions. They know the basics of the biosynthesis of terpenes.

Content: Isomerism (structural isomers, stereoisomers). Descriptive chemistry of natural products (glycerides, peptides, saccharides). Reaction mechanisms (substitutions, additions, eliminations, condensations). The citric acid cycle, the glyoxylate cycle. Biosynthesis of terpenes.

Literature: Carsten Schmuck, Basisbuch Organische Chemie, Pearson

Prerequisites / notice: Der Stoff der Basischemie wird vorausgesetzt.

Basic Courses II: Examination Block 2

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>751-1551-00L</td>
<td>Ressourcen- und Umweltökonomie</td>
<td>O</td>
<td>3 credits</td>
<td>2V</td>
<td>L. Bretschger, A. Müller</td>
</tr>
<tr>
<td>Abstract</td>
<td>Relationship between economy and environment, market failure, external effects and public goods, contingent valuation, internalisation of externalities; economics of non-renewable resources, economics of renewable resources, cost-benefit analysis, sustainability, and international aspects of resource and environmental economics.</td>
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</tbody>
</table>
Objective
Understanding of the basic issues and methods in resource and environmental economics; ability to solve typical problems in the field using the appropriate tools, which are concise verbal explanations, diagrams or mathematical expressions.

Topics are:
- Introduction to resource and environmental economics
- Importance of resource and environmental economics
- Main issues of resource and environmental economics
- Normative basis
- Utilitarianism
- Fairness according to Rawls
- Economic growth and environment
- Externalities in the environmental sphere
- Governmental internalisation of externalities
- Private internalisation of externalities: the Coase theorem
- Free rider problem and public goods
- Types of public policy
- Efficient level of pollution
- Tax vs. permits
- Command and Control Instruments
- Empirical data on non-renewable natural resources
- Optimal price development: the Hotelling-rule
- Effects of exploration and Backstop-technology
- Effects of different types of markets.
- Biological growth function
- Optimal depletion of renewable resources
- Social inefficiency as result of over-use of open-access resources
- Cost-benefit analysis and the environment
- Measuring environmental benefit
- Measuring costs
- Concept of sustainability
- Technological feasibility
- Conflicts sustainability / optimality
- Indicators of sustainability
- Problem of climate change
- Cost and benefit of climate change
- Climate change as international ecological externality
- International climate policy: Kyoto protocol
- Implementation of the Kyoto protocol in Switzerland

Content
- Economy and natural environment, welfare concepts and market failure, external effects and public goods, measuring externalities and contingent valuation, internalising external effects and environmental policy, economics of non-renewable resources, renewable resources, cost-benefit-analysis, sustainability issues, international aspects of resource and environmental problems, selected examples and case studies.

Lecture notes
The script and lecture material are provided at:
https://moodle-app2.let.ethz.ch/course/view.php?id=140

Literature

Basic Courses II: Additional Courses

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>752-0050-00L</td>
<td>Laboratory Course in Physics for Students in Food Sciences</td>
<td>O</td>
<td>2</td>
<td>4P</td>
<td>A. Biland, M. Münich</td>
</tr>
</tbody>
</table>

Abstract
The central aim is to provide an individual experience of the physical phenomena and the basic principles of the experiment. By conducting simple physical experiments the student will learn how to properly use physical instruments and how to evaluate the results correctly.

Objective
This laboratory course aims to provide basic knowledge of
- the setup of a physics experiment,
- the use of measurement instruments,
- various measuring techniques,
- the analysis or measurement errors,
- and the interpretation of the measured quantities.

Content
Fehlerrechnung, 9 ausgewählte Versuche zu folgenden Themen:


Die Auswahl der Versuche kann zwischen den verschiedenen Studiengängen variieren.

Lecture notes
Anleitungen zum Physikalischen Praktikum

752-4003-00L | Practical Course in Microbiology | O    | 2    | 3P    | M. Künzler |

Abstract
Basic principles of the handling of microorganisms (MO) - Detection of MO in the environment - Foodmicrobiology - Morphology and diagnostics of MO - Morphology and physiology of fungi - Antimicrobial agents - Microbial genetics - Bacterial physiology and interactions - Microbial pest control

Objective
The students are familiar with the laboratory work with microorganisms. Specific emphasis is put on the isolation and maintenance of pure cultures and the required hygiene measures. The students know the practical, clinical and ecological importance of microorganisms.

Content
In an introductory part students are made familiar with the handling and cultivation of microorganisms (MO). Afterwards, the students detect MO in the environment and use MO for the conservation of food. This part is then followed by a practical introduction on routine diagnostics of MO and experiments with antimicrobial agents. The part on diagnostics is complemented by an overview over the morphology and physiology of fungi. On experiments on plant-bacteria-interactions - a current research topic at the Institute of Microbiology - the students experience the interaction of MO with higher organisms. Some simple experiments demonstrate the importance of MO in molecular genetics. The course ends with an example of applied microbiology i.e. an experiment on microbial pest control.

Lecture notes
A detailed script of approx. 100 pp. and other relevant documents are available at https://moodle-app2.let.ethz.ch/course/view.php?id=1646 at latest 1 week before the beginning of the practical course.
Prerequisites / notice

Performance of the students in this practical course is controlled by:

1. Attendance of all 7 course days
2. Giving a short communication to a selected topic of Microbiology (in groups of 3 students)
3. Handing in of written reports to selected experiments (in groups of 2 students)

Participating PhD students who collect credit points during their thesis are examined in a 30-minute oral exam at the end of the course.

### Basics of Food Science

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>752-1100-00L</td>
<td>Food Analysis I</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>T. Gude</td>
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<tr>
<td>Objective</td>
<td>To understand the basic principles of analytical chemistry. To get acquainted with the principles and applications of important routine methods of instrumental food analysis (UV/VIS, IR, AAS, GC, HPLC);</td>
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<tr>
<td>Content</td>
<td>To understand the basic principles of analytical chemistry. To get acquainted with the principles and applications of important routine methods of instrumental food analysis (UV/VIS, IR, AAS, GC, HPLC);</td>
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</table>

Lecture notes
- The lectures are supplemented with handouts.

Literature
- a) Georg Schwedt, Analytische Chemie, 2. vollständig überarbeitete Auflage 2008
- b) R. Matthes, G. Steiner, M. Fischer, Lebensmittelanalytik, 5. Auflage 2014

### 5. Semester

#### Basics of Food Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>752-5001-00L</td>
<td>Food Biotechnology I</td>
<td>W</td>
<td>4 credits</td>
<td>3V</td>
<td>C. Lacroix, L. Meile, M. Stevens</td>
</tr>
<tr>
<td>Objective</td>
<td>The main goal for this course is to provide students with basic information for understanding biotechnology applied to food processing. For the students, the aim will be:</td>
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<tr>
<td>Content</td>
<td>Biotechnology has been defined as any technique that uses living organisms, or substances from those organisms, to make or modify a product, to improve plants or animals, or to develop microorganisms for specific uses. In this course, basic knowledge for understanding biotechnology as applied to food processing will be presented. This course builds on the application of principles learned from other basic courses in the Bachelor program, especially microbiology and microbial metabolism, molecular biology, biochemistry, physics and engineering. Students will learn about the physiology of important productive microorganisms (lactococci, bifidobacteria, propionibacteria and fungi) used in food fermentations, closely related to applications in biotechnology. Microbial kinetics, and design and operation of bioreactors used for both research and industrial scale production of traditional foods and modern food ingredients will be presented. This part will be illustrated by examples of food fermentation processes, representative of specific challenges. Finally, the application of modern molecular tools to food biotechnology will be discussed.</td>
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Lecture notes
- A complete course document and/or a copy of the power point slides from each lecture will be provided.

Literature
- a) Georg Schwedt, Analytische Chemie, 2. vollständig überarbeitete Auflage 2008
- b) R. Matissek, G. Steiner, M. Fischer, Lebensmittelanalytik, 5. Auflage 2014

### Autumn Semester 2015

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-6001-00L</td>
<td>Introduction to Nutritional Science</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>M. B. Zimmermann, C. Wolfrum</td>
</tr>
<tr>
<td>Objective</td>
<td>To introduce the students to the both macro- and micronutrients in relation to food and metabolism.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>The course is divided into two parts. The lectures on micronutrients are given by Prof. Zimmermann and the lectures on macronutrients are given by Prof. Wolfrum. Prof. Zimmermann discusses the micronutrients, including fat-soluble vitamins, water-soluble vitamins, minerals and trace elements. Prof. Wolfrum introduces basic nutritional aspects of proteins, fats, carbohydrates and energy metabolism. The nutrients are described in relation to digestion, absorption and metabolism. Special aspects of homeostasis and homeorhesis are emphasized.</td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Lecture notes
- There is no script. Powerpoint presentations will be made available.

Literature
- Elmadfa I & Leitzmann C: Ernährung des Menschen
- UTB Ulmer, Stuttgart, 4. überarb. Ausgabe 2004
- Garrow JS and James WPT: Human Nutrition and Dietetics
- Churchill Livingstone, Edinburgh, 11th rev. ed. 2005

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-4005-00L</td>
<td>Food Microbiology I</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>M. Loesnner</td>
</tr>
<tr>
<td>Objective</td>
<td>This lecture is the first part of a one-year course. It offers insights into the fundamentals and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts and molds present in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>This lecture offers insights into the basics, practical consequences and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts, molds and protozoa in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms.</td>
<td></td>
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</tbody>
</table>

Data: 06.02.2019 13:00
Autumn Semester 2015
Content
1. History of Food Microbiology
   1.1. Short synopsis of foodborne microorganisms
   1.2. Spoilage of Foods
   1.3. Foodborne Disease
   1.4. Food Preservation
   1.5. VIP’s of Food Microbiology
2. Overview of Microorganisms in Foods
   2.1. Origin of foodborne Microorganisms
   2.2. Bacteria
   2.3. Yeasts
   2.4. Molds
3. Microbial Spoilage of Foods
   3.1. Intrinsic and Extrinsic Parameters
   3.2. Meats, Seafoods, Eggs
   3.3. Milk and Milk Products
   3.4. Vegetable and Fruit Products
   3.5. Miscellaneous (baked goods, nuts, spices, ready-to-eat products)
   3.6. Drinks and Canned Foods
4. Foodborne Disease
   4.1. Significance and Transmission of Foodborne pathogens
   4.2. Staphylococcus aureus
   4.3. Gram-positive Sporeformers (Bacillus & Clostridium)
   4.4. Listeria monocytogenes
   4.5. Salmonella, Shigella, Escherichia coli
   4.6. Vibrio, Yersinia, Campylobacter
   4.7. Brucella, Mycobacterium, Aeromonas, Plesiomonas
   4.8. Parasites
   4.9. Viruses and Bacteriophages
   4.10. Mycotoxins
   4.11. Bioactive Amines
   4.12. Miscellaneous (Antibiotic-resistant Bacteria, Biofilms)

Lecture notes
Electronic copies of the presentation slides (PDF) will be made available for download.

Literature
Recommendations will be given in the first lecture

Food Science General Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-1101-00L</td>
<td>Finances and Accounting System</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>M. Dumondel</td>
</tr>
<tr>
<td>Abstract</td>
<td>To understand accounting as a component of the complex system of the enterprise</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>To understand accounting not as an isolated discipline, but as a part of the complex system of the enterprise</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>Accounting system as a part of management economics. The different steps for scheduling and evaluation of the accountancy will be studied. The main part of the lecture is dedicated to the financial accounting nevertheless the fundamentals of the internal cost-accounting will also be presented. The lecture will also include the clarification of concrete cases and the calculation of practical exercises.</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Lecture notes</td>
<td>Course documentation and specified educational books</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literature</td>
<td>In the lecture one indicates</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0317-00L</td>
<td>Immunology I</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>A. Oxenius, M. Kopf</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>Introduction into structural and functional aspects of the immune system. Basic knowledge of the mechanisms and the regulation of an immune response.</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
| Content      | - Introduction and historical background
   - Innate and adaptive immunity, Cells and organs of the immune system
   - B cells and antibodies
   - Generation of diversity
   - Antigen presentation and Major Histoincompatibility (MHC) antigens
   - Thymus and T cell selection
   - Autoimmunity
   - Cytotoxic T cells and NK cells
   - Th1 and Th2 cells, regulatory T cells
   - Allergies
   - Hypersensitivities
   - Vaccines, immune-therapeutic interventions |
| Lecture notes| Electronic access to the documentation will be provided. The link can be found at "Lernmaterialien" |
| Prerequisites / notice | Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a "Sessionsprüfung". |

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-1307-00L</td>
<td>Managerial Economics Agri-Food Chain: Strategic Concepts</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>B. Höltchi, M. Weber</td>
</tr>
<tr>
<td>Abstract</td>
<td>Learn and exercise strategic concepts in the Agri-Food chain, i.e. theories of economics based decision making combined with entrepreneurial practice.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>The main objective is to understand strategic decisions along the value chain in the Agri-Food Chain.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Content      | - Basics of strategy & strategic concepts
   - Classic process of strategy process
   - Selected alternative processes
   - Case studies |
| Lecture notes| Dokuments will be distributed per lecture. |
| Literature   | Lombriser Roman & Aplanalp Peter: Strategisches Management |

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-2120-00L</td>
<td>Consumer Behaviour I</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>M. Siegrist, C. Keller, B. S. Sütterlin</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction in consumer research. The following aspects will be emphasized in the course: Consumer decision making, individual determinants of consumer behavior, environmental influences on consumer behavior, influencing consumer behavior</td>
<td></td>
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</tbody>
</table>

Autumn Semester 2015
### Food Chemistry II

**Objective**: To familiarize with the structure, properties and reactivity of food constituents. To understand the relationship between the multiple chemical reactions and the quality of food.

**Content**: Descriptive chemistry of food constituents (proteins, lipids, carbohydrates, plant phenolics, flavour compounds).

Reactions which affect the colour, flavour, texture, and the nutritional value of food raw materials and food products during processing, storage and preparation in a positive or in a negative way (e.g. lipid oxidation, Maillard reaction, enzymatic browning).

Links to food analysis, food processing, and nutrition.

**Lecture notes**: The lectures are supplemented with handouts.


### Food Analysis II

**Objective**: To get acquainted with the principles and applications of mass spectrometry in food analytics.

**Content**: Main focus: Mass spectrometry, applications of mass spectrometry (MS).

**Lecture notes**: The lectures are supplemented with handouts.

### Food Process Engineering II

**Objective**: To procure students with the basics of mechanical process engineering with main focus on mechanical unit operations used in the food industry.

**Content**: Training in mechanical unit operations and understanding of their application in food processing.

**Lecture notes**: Script and slides, online available.

**Literature**: - Matthias Stiess, *Mechanische Verfahrenstechnik Band, 1 & 2*, Springer Verlag
  - F. Löffler, J. Raasch, *Grundlagen der Mechanischen Verfahrenstechnik*, Vieweg Verlag

### Food Materials Science

**Objective**: Understanding the fundamental physical principles ruling the self-assembly, aggregation, processing and structure-properties relationship in food systems constituted by polysaccharides (polymers), proteins (colloids) and lipids (surfactants).

**Content**: Principles of soft condensed matter applied to food polymers, surfactants and colloids

**Lecture notes**: Wird am Praktikumsanfang abgegeben.

**Literature**: - Krämer: "Lebensmittel-Mikrobiologie" (Ulmer; UTB)

### Physiology and Anatomy III

**Objective**: Imparts a basic understanding of physiology and anatomy in man, focusing on the interrelations between morphology and function of the human organism. This is fostered by discussing all subjects from a functional point of view. One major topic of the lecture is food intake and digestion with its correlated chemosensory, endocrine and metabolic processes.

**Content**: At the end of the course the students understand the basic functions of the organ systems and functionally important morphological features. One focus of the course is on aspects related to nutrition and overweight including the resulting diseases.

### Bachelor Thesis

**Objective**: The Bachelor Thesis completes the Bachelor programme and consists of a scientific project carried out independently under the tutorship of a lecturer at D-HEST.

**Prerequisites / notice**: During the course we will work with the food-borne pathogen Listeria monocytogenes. Listeria monocytogenes represents a particular threat in case of pregnancy. Due to biosafety reasons participation is not allowed in case of pregnancy.

### Bachelor's Thesis

**Objective**: THE ENROLLMENT IS DONE BY THE STUDY ADMINISTRATION OFFICE

**Abstract**: The Bachelor Thesis completes the Bachelor programme and consists of a scientific project carried out independently under the tutorship of a lecturer at D-HEST.
Objective
The Bachelor Thesis aims at fostering the student's ability to independent, structured and scientific working and at deepening their knowledge in a specific field.

Complementary Courses
No acquisition of credits

<table>
<thead>
<tr>
<th>Food Science Bachelor - Key for Type</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>O Compulsory</td>
<td>E- Recommended, not eligible for credits</td>
</tr>
<tr>
<td>W+ Eligible for credits and recommended</td>
<td>Z Courses outside the curriculum</td>
</tr>
<tr>
<td>W Eligible for credits</td>
<td>Dr Suitable for doctorate</td>
</tr>
</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>V lecture</th>
<th>P practical/laboratory course</th>
</tr>
</thead>
<tbody>
<tr>
<td>G lecture with exercise</td>
<td>A independent project</td>
</tr>
<tr>
<td>U exercise</td>
<td>D diploma thesis</td>
</tr>
<tr>
<td>S seminar</td>
<td>R revision course / private study</td>
</tr>
<tr>
<td>K colloquium</td>
<td></td>
</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System
Special students and auditors need special permission from the lecturers.
### Educational Science

#### Food Science TC
**Detailed information on the programme at:** [www.didaktischeausbildung.ethz.ch](http://www.didaktischeausbildung.ethz.ch)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0240-00L</td>
<td>Human Learning (EW1)</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>E. Stern</td>
</tr>
</tbody>
</table>

**Abstract**
This course looks into scientific theories and also empirical studies on human learning and relates them to the school.

**Objective**
Anyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.

**Content**

**Literature**

**Lecture notes / Prerequisites / notice**
- For a smooth semester planning, early registration and personal attendance at the first lecture meeting is requested.
- Folien werden zur Verfügung gestellt.
- Lecture notes
- Literature
- Prerequisites / notice
- Number of participants limited to 20.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0242-06L</td>
<td>Cognitive Activating Instructions in MINT Subjects</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>R. Schumacher</td>
</tr>
</tbody>
</table>

**Abstract**
This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

**Objective**
- Get to know cognitive activating instructions in MINT subjects
- Get information about recent literature on learning and instruction

**Prerequisites / notice**
- Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0242-07L</td>
<td>Human Intelligence</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>E. Stern, E. Ziegler</td>
</tr>
</tbody>
</table>

**Abstract**
This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

**Objective**
- Understanding research methods used in the empirical human sciences
- Getting to know intelligence tests
- Understanding findings relevant for education

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler</td>
</tr>
</tbody>
</table>

**Abstract**
This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

**Objective**
- Understanding research methods used in the empirical educational sciences
- Understand and critically examine information from scientific journals and media
- Understand pedagogically relevant findings from the empirical educational sciences

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0242-22L</td>
<td>Coping with Psychosocial Demands of Teaching (EW 4)</td>
<td>W</td>
<td>2</td>
<td>3S</td>
<td>A. Deiglmayr, P. Greutmann, S. Hofer</td>
</tr>
</tbody>
</table>

**Abstract**
This lecture is only apt for students who intend to enrol in the programs "Lehrdipлом" or "Didaktisches Zertifikat". It is about learning in childhood and adolescence.

**Prerequisites / notice**
- Enrollment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).

**Number of participants limited to 30.

**Objective**
- Get information about recent literature on learning and instruction

**Prerequisites / notice**
- Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

**Number of participants limited to 20.

**Objective**
- Understand pedagogically relevant findings from the empirical educational sciences
- Understand and critically examine information from scientific journals and media
- Understand pedagogically relevant findings from the empirical educational sciences
The successful participation in EW1 ("Human Learning") and EW2 ("Designing Learning Environments for School") is recommended, but not a mandatory prerequisite.

Abstract
In this class, students will learn concepts and skills for coping with psychosocial demands of teaching.

Objective
Students possess theoretical knowledge and practical competences to be able to cope with the psychosocial demands of teaching.

(1) They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents).

(2) They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions).

Subject Didactics and Professional Training

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-9020-00L</td>
<td>Teaching Internship Including Examination Lessons Food Science</td>
<td>W</td>
<td>6</td>
<td>13P</td>
<td>G. Kaufmann</td>
</tr>
</tbody>
</table>

The teaching internship can just be visited if all other courses of TC are completed.

Repetition of the teaching internship is excluded even if the examination lessons are to be repeated.

Abstract
Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as assessed as Examination Lessons.

Objective
- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils’ work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Content

Die Themen für die beiden Prüfungslektionen am Schluss des Praktikums erfahren die Studierenden in der Regel eine Woche vor dem Prüfungstermin. Sie erstellen eine Vorbereitung gemäss Anleitung und reichen sie bis am Vortrag um 12 Uhr den beiden Prüfungsexperten (Fachdidaktiker/-in, Departementsvertreter/-in) ein. Die gehaltenen Lektionen werden kriteriumsorientiert bewertet. Die Beurteilung umfasst auch die schriftliche Vorbereitung und eine mündliche Reflexion des Kandidaten/der Kandidatin über die gehaltenen Lektionen im Rahmen eines kurzen Kolloquiums.

Lecture notes
Dokument; schriftliche Vorbereitung für Prüfungslektionen.

Further Subject Didactics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-9005-00L</td>
<td>Mentored Work Specialised Courses in the Respective Subject with an Educational Focus Food Sc.</td>
<td>O</td>
<td>2</td>
<td>4A</td>
<td>G. Kaufmann, K. Koch, U. Lerch</td>
</tr>
</tbody>
</table>

Abstract
In the mentored work on their subject specialisation, students link high-school and university aspects of the subject, thus strengthening their teaching competence with regard to curriculum decisions and the future development of the tuition. They compile texts under supervision that are directly comprehensible to the targeted readers - generally specialist-subject teachers at high-school level.

Objective
- To familiarise themselves with a new topic by obtaining material and studying the sources, so that they can selectively extend their specialist competence in this way.
- To independently develop a text on the topic, with special focus on its mathematical comprehensibility in respect of the level of knowledge of the targeted readership.
- To try out different options for specialist further training in their profession.

Content
Thematische Schwerpunkte:

Lernformen:

Lecture notes
Eine Anleitung zur mentorierten Arbeit in FV wird zur Verfügung gestellt.

Literature
Die Literatur ist themenspezifisch. Sie muss je nach Situation selber beschafft werden oder wird zur Verfügung gestellt.

Prerequisites / notice
Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 822 of 1434
<table>
<thead>
<tr>
<th>Key for Hours</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Disciplinary Subjects

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
752-3103-00L | **Food Rheology I** | W+ | 3 credits | 2V | P. A. Fischer

**Abstract**
Rheology is the science of flow and deformation of matter such as polymers, dispersions (emulsions, foams, suspensions), and colloidal systems. The fluid dynamical basis, measuring techniques (rheometry), and the flow properties of different fluids (Newtonian, non-Newtonian, viscoelastic) are introduced and discussed.

**Objective**
The concept of rheological constitutive equations and the application to different material classes. The course provides an introduction on the link between flow and structural properties of flowing material. Rheometrical techniques and appropriate measuring protocols for the characterization of complex fluids will be discussed.

**Content**
Lectures will be given on general introduction (4h), fluid dynamics (4h), complex flow behavior (4h), influence of temperature (2h), rheometers (4h), rheological tests (6h) and structure and rheology of complex fluids (4h).

**Lecture notes**
Notes will be handed out during the lectures.

**Literature**
Provided in the lecture notes.

---

752-2003-00L | **Selected Topics in Food Technology** | W+ | 3 credits | 2V | J. Ubbink

**Abstract**
The focus of the lecture course is on both broadening and deepening the knowledge on food technology, and on providing an introduction to the context in which the food technologist will operate. The lecture course is developed from the perspective of the food technologist and the food developer, and will recapitulate and extend practical as well as fundamental aspects of food technology.

**Objective**
- To revive the knowledge of the basic operations of food technology and to become acquainted with the principles and use of several advanced technologies,
- To be able to quantitatively apply physical principles in the optimization of food processing and in the prediction of the shelf life of foods,
- To be able to assess and select technologies to achieve specific aims in food processing and development,
- To develop a basic understanding of contextual aspects impacting the work practice of food technologists and food developers,
- To gain experience in the development of an R&D project in the wider food area.

**Content**
Introduction

I.1 Historical aspects of food technology
I.2 Processes, ingredients, products, systems
I.3 Food technology and food science
I.4 Impact of food technology on the modern diet
I.5 Global food: current situation and possible trends

II. Engineering approaches in food technology
II.1 Phase transitions in foods
II.2 The state diagram
II.3 The state diagram in relation to food processing and food stabilization
II.4 Materials science of water in foods
II.5 Encapsulation and delivery of bioactive ingredients

III. Food technology context
III.1 Elements of project management
III.2 Intellectual property
III.3 Food technology and nutrition
III.4 Interface with food sustainability
III.5 Cooking & artisanal food preparation

IV. Project work
IV.1 Idea formulation
IV.2 Exploration of scientific and technological background
IV.3 Development of project approaches
IV.4 Presentation of project and preparation of written proposal

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752-2314-00L | **Physics of Food Colloids** | W+ | 3 credits | 2V | P. A. Fischer, R. Mezzenga

**Abstract**
In Physics of Food Colloids the principles of colloid science will applied to the aggregation of food material such as proteins, polysaccharides, and emulsifiers. Mixtures of such raw material determine the appearance and performance of our daily food. Examples of colloidal laws at work will link food colloid science to the manufacturing and processing of food.

**Objective**
The aggregation of food raw material determine to appearance and performance of a complex food system as far as nutritional aspects. The underlying colloidal laws are reflecting the structure of the individual raw material (length scale, character of the interacting forces).

Once those concepts are appreciated the aggregation of most food systems falls into recognizable patterns that can be used to modify and structure exiting food or to design new products. The application and use of those concepts are discussed in light of common food production.

**Content**
Lectures will be given on interfacial tension (4h), protein aggregation in bulk and interfaces (4h), Pickering emulsions (2h), polysaccharides (2h), aggregation of complex mixtures (4h), foams (2h), and the use of light scattering in investigation complex food structures (6h).

**Lecture notes**
Notes will be handed out during the lectures.

**Literature**
Provided in the lecture notes.

---

752-3021-00L | **Food Process Design and Optimization** | W+ | 4 credits | 2G | E. J. Windhab

**Abstract**

Training by case studies from research and industrial production.

**Objective**
Quantitative process analysis and derivation of process-structure functions for complex liquid or semi-liquid food systems with non-Newtonian flow properties. Handling of optimisation and up-/down-scaling procedures.

**Content**
S-PRO2 scheme, reverse engineering approach, dimension analysis, Metzner-Otto and Rieger-Neubert design schemes of stirred reactors for non-Newtonian fluid processing, mixing/mixing statistics, mixing characteristics, power characteristics, dispersing characteristics, dispersing processes in rotor/stator and membrane devices, spray processing, extrusion processing, diverse case studies for design and scaling of processes for food structure processing

**Lecture notes**
printed handouts (ca. 180)

**Literature**
List of ca. 30 papers and 5 books given in course
Process Measurements and Automation  
Overview on Process Automation, Information Management in processes, process data handling and analysis, In-line measurements of complex food systems, Process control schemes, Overview of sensors and sensor principles, integrated process control case studies  
Understanding the interplay of in-line measurements of complex food properties in processes, process data handling and data analysis as well as building blocks for process control.  
Overview Process Automation, Process Control and process data management, Industrial design of automated/controlled processes, overview on sensors/sensor principles, case studies of in-line measurements and control in/of food production processes  
Printed script (120 pages, 80 figures), diverse publications  
List of publications and books given in course  
VT I-III  

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<td>2V+1U</td>
<td>L. Meier</td>
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<td>Key concepts of experimental design. Planning and analysis of single factor experiments, block designs, full factorial and fractional designs, split-plot and strip-plot designs. Random effects and mixed effects models.</td>
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<td>W+</td>
<td>5</td>
<td>2V+1U</td>
<td>M. Dettling</td>
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<td>This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning &quot;good practice&quot; that can be applied in every student's own projects and daily work life.</td>
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<td>The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.</td>
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<tr>
<td></td>
<td>A script will be available.</td>
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</table>
|              | Faraway (2005): Linear Models with R  
Faraway (2006): Extending the Linear Model with R  
Draper & Smith (1998): Applied Regression Analysis  
Fox (2008): Applied Regression Analysis and GLMs  
Montgomery et al. (2006): Introduction to Linear Regression Analysis |      |      |               |           |
|              | The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held. |      |      |               |           |
|              | In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit. |      |      |               |           |

Special Topics in Toxsiology  
Journal-club style course involving student presentations and active discussion and critique of recent publications and modern experimental strategies. The focus is on chemical, biochemical, and nutritional aspects of selected topics in Toxicology, with a new group of topics addressed each semester  
-to stimulate student interest and provide advanced knowledge of current research in Toxicology and its related sciences  
-to develop skills in critical evaluation of scientific literature, oral presentation and questioning  
-to understand modern experimental techniques and research approaches relevant in toxicology  
The journal-club style course involves student presentations and active discussion of recent publications. The primary focus is on chemical, biochemical, and nutritional aspects of selected current topics in Toxicology. Participants are masters or PhD students in Food Sciences and related disciplines (i.e. Chemistry, Biochemistry, Pharmaceutical Sciences, etc.).  
A selection of approximately 20 papers from recent primary scientific literature.
Prerequisites / notice

The course is open to Masters or PhD level students.

For Masters level participants, a strict prerequisite is (a) previously taken and passed "Introduction to Molecular Toxicology" (752-1300) and/or (b) previous courses supporting equivalent knowledge plus permission from the instructor. Please contact the instructor before the start of the class, explaining the basis of your previous knowledge other than the Introduction course, to request special permission. If you would like to take "Special Topics in Toxicology", do not register at the same time for "Advanced Topics in Toxicology". It is only possible to take one, and it is only possible to take the advanced level after completing this course.

752-1302-00L Advanced Topics in Toxicology W 2 credits 2G S. J. Sturla

Abstract

Journal-club style course that involves student presentations of selected topics in Toxicology on the basis of current primary research and review papers.

Objective

The goals are to stimulate student interest and provide advanced knowledge of current research in the interdisciplinary area of Food and Nutrition Toxicology and its related sciences. The student should develop skills in the critical evaluation of scientific literature, oral presentation and questioning, and understanding modern experimental techniques in Molecular Toxicology.

Content

The journal-club style course involves student presentations of recent publications. The primary focus is on chemical and biochemical aspects of selected topics in Toxicology. Participants are generally masters or PhD students in Food Sciences and related disciplines (i.e. Chemistry, Pharmaceutical Sciences, etc.), and strong knowledge of organic chemistry and biochemistry are prerequisite. Selected course topics change every semester.

Prerequisites / notice

Participants are required to have completed previously "Special Topics in Toxicology" (752-1301-00L). Both courses are run concurrently every semester. It is only possible to register for one course at a time. Do not register for "Advanced Topics in Toxicology" until after you have completed "Special Topics in Toxicology"

Introduction to the EU and in the area of food safety (Directorate General SANCO, regulation on food safety), legislative procedure in the EU, introduction into the relevant bilateral agreements CH-EU, introduction into international organisations (e.g. Codex Alimentarius), general principles of the Swiss food law and the most important regulations as well as the most important legal procedures, legal settlement and the duties and responsibilities of the Food control authorities.

The lecture will be held in German.

Qualifications: General knowledge of the food sciences.

The lectures are supplemented with handouts.

Course prerequisites: Food Chemistry I/II and Food Analysis I/II (or equivalent)

752-4009-00L Molecular Biology of Foodborne Pathogens W+ 3 credits 2V M. Loessner, M. Schuppler

Abstract

The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.

Objective

Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks.

Content

Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks?

Lecture notes

Electronic copies of the presentation slides (PDF) will be made available for download to registered students.

Literature

Recommendations will be given in the first lecture

Prerequisites / notice

Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until 11:15 h), with no break.

752-5103-00L Functional Microorganisms in Foods W+ 3 credits 2G C. Lacroix, T. de Wouters, L. Meile, C. Schwab

Abstract

This integration course will discuss new applications of microorganisms with functional properties in food and functional food products. Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of functional microorganisms to produce food with high quality, safety and potential health benefits for consumers.

Objective

To understand the principles, roles and mechanisms of microorganisms with metabolic activities of high potential for application in traditional and functional foods utilization with high quality, safety and potential health benefits for the consumers. This course will integrate basic knowledge in food microbiology, microbial physiology, biochemistry, and technology.

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 826 of 1434
This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products and characterization of functionality and safety of food bacteria. Specialists from the Laboratory of Food Biotechnology, as well as invited speakers from the industry will contribute to the selected topics as follows:

- Probiotics and Prebiotics: Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.

- Bioprotective Cultures and Antimicrobial Metabolites: Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.

- Legal and Protection Issues Related Functional Foods

- Industrial Biotechnology of Flavor and Taste Development

- Safety of Food Starter Cultures and Probiotics

Students will be required to complete a group project on food products and ingredients which of with from functional bacteria. The project will involve information research and analysis followed by an oral presentation and short written report.

**Methodology Subjects**

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**Literature**

The course starts with the basics of linear regression modeling, and then proceeds to parameter estimation, tests and confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, categorical input variables, shrinkage and general modeling strategies.

The last third of the course is dedicated to an introduction into generalized linear regression models: this includes logistic regression for binary response variables, Poisson regression for count data, cumulative logit models for ordered, and multinomial regression for categorical response variables.

A script will be available.

This course will provide knowledge and biological background on genetically modified organisms (GMO) and food produced with the help of GMO, especially on the molecular basis of GMO constructions with emphasis on genetically modified food in Switzerland and the EU. Criteria of rationale food safety and health assessment in agriculture and food consumption will be elaborated.

Overview on application in gene technology, the gene transfer potential of bacteria, plants and other organisms and the mostly used transgenes in food as well as on GMO used for food production and their detection technologies in food; food safety assessment of GMO food; information on the legislation in Switzerland and EU-countries.

Copies of slides from lectures will be provided

Actual publications from literature will be provided

Good knowledge in biology, especially in microbiology and molecular biology are prerequisites. Some contents will be provided by registered students who will individually or as a group present an actual publication.

This course is open to Master and MAS students in food and science and nutrition or related. Basic knowledge of food chemistry and nutrition is expected, as well as an understanding of food processing.

Students should be able to
- describe and compare the major concepts/criteria used for the evaluation of the nutritional quality of food
- apply these criteria when assessing the effects of selected processing technologies on nutritional quality.

The course gives inputs on compositional changes in food due to processing (with focus on thermal/chilling, enzymatic, chemical, emerging technologies) or new formulation strategies. Possible evaluation methods for these changes (e.g. nutritional profile) will be addressed.

There is no script. Powerpoint presentations and relevant scientific articles will be available on-line for students. A selection of recommended readings will be given at the beginning of the course.

The course is open to Master and MAS students in food and science and nutrition or related. Basic knowledge of food chemistry and nutrition is expected, as well as an understanding of food processing.

The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented.

Students are able
- to evaluate the scientific evidence on the effects of diet on human health
- to describe the role of nutritional factors in the prevention of chronic diseases
- to assess the nutritional status of a population (Switzerland taken as an example)
- to put forward preventive measures addressing individuals but also our society in relation to the obesity epidemic.
Content
The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented. Switzerland taken as an example, the health risks associated with our nutritional habits will be evaluated. Finally, examples of preventive measures addressing individuals but also the society in relation to the obesity epidemic and other threats to health are discussed.

752-6402-00L
Nutrigenomics
Nutrigenomics - toward personalized nutrition?
Breakthroughs in biology recently led nutrition scientists to apply modern tools (genomics, transcriptomics, proteomics, metabolomics, genetics, epigenetics) to the analysis of the interactions of food with humans. The lecture presents these tools and illustrates their application in selected topics relevant to human nutrition and food sciences.

Objective
- Overall understanding of the transdisciplinary research being conducted under the term nutrigenomics.
- Overall understating of the omics technologies used in nutrigenomics and their applications to human nutrition and food science.
- Ability to critically evaluate the potential and risks associated with the field of nutrigenomics

Content
- Overall understanding of the transdisciplinary research being conducted under the term nutrigenomics.
- The lecture is completed by an optional project entitled 'Personalized Nutrition' in which the students have the opportunity to receive a personalized nutritional guidance that is based on their own genetic makeup. The scientific literature on which the genetic tests are based is presented by the students during the lecture.

Lecture notes
The script is composed of circa 450 slides (ca 18 slides/lecture) organized in 9 modules

Module A
From biochemical nutrition research to nutrigenomics

Module B
Nutritional genomics

Module C
Nutrigenetics

Module D
Nutri-epigenomics

Module E
Transcriptomics in nutrition research

Module F
Proteomics in nutrition research

Module G
Metabolomics in nutrition research

Module H
Nutritional systems biology

Module I
Individualized nutrition - opportunities and challenges

Literature
No extra reading requested. Most slides in the lecture are referenced with web addresses.

Prerequisites / notice
Basic training in biochemistry, molecular biology, physiology, and human nutrition. Interest in interdisciplinary sciences linking molecular biology to human health. Interest in the application of analytical laboratory methods to the understanding of human biology, in particular nutrition.

752-1301-00L
Special Topics in Toxicology
Journal-club style course involving student presentations and active discussion of recent publications and modern experimental strategies. The focus is on chemical, biochemical, and nutritional aspects of selected topics in Toxicology, with a new group of topics addressed each semester

Objective
- To stimulate student interest and provide advanced knowledge of current research in Toxicology and its related sciences
- To develop skills in critical evaluation of scientific literature, oral presentation and questioning
- To understand modern experimental techniques and research approaches relevant in toxicology

Content
The journal-club style course involves student presentations and active discussion of recent publications. The primary focus is on chemical, biochemical, and nutritional aspects of selected current topics in Toxicology. Participants are masters or PhD students in Food Sciences and related disciplines (i.e. Chemistry, Biochemistry, Pharmaceutical Sciences, etc.).

Literature
A selection of approximately 20 papers from recent primary scientific literature.

Prerequisites / notice
The course is open to Masters or PhD level students.

For Masters level participants, a strict prerequisite is (a) previously taken and passed "Introduction to Molecular Toxicology" (752-1300) and/or (b) previous courses supporting equivalent knowledge plus permission from the instructor. Please contact the instructor before the start of the class, explaining the basis of your previous knowledge other than the Introduction course, to request special permission.

If you would like to take "Special Topics in Toxicology", do not register at the same time for "Advanced Topics in Toxicology". It is only possible to take one, and it is only possible to take the advanced level after completing this course.

Methodology Subjects

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<td>W+</td>
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Abstract
Key concepts of experimental design. Planning and analysis of single factor experiments, block designs, full factorial and fractional designs, split-plot and strip-plot designs. Random effects and mixed effects models.

Objective
Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R.

Content

Lecture notes
see website
The course starts with the basics of linear regression modeling, and then proceeds to parameter estimation, tests and confidence intervals. A script will be available. In this practical course different meals are prepared and then analyzed in the laboratory. The analyses comprise energy, macronutrients, and specific micronutrients as well as polyphenols and phytic acid. Based on the results the nutritional value of each meal is critically evaluated and discussed. The practical work is accompanied by a lecture on the basic principles of analytical chemistry.

The last third of the course is dedicated to an introduction into generalized linear regression models: this includes logistic regression for binary response variables, Poisson regression for count data, cumulative logit models for ordered, and multinomial regression for categorical response variables.

The practical work is accompanied by a lecture on the basic principles of analytical chemistry.

This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning "good practice" that can be applied in every student's own projects and daily work life.

The practical work is accompanied by a lecture on the basic principles of analytical chemistry.

The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

### Optional Subjects

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<td>W</td>
<td>3</td>
<td>2G</td>
<td>C. Lacroix, T. de Wouters, L. Meile, C. Schwab</td>
</tr>
<tr>
<td>752-6301-00L</td>
<td>Selected Topics in Physiology Related to Nutrition</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>W. Langhans</td>
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This integration course will discuss new applications of microorganisms with functional properties in food and functional food products. Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of functional microorganisms to produce foods with high quality, safety and potential health benefits for consumers.

To understand the principles, roles and mechanisms of microorganisms with metabolic activities of high potential for application in traditional and fundamental foods utilization with high quality, safety and potential health benefits for the consumers. This course will integrate basic knowledge in food microbiology, microbial physiology, biochemistry, and technology.

This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products and characterization of functionality and safety of food bacteria. Specialists from the Laboratory of Food Biotechnology, as well as invited speakers from the industry will contribute to the selected topics as follows:

- Probiotics and Prebiotics: Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.
- Bioprotective Cultures and Antimicrobial Metabolites: Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.
- Legal and Protection Issues Related Functional Foods
- Industrial Biotechnology of Flavor and Taste Development
- Safety of Food Starter Cultures and Prebiotics

Students will be required to complete a group project on food products and ingredients with of from functional bacteria. The project will involve information research and analysis followed by an oral presentation and short written report.

Copy of the power point slides from lectures will be provided.

A list of references will be given at the beginning of the course for the different topics presented during this course.
The course introduces basic concepts of the interaction between nutrition and exercise and cognitive performance. To understand the potential effects of nutrition on exercise performance, with a focus on concepts and principles of nutrition before, during and after exercise.

Prerequisites / notice

The course will cover elementary aspects of sports nutrition physiology, including carbohydrate, glycogen, fat, protein and energy metabolism. A main focus will be to understand nutritional aspects before exercise to be prepared for intensive exercise bouts, how exercise performance can be supported by nutrition during exercise and how recovery can be assisted by nutrition after exercise. Although this is a scientific course, it is a goal of the course to translate basic sports nutrition science into practical sports nutrition examples.

Language: English

It is strongly recommended to attend the lectures. The lecture (including the handouts) is not designed for distance education.

Gene Technology in Foods

This course will increase basic knowledge on biotechnological constructions and application of genetically modified organisms (GMO) which are used worldwide in food production systems. The course discusses health issues, the legislation frame and food safety aspects of GMO applications in agriculture, food production and consumption in Switzerland and EU-countries.

Prerequisites / notice

Copies of slides from lectures will be provided.

Literature

Actual publications from literature will be provided.

Advanced Topics in Toxicology

Journal-club style course that involves student presentations of selected topics in Toxicology on the basis of current primary research and review papers.

Prerequisites / notice

Participants are required to have completed previously "Special Topics in Toxicology" (752-1301-00L). Both courses are run concurrently every semester. It is only possible to register for one course at a time. Do not register for "Advanced Topics in Toxicology" until after you have completed "Special Topics in Toxicology".

Major in Human Health, Nutrition and Environment

Disciplinary Subjects

Disciplinary courses: Module Public Health plus one additional module (Infectious Diseases or Nutrition and Health or Environment and Health). A minimum of 10 CP per module have to be obtained.
The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.

Objective

- development of T and B cells
- the dynamics of an immune response during acute and chronic infection
- mechanisms of immunopathology
- modern vaccination strategies

Content

- development, activation, and differentiation of different types of T cells and their effectormechanisms during immune responses,
- Recognition of pathogenic microorganisms by the host cells and molecular events thereafter,
- events and signals for maturation of naive B cells to antibody producing plasma cells and memory B cells.
- Optimization of B cell responses by intelligent design of new vaccines
- Development and selection of CD4 and CD8 T cells, natural killer T cells (NK), and regulatory T cells (Treg)
- NK T cells and responses to lipid antigens
- Differentiation, characterization, and function of CD4 T cell subsets such as Th1, Th2, and Th17
- Overview of cytokines and their effector function
- Co-stimulation (signals 1-3)
- Dendritic cells
- Evolution of the "Danger" concept
- Cells expressing Pattern Recognition Receptors and their downstream signals
- T cell function and dysfunction in acute and chronic viral infections

Literature

Documents of the lectures are available for download at: https://moodle-app2.let.ethz.ch/course/view.php?id=998

Prerequisites / notice

Immunology I and II

551-1171-00L

Milestones and current topics of innate immunity, antigen presenting, B cells, thymus and T cells, cytotoxic T cells and NK cells, and tumor immunology.

Lecture notes

Original and review articles will be distributed by the lecturer.

Literature

Literaturunterlagen werden vor Beginn des Kurses auf folgender website zugänglich sein: Moodle Course https://moodle-app2.let.ethz.ch/course/view.php?id=1002

701-0263-01L

Seminar in Evolutionary Ecology of Infectious Diseases

Objective

This is an advanced course that will require significant student participation. Students will learn how to evaluate and present scientific literature and trace the development of ideas related to understanding the ecology and evolutionary biology of infectious diseases.

Content

A core set of ~10 classic publications encompassing unifying themes in infectious disease ecology and evolution, such as virulence, resistance, metapopulations, networks, and competition will be presented and discussed. Pathogens will include bacteria, viruses and fungi. Hosts will include animals, plants and humans.

Literature

Papers will be assigned and downloaded from a web page announced during the lecture.

701-1341-00L

Water Resources and Drinking Water

Abstract

The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Natural processes, anthropogenic pollution, legislation of groundwater and surface water, and of drinking water as well as water treatment will be discussed for industrialized and developing countries.

Objective

The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality.

Content

The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. The various water resources, particularly groundwater and surface water, are discussed as part of the natural water cycle influenced by anthropogenic activities such as agriculture, industry, urban water systems. Furthermore legislation related to water resources and drinking water will be discussed. The lecture is focused on industrialized countries, but also addresses global water issues and problems in the developing world. Finally unit processes for drinking water treatment (filtration, adsorption, oxidation, disinfection etc.) will be presented and discussed.

Literature

Handouts will be distributed

752-2122-00L

Food and Consumer Behaviour

Abstract

This course focuses on food consumer behavior, consumer's decision-making processes and consumer's attitudes towards food products.

Objective

The course provides an overview about the following topics: Factors influencing consumer's food choice, food and health, attitudes towards new foods and food technologies, labeling and food policy issues.

752-4009-00L

Molecular Biology of Foodborne Pathogens

Abstract

The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.

Objective

Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks.
Epidemiology and Prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented.

Students are able to:
- evaluate the scientific evidence on the effects of diet on human health
- describe the role of nutritional factors in the prevention of chronic diseases
- assess the nutritional status of a population (Switzerland taken as an example)
- put forward preventive measures addressing individuals but also our society in relation to the obesity epidemic

The module "public health concepts" offers an introduction to key principles of public health. Students get acquainted with the concepts and methods of epidemiology. Students also learn to use epidemiological data for prevention and health promotion purposes. Public health concepts and intervention strategies are presented, using examples from infectious and chronic diseases.

At the end of this module students are able to:
- interpret the results of epidemiological studies
- critically assess scientific literature
- know the definition, dimensions and determinants of health
- plan public health interventions and health promotion projects

Concepts of descriptive and analytical epidemiology, study designs, measures of effect, confounding and bias, screening, surveillance, definition of health and health promotion, health dimensions and health determinants, prevention strategies, public health interventions, public health action cycle, epidemiology and prevention of infectious and chronic diseases (HIV, Tuberculosis, Obesity, Public health nutrition).

Handouts are provided to students in the classroom.

Language of the course is English.
Abstract

Nutrigenomics - toward personalized nutrition?

Breakthroughs in biology recently led nutrition scientists to apply modern tools (genomics, transcriptomics, proteomics, metabolomics, genomics, epigenetics) to the analysis of the interactions of food with humans. The lecture presents these tools and illustrates their application in selected topics relevant to human nutrition and food sciences.

Objective

- Overall understanding of the transdisciplinary research being conducted under the term nutrigenomics.
- Overall understanding of the omics technologies used in nutrigenomics and their applications to human nutrition and food science.
- Ability to critically evaluate the potential and risks associated with the field of nutrigenomics

Content

- For the content of the script see section "Skript" below
- The lecture is completed by an optional project entitled 'Personalized Nutrition' in which the students have the opportunity to receive a personalized nutritional guidance that is based on their own genetic makeup. The scientific literature on which the genetic tests are based is presented by the students during the lecture.

Lecture notes

The script is composed of circa 450 slides (ca 18 slides/lecture) organized in 9 modules

Module A
From biochemical nutrition research to nutrigenomics

Module B
Nutritional genomics

Module C
Nutrigenetics

Module D
Nutri-epigenomics

Module E
Transcriptomics in nutrition research

Module F
Proteomics in nutrition research

Module G
Metabolomics in nutrition research

Module H
Nutritional systems biology

Module I
Individualization - opportunities and challenges

Literature

No extra reading requested. Most slides in the lecture are referenced with web addresses.

Prerequisites / notice

Basic training in biochemistry, molecular biology, physiology, and human nutrition. Interest in interdisciplinary sciences linking molecular biology to human health. Interest in the application of analytical laboratory methods to the understanding of human biology, in particular nutrition.

Methodology Subjects

Methodical courses are equivalent to the module Term Paper and Seminar. Missing CPs can be obtained from the major programs Food Processing, Food Quality and Safety, or Nutrition and Health.

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
</table>

Abstract

Writing of a review paper of scientific quality on a topic in the domain of Human Health, Nutrition and Environment based on critical evaluation of scientific literature.

Objective

- Acquisition of knowledge in the field of the review paper
- Assessment of original literature as well as synthesis and analysis of the findings
- Practising of academic writing in English
- Giving an oral presentation with discussion on the topic of the review paper

Content

Topics are offered in the domains of the major 'Human Health, Nutrition and Environment' covering 'Public Health', 'Infectious Diseases', 'Nutrition and Health' and 'Environment and Health'.

Lecture notes

Guidelines will be handed out in the beginning.

Literature

Literature will be identified based on the topic chosen.

Optional Subjects

Choice of a module not yet selected as a disciplinary course. Choice between Infectious Diseases, Nutrition and Health, and Environment and Health.

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>752-4009-00L</td>
<td>Molecular Biology of Foodborne Pathogens</td>
<td>W+</td>
<td>3 credits</td>
<td>2V</td>
<td>M. Loessner, M. Schuppler</td>
</tr>
</tbody>
</table>

Abstract

The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.

Objective

Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks.

Content

Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks?

Lecture notes

Electronic copies of the presentation slides (PDF) will be made available for download to registered students.

Literature

Recommendations will be given in the first lecture

Prerequisites / notice

Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until 11:15 h), with no break.
Obtain a detailed understanding of Milestones in Immunology: old concepts and modern experiments

Nutrigenomics

W

Milestones and current topics of innate immunity, antigen presentation, B cells, thymus and T cells, cytotoxic T cells and NK cells, and tumor immunology.

Literature

Documents of the lectures are available for download at:

The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

Literature

Documents of the lectures are available for download at:

Diseases

This is an advanced course that will require significant student participation. Students will learn how to evaluate and present scientific data: 06.02.2019 13:00

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 835 of 1434
This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products. It will be mentioned in handouts.

The course provides an overview about the following topics: Factors influencing consumer's food choice, food and health, attitudes towards food products, and new foods and food technologies, labeling and food policy issues. No extra reading is requested. Most slides in the lecture are referenced with web addresses.

A list of references will be given at the beginning of the course for the different topics presented during this course.

The course focuses on food consumer behavior, consumer's decision-making processes and consumer's attitudes towards food products. Copy of the power point slides from lectures will be provided. The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved processes, anthropogenic pollution, legislation of groundwater and surface water and of drinking water as well as water treatment will be discussed for industrialized and developing countries.

Students will be required to complete a group project on food products and ingredients with functional bacteria. The project will involve information research and analysis followed by an oral presentation and short written report.

This integration course will discuss new applications of microorganisms with functional properties in food and functional food products. Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of functional microorganisms to produce food with high quality, safety and potential health benefits for consumers.

Basic training in biochemistry, molecular biology, physiology, and human nutrition. Interest in interdisciplinary sciences linking molecular biology to human health. Interest in the application of analytical laboratory methods to the understanding of human biology, in particular nutrition.

Food and Consumer Behaviour

This course focuses on consumer behavior, consumer's decision-making processes and consumer's attitudes towards food products. The course provides an overview about the following topics: Factors influencing consumer's food choice, food and health, attitudes towards new foods and food technologies, labeling and food policy issues.

Water Resources and Drinking Water

The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the source to the tap. Natural processes, anthropogenic pollution, legislation of groundwater and surface water and of drinking water as well as water treatment will be discussed for industrialized and developing countries.

The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality. The various water resources, particularly groundwater and surface water, are discussed as part of the natural water cycle influenced by anthropogenic activities such as agriculture, industry, urban water systems. Furthermore, legislation related to water resources and drinking water will be discussed. The lecture is focused on industrialized countries, but also addresses global water issues and problems in the developing world. Finally, unit processes for drinking water treatment (filtration, adsorption, oxidation, disinfection etc.) will be presented and discussed.

Handouts will be distributed.

Molecular Evolution, Phylogenetics and Phylodynamics

Data: 06.02.2019 13:00

Autumn Semester 2015

Page 836 of 1434
The aim of the course is to provide up-to-date knowledge on how we can obtain an understanding of the evolution and population dynamics of organisms based on their genetic sequencing data, employing key concepts from molecular evolution, phylogenetics and phylodynamics. Throughout the course, we tie the models and methods closely with applications, mainly in the field of epidemiology and evolution.

Attendees will learn what information is contained in genetic sequencing data and how this information is extracted from the sequencing data. The main concepts introduced are:

- models in molecular evolution
- phylogenetic & phylodynamic inference
- maximum likelihood and Bayesian statistics
- stochastic processes

Attendees will apply these concepts to a number of applications yielding biological insight into:

- epidemiology
- pathogen evolution
- macroevolution of species

The course consists of three parts. We first introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Second, we employ these evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades.

Slides of the lecture will be available online.

The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:

- Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST.

Basic knowledge in linear algebra, analysis, and statistics.

### Minors

#### Food Biotechnology

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<tbody>
<tr>
<td>752-5105-00L</td>
<td>Biotechnology of Alcoholic Beverages</td>
<td>W+</td>
<td>2</td>
<td>2V</td>
<td>H. J. Gafner, S. Schönenberg</td>
</tr>
</tbody>
</table>

To understand the process cycle and control of beer, wine and distillate production.

### Lecture notes

The handouts for the lecture will be distributed at the beginning of every lecture unit. In the wine lectures the treated subjects will be examined as self controls in form of multiple choice questions.

### Literature

The literature is announced in the handouts for beer and wine at the beginning of the lectures.

### Prerequisites / notice

Sound knowledges in microbiology, molecular genetics, biochemistry and physiology in fermentd beverages are required.
This course will address selected and current topics on applications of microorganisms with functional properties in food and functional foods and characterization of functionality and safety of food bacteria. Specialists from the Laboratory of Food Biotechnology, as well as invited speakers from the industry will contribute to the selected topics as follows:

- **Probiotics and Prebiotics:** Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.

- **Bioprotective Cultures and Antimicrobial Metabolites:** Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.

- **Legal and Protection Issues Related Functional Foods**

- **Industrial Biotechnology of Flavor and Taste Development**

- **Safety of Food Starter Cultures and Probiotics**

Students will be required to complete a group project on food products and ingredients with or of from functional bacteria. The project will involve information research and analysis followed by an oral presentation and short written report.

### Food Chemistry

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>752-1021-00L</td>
<td>Selected Topics in Food Chemistry (HS)</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>L. Nyström</td>
</tr>
<tr>
<td>Abstract</td>
<td>Two major topics of the course are I. Enzymes in Food Sciences and II. Molecular Gastronomy. I. To understand use of enzymes in food processing and analysis. II. To explain the physicochemical features of ingredients and reactions applied in molecular gastronomy.</td>
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<tr>
<td>Objective</td>
<td>I. Enzymes in foods: the use of added enzymes in food processing, control and/or utilization of endogenous enzymes, production of enzyme preparations for food use, and chemical analysis of food components by enzymatic methods. I. Case studies in modern molecular gastronomy: phenomena, chemicals, reactions and techniques applied.</td>
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<tr>
<td>Content</td>
<td>The lectures are supplemented with handouts.</td>
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<tr>
<td>Lecture notes</td>
<td>Courses prerequisites; Food Chemistry I/II and Food Analysis I/II (or equivalent)</td>
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<tr>
<td>Literature</td>
<td>A list of references will be given at the beginning of the course for the different topics presented during this course.</td>
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<tr>
<td>Prerequisites</td>
<td><em>Analytische Chemie I (3. Semester)</em>, Analytische Chemie II (4. Semester)* (or equivalent)</td>
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### Food Microbiology

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<td>752-4009-00L</td>
<td>Molecular Biology of Foodborne Pathogens</td>
<td>W+</td>
<td>3</td>
<td>2V</td>
<td>M. Loessner, M. Schuppler</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.</td>
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<tr>
<td>Objective</td>
<td>Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks.</td>
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<tr>
<td>Content</td>
<td>Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks?</td>
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<tr>
<td>Lecture notes</td>
<td>Electronic copies of the presentation slides (PDF) will be made available for download to registered students.</td>
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<tr>
<td>Literature</td>
<td>Recommendations will be given in the first lecture</td>
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<tr>
<td>Prerequisites</td>
<td>Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until 11:15 h), with no break.</td>
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<tbody>
<tr>
<td>752-5103-00L</td>
<td>Functional Microorganisms in Foods</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>C. Lacroix, T. de Wouters, L. Meile, C. Schwab</td>
</tr>
<tr>
<td>Abstract</td>
<td>This integration course will discuss new applications of microorganisms with functional properties in food and functional food products. Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of functional microorganisms to produce food with high quality, safety and potential health benefits for consumers.</td>
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<tr>
<td>Objective</td>
<td>To understand the principles, roles and mechanisms of microorganisms with metabolic activities of high potential for application in traditional and functional foods utilization with high quality, safety and potential health benefits for the consumers. This course will integrate basic knowledge in food microbiology, microbial physiology, biochemistry, and technology.</td>
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</table>
This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products and characterization of functionality and safety of food bacteria. Specialists from the Laboratory of Food Biotechnology, as well as invited speakers from the industry will contribute to the selected topics as follows:

- Probiotics and Prebiotics: Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.
- Bioprotective Cultures and Antimicrobial Metabolites: Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.
- Legal and Protection Issues Related Functional Foods
- Industrial Biotechnology of Flavor and Taste Development
- Safety of Food Starter Cultures and Probiotics

Students will be required to complete a group project on food products and ingredients with of from functional bacteria. The project will involve information research and analysis followed by an oral presentation and short written report.

### Food Process Design

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<tr>
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</thead>
<tbody>
<tr>
<td>752-3021-00L</td>
<td>Food Process Design and Optimization</td>
<td>W+</td>
<td>4</td>
<td>2G</td>
<td>E. J. Windhab</td>
</tr>
<tr>
<td></td>
<td>Quantitative process analysis and derivation of process-structure functions for complex liquid or semi-liquid food systems with non-Newtonian flow properties. Handling of optimisation and up-/down-scaling procedures.</td>
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### Food Sensory Science and Consumer Behaviour

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<tbody>
<tr>
<td>752-2122-00L</td>
<td>Food and Consumer Behaviour</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>M. Siegrist, C. Hartmann, V. Visschers</td>
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<tr>
<td></td>
<td>This course focuses on food consumer behavior, consumer’s decision-making processes and consumer’s attitudes towards food products.</td>
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<td></td>
<td>The course provides an overview about the following topics: Factors influencing consumer’s food choice, food and health, attitudes towards new foods and food technologies, labeling and food policy issues</td>
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### Public Nutrition and Health

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<tbody>
<tr>
<td>752-6101-00L</td>
<td>Nutrition and Chronic Disease (HS)</td>
<td>W+</td>
<td>3</td>
<td>2V</td>
<td>M. B. Zimmermann</td>
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<tr>
<td></td>
<td>To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.</td>
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<td>To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.</td>
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<td></td>
<td>The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.</td>
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<tr>
<td></td>
<td>There is no script. Powerpoint presentations will be made available on-line to students.</td>
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<td>To be provided by the individual lecturers, at their discretion.</td>
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<td></td>
<td>No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.</td>
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<tr>
<td>752-6105-00L</td>
<td>Epidemiology and Prevention</td>
<td>W+</td>
<td>3</td>
<td>2V</td>
<td>M. Eichholzer</td>
</tr>
<tr>
<td></td>
<td>The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented.</td>
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### Safety and Quality in Agri-Food Chain

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<th>Number</th>
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<tbody>
<tr>
<td>751-1555-00L</td>
<td>Food Economics</td>
<td>W+</td>
<td>2</td>
<td>2G</td>
<td>A. Champetier de Ribes</td>
</tr>
</tbody>
</table>
| Abstract   | Food Economics proposes to explore important issues in food production, supply, and consumption using the concepts and tools of microeconomics.  
Objective | The two objectives of the class are:  
- to provide an overview of the important issues related to food markets and supply chains,  
- to present the economics concepts and tools that are useful to understand the functioning of food supply chains under various governance regimes or policies (emphasis on welfare analysis)  
Content | The course is balanced between presentation of economics concepts and illustration by case-studies. The lecture titles include:  
- Demand for food.  
- Matching demand with supply.  
- Industrial organization in the food supply chain.  
- Non-quality attributes of food.  
- When information is costly.  
- Food production and the environment.  
- The food sector within human economies.  
In addition, the students collectively identify and address an applied research question. We implement an empirical strategy to tackle the question before results are discussed individually by students during the final written examination.  
Lecture notes | Lecture notes are made available after each lecture.  
Prerequisites / notice | Students are expected to master basic microeconomics concepts such as demand, supply, or consumer and producer surplus. We will review how to calculate elasticities, tax and quota impacts on prices etc...but the class focuses on applications of these tools rather than on basic understanding. Students are expected to have taken at least one intermediary microeconomics class. |
| 752-2122-00L | Food and Consumer Behaviour          | W    | 2    | 2V    | M. Siegrist, C. Hartmann, V. Visschers |
| Abstract   | This course focuses on food consumer behavior, consumer's decision-making processes and consumer's attitudes towards food products.  
Objective | The course provides an overview about the following topics: Factors influencing consumer's food choice, food and health, attitudes towards new foods and food technologies, labeling and food policy issues.  
Content | The course is open to Master and MAS students in food and science and nutrition or related. Basic knowledge of food chemistry and nutrition is expected, as well as an understanding of food processing.  
Lecture notes | There is no script. Powerpoint presentations and relevant scientific articles will be available on-line for students. A selection of recommended readings will be given at the beginning of the course.  
Prerequisites / notice | The course is open to Master and MAS students in food and science and nutrition or related. Basic knowledge of food chemistry and nutrition is expected, as well as an understanding of food processing.  
| 752-2307-00L | Nutritional Aspects of Food Composition and Processing | W+   | 3    | 2V    | B. E. Baumer, J. M. Sych   |
| Abstract   | Lecture type course with an interdisciplinary approach for the evaluation of nutritional aspects of changes in food composition due to processing.  
Objective | Students should be able to  
- describe and compare the major concepts/criteria used for the evaluation of the nutritional quality of food  
- apply these criteria when assessing the effects of selected processing technologies on nutritional quality.  
- evaluate recent formulation strategies aimed to achieve additional physiological benefits for targeted population groups (i.e. functional foods),  
Content | The course gives inputs on compositional changes in food due to processing (with focus on thermal/chilling, enzymatic, chemical, emerging technologies) or new formulation strategies. Possible evaluation methods for these changes (e.g. nutritional profile) will be addressed.  
Lecture notes | There is no script. Powerpoint presentations and relevant scientific articles will be available on-line for students. A selection of recommended readings will be given at the beginning of the course.  
Prerequisites / notice | The course is open to Master and MAS students in food and science and nutrition or related. Basic knowledge of food chemistry and nutrition is expected, as well as an understanding of food processing.  
| 751-2401-00L | Food and Agricultural Trade Policy    | W+   | 3    | 2G    | R. Jörin                   |
| Objective  | The course focuses on the role of agricultural trade in a rapidly globalizing world. We analyze the impact of trade policy instruments on welfare and distribution.  
- Knowledge of the mechanisms of agricultural trade  
- Impact of trade policy instruments on welfare and distribution  
- Specific aspects of agricultural trade and links to other courses:  
- Trade and food security  
- Trade and environment  
- Trade and development  
Content | The course focuses on the role of agricultural trade in a rapidly globalizing world. We analyze the impact of trade policy instruments on welfare and distribution.  
By means of case studies the following specific aspects of agricultural trade are analyzed: trade and food security; trade and environment/natural resources; trade and development.  
Lecture notes | Handouts (power point presentations)  
### Lectures address 2 horticultural cropping systems and value chains, each one in 4 2h-lecture blocks. Afterwards, the students split in 2 groups for addressing a case study focusing on one of the cropping systems treated before. An excursion to a research site might be included. In a final colloquium, each group presents a report on their case study and their conclusions.

**Objective**
Achieve a deepened understanding of horticultural value chain challenges relating to ecological intensification, resource efficiency, climate change and healthy and safe food, and the problem solution strategies and scientific principles behind.

**Content**
In the autumn semester, the two addressed cropping systems and value chains are fruit-production and viticulture.
In the spring semester, the two addressed cropping systems and value chains are vegetable-production- and berry-production or glasshouse-horticulture.

**Lecture notes**
Documents handed out during the case studies.

**Prerequisites / notice**
The course builds on basic knowledge delivered in ‘Horticultural Crops I’ and ‘Horticultural Crops II’. If these courses have not been followed by interested participants, equivalent knowledge and experience will greatly support a successful and productive participation of the participating student.

Language: spoken E, G or F, Documents: Preferably English, G/F possible.

### Forum: Livestock in the World Food System

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-6001-00L</td>
<td>Forum: Livestock in the World Food System</td>
<td>W</td>
<td>2</td>
<td>1S</td>
<td>M. Kreuzer, S. Bauersachs, E. Hillmann, S. Neueneschwander</td>
</tr>
</tbody>
</table>

**Abstract**
This forum is a platform for the critical reflection of highly relevant topics of livestock in the frame of the world food system comprising issues from basic knowledge to acceptance in society. The exchange is operated by scientific writing and presentation.

**Objective**
In the Forum "Livestock in the World Food System", a topic of significance for livestock agriculture is selected by the students and subsequently dealt with from various angles (from scientific basis to production systems, environmental aspects and to the acceptance by society). The students learn to present a scientific subject in writing and orally to an audience and to defend the presentation in a discussion.

**Content**
The Forum "Livestock in the World Food System" will take place in blocks of 2 hours each. Once the general topic has been selected, it comprises two elements:

**Element 1. Oral Presentation:** The students form small groups and are lecturers. There are chair persons (moderators) from outside of these small groups and they also head the discussion. The remaining students and lecturers are the audience.

**Element 2. Scientific writing:** Option 1: preparation of a short scientific type of paper from a result table offered by the lecturers; Option 2: preparation of an abstract with limited word count from a scientific paper; Option 3: writing of a critical review of a paper. The students have to select 2 of the three options each. There will be a discussion be a discussion in small groups at two dates.

**Lecture notes**
no script

**Prerequisites / notice**
Requirements for allocation of the two credit points:
- Theatre presentation (with handout) at the forum
- Delivery of written documents of sufficient quality
- Active participation during the presentations by the other participants

### Gene Technology in Foods

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-5111-00L</td>
<td>Gene Technology in Foods</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>L. Meile</td>
</tr>
</tbody>
</table>

**Abstract**
This course will increase basic knowledge on biotechnological constructions and application of genetically modified organisms (GMO) which are used worldwide in food production systems. The course discusses health issues, the legislation frame and food safety aspects of GMO applications in agriculture, food production and consumption in Switzerland and EU-countries.

**Objective**
This course will provide knowledge and biological background on genetically modified organisms (GMO) and food produced with the help of GMO, especially on the molecular basis of GMO constructions with emphasis on genetically modified food in Switzerland and the EU.

**Content**
Criteria of rationale food safety and health assessment in agriculture and food consumption will be elaborated.

**Lecture notes**
Copies of slides from lectures will be provided

**Prerequisites / notice**
Good knowledge in biology, especially in microbiology and molecular biology are prerequisites.

### World Food System Summer School

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>751-0021-00L</td>
<td>World Food System Summer School</td>
<td>W Dr</td>
<td>4</td>
<td>6P</td>
<td>M. Grant, N. Buchmann</td>
</tr>
</tbody>
</table>

**Abstract**
Provide the opportunity for young scientists and practitioners to understand the challenges and opportunities of sustainable agriculture and organic production systems and to connect these to the broader context of the world food system. During the two week summer school at the Gut Rheinau, one of Switzerland's largest organic farms, participants will engage in lectures, workshops, group work, case

**Objective**
Understand: the science, relationships, interactions and trade-offs in food systems; the role and potential of organic production systems; potential interventions; the cultural, socio-political, economic and environmental factors to be incorporated into solutions. Build skills in systems thinking, multi-cultural and multi-disciplinary collaboration, participatory processes. Connect to a network of expert faculty/ scientists/ practitioners

**Content**
The content framework includes the following modules: world food system overview; agricultural production; Global change drivers; smallholder livelihoods and rural development; Agroforest systems; labelling; International policy and trade; Processing, distribution, and retail; Nutrition and health; National policy and state interventions. The course will conclude with a group work on food system challenges.

**Literature**
Some contents will be provided by registered students who will individually or as a group present an actual publication.

### Food Physics

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-3103-00L</td>
<td>Food Rheology I</td>
<td>W+</td>
<td>3</td>
<td>2V</td>
<td>P. A. Fischer</td>
</tr>
</tbody>
</table>
Rheology is the science of flow and deformation of matter such as polymers, dispersions (emulsions, foams, suspensions), and colloidal systems. The fluid dynamical basis, measuring techniques (rheometry), and the flow properties of different fluids (Newtonian, non-Newtonian, viscoelastic) are introduced and discussed.

The concept of rheological constitutive equations and the application to different material classes. The course provides an introduction on the link between flow and structural properties of flowing material. Rheometrical techniques and appropriate measuring protocols for the characterization of complex fluids will be discussed.

Lectures will be given on general introduction (4h), fluid dynamics (4h), complex flow behavior (4h), influence of temperature (2h), rheometers (4h), rheological tests (6h) and structure and rheology of complex fluids (4h).

Notes will be handed out during the lectures. Literature Provided in the lecture notes.

752-2314-00L Physics of Food Colloids W+ 3 credits 2V P. A. Fischer, R. Mezzenga

Abstract In Physics of Food Colloids the principles of colloid science will applied to the aggregation of food material such as proteins, polysaccharides, and emulsifiers. Mixtures of such raw material determine the appearance and performance of our daily food. Examples of colloidal laws at work will link food colloid science to the manufacturing and processing of food.

Objective The aggregation of food raw material determine to appearance and performance of a complex food system as far as nutritional aspects. The underlying colloidal laws are reflecting the structure of the individual raw material (length scale, character of the interacting forces). Once those concepts are appreciated the aggregation of most food systems falls into recognizable patterns that can be used to modify and structure exiting food or to design new products. The application and use of those concepts are discussed in light of common food production.

Content Lectures will be given on interfacial tension (4h), protein aggregation in bulk and interfaces (4h), Pickering emulsions (2h), polysaccharides (2h), aggregation of complex mixtures (4h), foams (2h), and the use of light scattering in investigation complex food structures (6h). Most chapters include some hand-ons to the gain knowledge to common food products.

Notes will be handed out during the lectures. Literature Provided in the lecture notes.

Food Toxicology

Number Title Type ECTS Hours Lecturers
752-1301-00L Special Topics in Toxicology W 2 credits 2G S. J. Sturla

Abstract Journal-club style course involving student presentations and active discussion and critique of recent publications and modern experimental strategies. The focus is on chemical, biochemical, and nutritional aspects of selected topics in Toxicology, with a new group of topics addressed each semester

Objective - to stimulate student interest and provide advanced knowledge of current research in Toxicology and its related sciences
- to develop skills in critical evaluation of scientific literature, oral presentation and questioning
- to understand modern experimental techniques and research approaches relevant in toxicology

Content The journal-club style course involves student presentations and active discussion of recent publications. The primary focus is on chemical, biochemical, and nutritional aspects of selected current topics in Toxicology. Participants are masters or PhD students in Food Sciences and related disciplines (i.e. Chemistry, Biochemistry, Pharmaceutical Sciences, etc.).

Literature A selection of approximately 20 papers from recent primary scientific literature.

Prerequisites / notice The course is open to Masters or PhD level students.

For Masters level participants, a strict prerequisite is (a) previously taken and passed "Introduction to Molecular Toxicology" (752-1300) and/or (b) previous courses supporting equivalent knowledge plus permission from the instructor. Please contact the instructor before the start of the class, explaining the basis of your previous knowledge other than the Introduction course, to request special permission.

If you would like to take "Special Topics in Toxicology", do not register at the same time for "Advanced Topics in Toxicology". It is only possible to take one, and it is only possible to take the advanced level after completing this course.

752-1302-00L Advanced Topics in Toxicology W 2 credits 2G S. J. Sturla

Abstract Journal-club style course that involves student presentations of selected topics in Toxicology on the basis of current primary research and review papers.

Objective The goals are to stimulate student interest and provide advanced knowledge of current research in the interdisciplinary area of Food and Nutrition Toxicology and its related sciences. The student should develop skills in the critical evaluation of scientific literature, oral presentation and questioning, and understanding modern experimental techniques in Molecular Toxicology.

Content The journal-club style course involves student presentations of recent publications. The primary focus is on chemical and biochemical aspects of selected topics in Toxicology. Participants are generally masters or PhD students in Food Sciences and related disciplines (i.e. Chemistry, Pharmaceutical Sciences, etc.), and strong knowledge of organic chemistry and biochemistry are prerequisite. Selected course topics change every semester.

Prerequisites / notice Participants are required to have completed previously "Special Topics in Toxicology" (752-1301-00L). Both courses are run concurrently every semester. It is only possible to register for one course at a time. Do not register for "Advanced Topics in Toxicology" until after you have completed "Special Topics in Toxicology".

529-0047-00L Risk Assessment of Chemicals W 7 credits 6A C. Bogdal, C. A. Baumel, K. Hungerbühler

Abstract Projects on chemical assessment with the focus on the analysis and assessment of basic substance data for selected chemical classes; analysis and modelling of technical processes; characterisation of environmental and health risks. Risk assessment on the basis of quality and protection goals. Estimation of model and parameter uncertainty. Precision and safety measures.

Objective Project thesis (report) on chemicals assessment; time frame totals ca. 80 hours.

Content Projects on chemical assessment with the focus on the following aspects:
* Analysis and assessment of basic substance data for selected chemical classes: physical chemical properties, environmental behaviour (distribution, persistence), human and eco-toxicity (biochemical metabolism, effect mechanisms), safety.
* Analysis and modelling of technical processes determining chemical release into the environment, e.g., chemicals applications.
* Characterisation of environmental and health risks on the basis of exposure and effect models, QSARs from environmental chemistry, toxicology and methods of risk analysis.
* Risk assessment on the basis of quality and safety goals. Estimation of the model and data uncertainty.
* Demonstration of possibilities and limits of precaution and safety measures (technical, organisational, concerning personnel) including effectiveness and efficiency.

Project teaching; time frame totals ca. 80 hours.

Lecture notes See recommended literature.
The master thesis completes the master programme and is an independent scientific project. Generally, the topic is selected from the student’s interest and expertise. Suitable for doctorate, it is important to achieve a high level in the research area.

The module Epidemiology and Prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented.

Objective
- to evaluate the scientific evidence on the effects of diet on human health
- to describe the role of nutritional factors in the prevention of chronic diseases
- to assess the nutritional status of a population (Switzerland taken as an example)
- to put forward preventive measures addressing individuals but also our society in relation to the obesity epidemic

Content
Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks?

Lecture notes
Electronic copies of the presentation slides (PDF) will be made available for download to registered students.

Literature

Prerequisites / notice
Co-operation with chemical companies.

Electives
- Public Colloquium in Food Science
- IFNH Seminars

Master Thesis
The Master thesis completes the master programme and is an independent scientific project. Generally, the topic is selected from the specific field of the major. It is supervised by a professor at D-HEST.

Objective
The Master Thesis must demonstrate the student’s ability to independent, structured and scientific working.
<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
Abstract
The MAS ETH in Architecture and Digital Fabrication is an interdisciplinary education programme initiated by the National Centre of Competence in Research (NCCR) Digital Fabrication and the ETH Zurich. The focus lies upon the methods and techniques of digital design and fabrication and their significance for future building culture.

Objective
The NCCR Digital Fabrication is an ambitious initiative that brings together leading researchers in the disciplines of architecture, engineering, robotics, material and computer sciences. As the main education platform for this NCCR, the MAS ETH in Architecture and Digital Fabrication will benefit from direct exchange with its investigators and immediate access to cutting edge research and innovation. In the NCCR's unique robotic fabrication facilities, the students will also have the opportunity to research digital design and construction processes, and to implement these directly in large-scale prototypes.

The MAS ETH in Architecture and Digital Fabrication is conceived as a 12 months full-time programme targeted at university graduates with excellent design skills and technical knowledge. The teaching language of the programme will be English. The programme begins on the 14th of September 2015. Applications will be accepted until the 30th of April 2015.

Participants will develop competence in complex design and production challenges and will be able to take leading positions in the field of architecture, construction, or the extended design and production industries.

Content
The MAS Digital Fabrication is a 1 year full-time programme and is structured as a series of teaching modules with an independent master thesis. Lessons within the modules are given in the form of lectures, practical workshops, and projects as the main modus for developing skills. Learning will be supported through one on one mentoring in studio, group critiques, symposia, and excursions.

Prerequisites / notice
A Master's degree in architecture or engineering acknowledged by ETH, or equivalent educational qualifications (i.e. a bachelor's degree and a minimum of two years professional experience in a directly related field). Additional critical requirements are proof of creative design skills and technological capabilities. Qualification will be assessed from application documents and skills will be evaluated through portfolio review.

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MAS in Architecture and Digital Fabrication - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
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</tr>
<tr>
<td>ECTS</td>
<td>European Credit Transfer and Accumulation System</td>
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</tbody>
</table>

Special students and auditors need special permission from the lecturers.
MAS in Architecture and Information

The studies take one full year and begin in the autumn semester.

The programme contains 75 CP and is divided into about 6-8 modules of 3-4 weeks, which are taught in seminars that are each concluded with an individual or group project. The studies end with an individual thesis.

For more information about the modules please visit: http://www.caad.arch.ethz.ch/

Teaching languages are English and German. The number of participants is 6 to 12.

Courses Offered

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>065-0069-07L</td>
<td>MAS ETH in Architecture and Information</td>
<td>E-</td>
<td>0 credits</td>
<td>6K</td>
<td>L. Hovestadt</td>
</tr>
</tbody>
</table>

Abstract
A fundamental theoretical and practical introduction to the application of information technologies in architecture. The MAS program CAAD is a yearly full time program, consisting of eight 4-weekly instruction modules with practical exercises and a concluding individual Masterthesis.

Objective
Development of new design methods, new construction forms, media architectures, narrative infrastructures, global models. Parametric and generative CAD systems, procedural, object-oriented and agent-based programming, introduction to JAVA/Processing, introduction to diverse computer-controlled machines with practical examples, development of machine-compatible building constructions, development of electronics for automated tasks, implementation of radio networks.

Content
http://www.mas.caad.arch.ethz.ch/
Lecture notes http://www.mas.caad.arch.ethz.ch/
Literature http://www.mas.caad.arch.ethz.ch/

MAS in Architecture and Information - Key for Type

| O | Compulsory | E- | Recommended, not eligible for credits |
| W+ | Eligible for credits and recommended | Z | Courses outside the curriculum |
| W | Eligible for credits | Dr | Suitable for doctorate |

Key for Hours

| V | lecture |
| G | lecture with exercise |
| U | exercise |
| S | seminar |
| K | colloquium |
| P | practical/laboratory course |
| A | independent project |
| D | diploma thesis |
| R | revision course / private study |

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Courses Offered

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>865-0000-01L</td>
<td>Planning and Monitoring of Projects</td>
<td>W</td>
<td>2</td>
<td>3G</td>
<td>R. Batliner, F. Brugger</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>The course provides an introduction to the methodology of results-based planning and steering of development projects. The course enables participants to use the most important instruments for project planning and for building an outcome-oriented monitoring system.</td>
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<tr>
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<td><strong>Prerequisites / notice</strong></td>
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<tr>
<td></td>
<td>Students of the course must fulfill requirements specified on the homepage of NADEL.</td>
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</tbody>
</table>

| 865-0000-06L | Impact Analysis: Methods and Applications.                           | W    | 2    | 3G    | I. Günther             |
|              | **Abstract**                                                         |      |      |       |                        |
|              | The course gives an introduction to the most important methods for rigorous impact analysis of development programs and projects. The course is designed to both cover the most fundamental methods of impact analysis and introduce real world case studies from national, international and non-governmental development organizations and asks how rigorous impact analysis has influenced their policies. |
|              | **Objective**                                                        |      |      |       |                        |
|              | Participants understand the most important methods of impact analysis. They are able to conduct small scale studies to evaluate the impact of their own programs as well as manage larger impact evaluations for their organizations. Participants are able to use the results of own and external impact studies. |
|              | **Content**                                                          |      |      |       |                        |
|              | Introduction to rigorous impact analysis; Case studies and their policy implications; Introduction to the required statistical knowledge; Potentials and limitations of quantitative analysis; Experimental and quasi-experimental methods; Relevant and feasible indicators for the measurement of outcomes and impacts; Data collection and analysis; Project management of an impact analysis. |
|              | **Prerequisites / notice**                                           |      |      |       |                        |
|              | Students of the course must fulfill requirements specified on the homepage of NADEL. Electronic registration may be done only after registration with NADEL secretariat. |

| 865-0037-00L | M4P - Making Markets Work for the Poor                               | W    | 2    | 3G    | R. Kappel              |
|              | **Abstract**                                                         |      |      |       |                        |
|              | The course conveys basic theoretical and empirical knowledge about private sector promotion in development assistance. The main focus is on measures to promote small and medium enterprises (SMEs). |
|              | **Objective**                                                        |      |      |       |                        |
|              | The course conveys basic theoretical and empirical knowledge about private sector promotion in development assistance. |
|              | **Prerequisites / notice**                                           |      |      |       |                        |
|              | Students of the course must fulfill requirements specified on the homepage of NADEL. |

| 865-0065-02L | Participatory Approaches and Qualitative Methods                      | W    | 2    | 3G    | L. B. Nilsen, R. Batliner |
|              | **Abstract**                                                         |      |      |       |                        |
|              | The course in Participatory Approaches and Qualitative Methods focuses on qualitative research design and the use of participatory approaches, practices and tools - especially relevant for field work and interventions in developing countries. |
|              | **Objective**                                                        |      |      |       |                        |
|              | Develop the participants' knowledge and understanding of qualitative research design, and enable them to apply participatory methods at various stages of the project cycle. |
|              | **Content**                                                          |      |      |       |                        |
|              | Key topics include:                                                 |      |      |       |                        |
|              | - The concepts of facilitation and participation.                    |      |      |       |                        |
|              | - Effective communication and facilitation in groups,                |      |      |       |                        |
|              | - Quantitative versus qualitative research design,                   |      |      |       |                        |
|              | - Key tools and practices for collecting, visualizing and assessing data in a community. |

| 865-0000-10L | Non-Renewable Resources - Fueling Development or Undermining the Future? | W    | 2    | 2G    | F. Brugger            |
|              | **Abstract**                                                         |      |      |       |                        |
|              | The course provides an introduction to the methodology of results-based planning and steering of development projects. The course enables participants to use the most important instruments for project planning and for building an outcome-oriented monitoring system. |
|              | **Prerequisites / notice**                                           |      |      |       |                        |
|              | Students of the course must fulfill requirements specified on the homepage of NADEL. |

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**Data:** 06.02.2019 13:00  **Autumn Semester 2015**  **Page 847 of 1434**
### Abstract
The course gives an introduction into the development challenges of resource-dependent economies from regulating extraction and extractive companies to promoting local linkages and managing revenues. It explores how international cooperation can support sustainable development outcomes.

### Objective
The course gives an introduction into the development challenges of resource-dependent economies from regulating extraction and extractive companies to promoting local linkages and managing revenues. It explores how international cooperation can support sustainable development outcomes.

### Topical Issues of Development Cooperation

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Type</th>
<th>Credits</th>
<th>Lecturer</th>
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<tbody>
<tr>
<td>865-0000-03L</td>
<td>Topical Issues of Development Cooperation</td>
<td>W</td>
<td>1.2</td>
<td>K. Hartgen, I. Günther</td>
</tr>
<tr>
<td></td>
<td>Only for MAS/CAS in Development and Cooperation students, as well as specialists with at least 24 months of practical experience in international cooperation. Doctoral students dealing with empirical research in the area of development and cooperation (EZA) may be admitted &quot;sur Dossier&quot;.</td>
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### Fragile Contexts - Politics, Security and Development

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<tr>
<td>865-0000-11L</td>
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<td>W</td>
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<td>F. Brugger, I. Günther</td>
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<tr>
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<td>Only for MAS/CAS in Development and Cooperation students, as well as specialists with at least 24 months of practical experience in international cooperation. Doctoral students dealing with empirical research in the area of development and cooperation (EZA) may be admitted &quot;sur Dossier&quot;.</td>
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### Vocational Education and Training between Poverty Alleviation and Economic Development

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<td>R. Batliner</td>
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<td>Only for MAS/CAS in Development and Cooperation students, as well as specialists with at least 24 months of practical experience in international cooperation. Doctoral students dealing with empirical research in the area of development and cooperation (EZA) may be admitted &quot;sur Dossier&quot;.</td>
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The participants are able to:
- Assess project proposals and ongoing project regarding their relevance and suitability in the specific country context
- Explain strengths and weaknesses of the opposing approaches "dual apprenticeship" and "competency based training" as well as synergies and incompatibilities between the two
- Describe the competent use of tools currently applied in VET

### References
- Students of the course must fulfill requirements specified on the homepage of NADEL. Electronic registration may be done only after registration with NADEL secretariate.

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### Key for Hours

- **V**: lecture
- **G**: lecture with exercise
- **U**: exercise
- **S**: seminar
- **K**: colloquium
- **P**: practical/laboratory course
- **A**: independent project
- **D**: diploma thesis
- **R**: revision course / private study

### Key for Credits

- **O**: Compulsory
- **W**: Eligible for credits and recommended
- **E-**: Recommended, not eligible for credits
- **Z**: Courses outside the curriculum
- **Dr**: Suitable for doctorate

---

**Special students and auditors need special permission from the lecturers.**
**MAS in Nutrition and Health**

**Disciplinary Subjects**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>752-6402-00L</td>
<td>Nutrigenomics</td>
<td>W+</td>
<td>3 credits</td>
<td>2V</td>
<td>G. Vergères</td>
</tr>
</tbody>
</table>
| Abstract     | Nutrigenomics - toward personalized nutrition?  
Breakthroughs in biology recently led nutrition scientists to apply modern tools (genomics, transcriptomics, proteomics, metabolomics, genetics, epigenetics) to the analysis of the transactions of food with humans. The lecture presents these tools and illustrates their application in selected topics relevant to human nutrition and food sciences. |
| Objective    | - Overall understanding of the transdisciplinary research being conducted under the term nutrigenomics.  
- Ability to critically evaluate the potential and risks associated with the field of nutrigenomics.  
- The lecture is completed by an optional project entitled 'Personalized Nutrition' in which the students have the opportunity to receive a personalized nutritional guidance that is based on their own genetic makeup. The scientific literature on which the genetic tests are based is presented by the students during the lecture. |
| Content      | - For the content of the script see section "Skript" below |
| Lecture notes| The script is composed of circa 450 slides (ca 18 slides/lecture) organized in 9 modules |
| Literature   | Individualized nutrition - opportunities and challenges |
| Prerequisites | Basic training in biochemistry, molecular biology, physiology, and human nutrition. Interest in interdisciplinary sciences linking molecular biology to human health. Interest in the application of analytical laboratory methods to the understanding of human biology, in particular nutrition. |
| 752-6105-00L| Epidemiology and Prevention                | W+   | 3 credits | 2V    | M. Eichholzer    |
| Abstract     | The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented. |
| Objective    | Students are able  
- to evaluate the scientific evidence on the effects of diet on human health  
- to describe the role of nutritional factors in the prevention of chronic diseases  
- to assess the nutritional status of a population (Switzerland taken as an example)  
- to put forward preventive measures addressing individuals but also our society in relation to the obesity epidemic |
| Content      | The module Epidemiology and prevention gives a brief introduction to epidemiology with the aim to enable students to judge the scientific evidence on dietary habits and health. The importance of nutrition in the prevention of chronic diseases such as type 2 diabetes, cardiovascular diseases, cancer, obesity etc. is presented. Switzerland taken as an example, the health risks associated with our nutritional habits will be evaluated. Finally, examples of preventive measures addressing individuals but also the society in relation to the obesity epidemic and other threats to health are discussed. |
| 752-2307-00L| Nutritional Aspects of Food Composition and Processing | W+   | 3 credits | 2V    | B. E. Baumer, J. M. Sych |
| Abstract     | Lecture type course with an interdisciplinary approach for the evaluation of nutritional aspects of changes in food composition due to processing.  
Students should be able to  
- describe and compare the major concepts /criteria used for the evaluation of the nutritional quality of food  
- apply these criteria when assessing the effects of selected processing technologies on nutritional quality.  
- evaluate recent formulation strategies aimed to achieve additional physiological benefits for targeted population groups (i.e. functional foods). |
| Content      | The course gives inputs on compositional changes in food due to processing (with focus on thermal/chilling, enzymatic, chemical, emerging technologies) or new formulation strategies. Possible evaluation methods for these changes (e.g. nutritional profile) will be addressed. |
| Lecture notes| There is no script. Powerpoint presentations and relevant scientific articles will be available on-line for students. A selection of recommended readings will be given at the beginning of the course. |
| Prerequisites | The course is open to Master and MAS students in food and science and nutrition or related. Basic knowledge of food chemistry and nutrition is expected, as well as an understanding of food processing. |
| 752-6301-00L| Selected Topics in Physiology Related to Nutrition | W+   | 3 credits | 2V    | W. Langhans      |
| Abstract     | Gives the students background knowledge necessary for a basic understanding of the complex relationships between food composition and nutrition on one hand and the functioning, as well as the malfunctioning, of major organ systems on the other hand. |
The practical course nutrient analysis in foods includes the preparation and chemical analysis of meals from different types of diets. The course will cover elementary aspects of sports nutrition physiology, including carbohydrate, glycogen, fat, protein and energy metabolism. A main focus will be to understand nutritional aspects before exercise to be prepared for intensive exercise bouts, how exercise performance can be supported by nutrition during exercise and how recovery can be assisted by nutrition after exercise. Although this is a scientific course, it is a goal of the course to translate basic sports nutrition science into practical sports nutrition examples.

Lecture notes
A script and lecture slides are handed out before the start. Attendance in compulsory for the lecture and the laboratory work.

Prerequisites / notice
Students will work in groups. Performance is assessed by a short test on course content, results presentation and a short report.

Objective
Knowing analytical methods to determine macro- and micronutrient content in foods. Critical evaluation of analytical results and interpretation in relation to nutritional value of meals.

Content
The practical course nutrient analysis in foods includes the preparation and chemical analysis of meals from different types of diets. The course of macronutrients, specific micronutrients and secondary plant components are analyzed using common analytical methods. The analytical results are compared with calculated data from food composition databases and critically evaluated. The nutritional values of the meals in relation to specific chronic diseases are discussed. The practical course is accompanied by a lecture on the basic principles of analytical chemistry.

752-6101-00L Nutrition and Chronic Disease (HS) W 3 credits M. B. Zimmermann

Abstract
To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

Objective
To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.

Content
The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

Lecture notes
There is no script. Powerpoint presentations will be made available on-line to students.

Literature
To be provided by the individual lecturers, at their discretion.

Prerequisites / notice
No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.

752-6403-00L Nutrition and Performance W+ 2 credits S. Mettler, M. B. Zimmermann

Abstract
The course introduces basic concepts of the interaction between nutrition and exercise and cognitive performance.

Objective
To understand the potential effects of nutrition on exercise performance, with a focus on concepts and principles of nutrition before, during and after exercise.

Content
The course will cover elementary aspects of sports nutrition physiology, including carbohydrate, glycogen, fat, protein and energy metabolism. A main focus will be to understand nutritional aspects before exercise to be prepared for intensive exercise bouts, how exercise performance can be supported by nutrition during exercise and how recovery can be assisted by nutrition after exercise. Although this is a scientific course, it is a goal of the course to translate basic sports nutrition science into practical sports nutrition examples.

Lecture notes
Lecture slides and required handouts will be available on the ETH website. Information on further reading will be announced during the lecture. There will be some mandatory as well as voluntary readings.

Literature
General knowledge about nutrition, human biology, physiology and biochemistry is a prerequisite for this course. The course builds on basic nutrition and biochemistry knowledge to address exercise performance and related aspects of nutrition.

Prerequisites / notice
No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.

The course is designed for 3rd year Bachelor students, Master students and postgraduate students (MAS/CAS).

Language: English
It is strongly recommended to attend the lectures. The lecture (including the handouts) is not designed for distance education.

Electives

752-2122-00L Food and Consumer Behaviour W 2 credits M. Siegrist, C. Hartmann, V. Visschers

Abstract
This course focuses on food consumer behavior, consumer's decision-making processes and consumer's attitudes towards food products.

Objective
The course provides an overview about the following topics: Factors influencing consumer's food choice, food and health, attitudes towards new foods and food technologies, labeling and food policy issues.

752-0801-00L Food Law and Legislation W 1 credit C. Spinner, E. Zbinden Kaeser

Abstract
Principles of the Swiss food law, introduction to the principles of the EU, international organisations and international contracts.

Objective
Overview about the general principles, institutions and execution of the Swiss food law as well as a presentation of the most important regulations of the Swiss food legislation. Knowledge about the principles and the structure of the EU in general and in the area of food safety, overview on the bilateral agreements CH-EU as well as on the most important international organisations (Codex Alimentarius and WTO) and their influence on the Swiss regulations on food safety.

Content
General introduction into the EU and in the area of food safety (Directorate General SANCO, regulation on food safety), legislative procedure in the EU, introduction into the relevant bilateral agreements CH-EU, introduction into international organisations (e.g. Codex Alimentarius), general principles of the Swiss food law and the most important regulations as well as the most important legal procedures, legal settlement and the duties and responsibilities of the Food control authorities.

Lecture notes
Copies of the presentations will be handed out.

Literature
Documents about Codex Alimentarius, the EU as well as the Swiss food law and some regulations will be handed out.

Prerequisites / notice
Qualifications: General knowledge of the food sciences. The lecture will be held in German.

752-5103-00L Functional Microorganisms in Foods W 3 credits C. Lacroix, T. de Wouters, L. Meile, C. Schwab

Abstract
The course provides an overview about the following topics: Factors influencing consumer's food choice, food and health, attitudes towards new foods and food technologies, labeling and food policy issues.

Objective
No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.

The course is designed for 3rd year Bachelor students, Master students and postgraduate students (MAS/CAS).

Language: English
It is strongly recommended to attend the lectures. The lecture (including the handouts) is not designed for distance education.
Immunology I

This course will increase basic knowledge on biotechnological constructions and application of genetically modified organisms (GMO) with high quality, safety and potential health benefits for consumers.

Handouts are provided to students in the classroom.

Actual publications from literature will be provided.

At the end of this module students are able:

- Probiotics and Prebiotics: Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.
- Bioprotective Cultures and Antimicrobial Metabolites: Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.
- Legal and Protection Issues Related Functional Foods
- Industrial Biotechnology of Flavor and Taste Development
- Safety of Food Starter Cultures and Prebiotics

Students will be required to complete a group project on food products and ingredients with or from functional bacteria. The project will involve information research and analysis followed by an oral presentation and a written report.

A list of references will be given at the beginning of the course for the different topics presented during this course.

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<tr>
<td>551-0317-00L</td>
<td>Gene Technology in Foods</td>
<td>W 3 credits</td>
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<td>752-5111-00L</td>
<td>Immunology I</td>
<td>W 3 credits</td>
<td>2V</td>
<td>A. Oxenius, M. Kopf</td>
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<tr>
<td>752-6151-00L</td>
<td>Public Health Concepts</td>
<td>W+ 3 credits</td>
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Data: 06.02.2019 13:00  Autumn Semester 2015  Page 851 of 1434
Abstract
The study program is completed with the Master thesis, an independent scientific work. Topics are selected within the domains of the MAS program. The work is supervised by a lecturer of the MAS program.

Objective
The Master thesis must demonstrate the student's ability to independent, structured and scientific working.

MAS in Nutrition and Health - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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<th>W+</th>
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Key for Hours

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<td>G</td>
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<td>K</td>
<td>colloquium</td>
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ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Courses Offered

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
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<tr>
<td>065-0013-00L</td>
<td>MAS-Programme “Building Process Leadership”</td>
<td>E-</td>
<td>0</td>
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**Abstract**

The MAS program “Competency in the Building Process” provides graduates of the program with a thorough understanding of the complexities of a project, instilling them with an increased capacity to assess the consequences of their actions and decisions. Upon successful completion of the studies, graduates are qualified to assume the complex duties of an overall project leader in building projects.

**Objective**

Over the course of the MAS program, students review and closely examine professional experiences gained so far. The goal of the program is to develop an understanding and form opinions on the present-day building process. The course directs students to draw independent conclusions and set forecasts for design professionals in the building process, creating a basis, in conjunction with group discussions, for independent study.

**Content**

The Master of Advanced Studies in «Competency in the Building Process» imparts an integral view of the building process. Ever-changing technical and social demands, complex permit processes and increasing pressure to speed up production and completion times have led to the fragmentation and specialization of services and work performed by building process participants. Maintaining an overview of the project are the architects and engineers, who draw from a broad knowledge base as they direct, coordinate and moderate all disciplines involved in the design and construction process.

The MAS program «Competency in the Building Process» is a part-time study for professionally experienced architects and engineers. It provides graduates of the program with a thorough understanding of the complexities of a project, instilling them with an increased capacity to assess the consequences of their actions and decisions. Upon successful completion of the studies, graduates are qualified to assume the complex duties of an overall project leader in building projects.

The first three semesters of the study are comprised of: «Construction Participants», «Services» and «Strategies Interests». Explored in the first semester is communication as it relates to qualifications, acquisition and the organisation chart of the participating client, architects and design and construction professionals. The second semester then turns to the building process as a sequence of activities, placing its focus on basic principles and the services, i.e., the commission for design services, the service model, relevant economic considerations, the overall project leader, coordination of specialty engineers and the project leader. Over the course of the third semester, correlations are then drawn between the topic areas as they relate to the strategies and interests of building industry players. An in-depth look is also taken at the competencies of design professionals. The masters thesis in the fourth and final semester completes the course of study.

**Literature**

Literaturempfehlungen unter www.bauprozess.arch.ethz.ch
Sacha Menz (Hrsg.), Drei Bücher über den Bauprozess, vdf Hochschulverlag an der ETH Zürich, 2009

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### Key for Type

- **O**: Compulsory
- **W+**: Eligible for credits and recommended
- **W**: Eligible for credits
- **E-**: Recommended, not eligible for credits
- **Z**: Courses outside the curriculum
- **Dr**: Suitable for doctorate

### Key for Hours

- **V**: lecture
- **G**: lecture with exercise
- **U**: exercise
- **S**: seminar
- **K**: colloquium
- **P**: practical/laboratory course
- **A**: independent project
- **D**: diploma thesis
- **R**: revision course / private study

**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
The MAS-program in “History and Theory of Architecture” is a two-year half-time course and contains 60 CP. The course starts in the autumn semester.

Attendance of classes supplemented by independent research; practical training periods and excursions; lectures/seminars on one to two days per week, in total 600 ca. contact hours, in addition private study ca. 600 hours (for each in-class day one day of work preparation), two individually tutored seminar papers on chosen subjects (200 hours) and credited Master's thesis (600 hours).

### Courses Offered

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>065-0003-00L</td>
<td>MAS-Programme &quot;History and Theory of Architecture&quot; E-</td>
<td>E-</td>
<td>0 credits</td>
<td>4V</td>
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</table>

**Abstract**

The program aims at enhancing students' understanding of subject matter and methods in the field of research into architectural theory and at assisting them in the critical investigation of the history and theory of architecture.

**Objective**

The historical and social roots of architecture are an essential aspect of the work of architects. To adapt the past to ones own thinking and knowledge, is a challenge. This will be done in a lively and reflecting process. Anyone faced with this challenge in the practical work will find a quality for his buildings that can't be reached by only considering urbanistic, aesthetic and functional factors.

Based on selected issues, the participants of the MAS-program «Geschichte und Theorie der Architektur» get acquainted with the methods of historic research. Participants will gain a deeper insight into the subjects and methods of architectural historians and will be supported in scientific discourses.

**Content**

The MAS-program «Geschichte und Theorie der Architektur» includes a weekly four-hour seminar in which the techniques of scientific work (methodology, creating a bibliography, researching, textual criticism, editing) and practicing essential aspects of art and architecture are discussed on the basis of texts and buildings before they are written down in textual form.

Historiographical and methodological aspects as well as training in analyzing and describing architectural phenomena are at the forefront. A major concern is also to improve the ability for writing of texts (encyclopedia articles, short essays, project descriptions, academic papers). Writing is a key instrument not only of disciplinary discourse, but also the public exchange of research.

Depending on the topic of the course, there is a single or multi-day trip, during which the participants talk about the buildings that are visited. In addition, each semester, at least two additional courses of the Institute gta have to be visited.

The course concludes with a diploma thesis written on a subject that is chosen by the students. The concept and writing of this work are intended to be a process that evolves continuously while studying. The thesis can be extended into a dissertation, provided the student has a graduate degree that is acknowledged by the ETH.

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### MAS in History and Theory of Architecture (GTA) - Key for Type

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<th>Description</th>
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### Key for Hours

<table>
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<td>P</td>
<td>practical/laboratory course</td>
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<td>A</td>
<td>independent project</td>
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<td>diploma thesis</td>
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**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
MAS in Housing

The course offered with the MAS-program "Housing" is classified in four relevant modules:

- Module 1: social and historical context of housing, housing design and construction.
- Module 2: Housing design, past and present: Typology, biography of usage.
- Module 3: Housing as a contribution of urban design and neighborhood development.
- Module 4: Sustainable development - a new goal in housing design and construction.

Also see separate program.

The attendance of the lecture "Housing" of Prof. Eberle in the autumn semester is compulsory.

Individual chosen 3-4 further lectures or seminars in the Autumn or Spring Semester have to be attended (6 CP).

The modules 3 and 4 are offered in the Spring Semester.

Courses Offered

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<tr>
<td>065-0059-00L</td>
<td>MAS-Programme &quot;Housing&quot; ■</td>
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<td>M. A. Glaser</td>
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Abstract

Relevant issues about the provision, the design and the construction of housing and quality of living are explored based on an interdisciplinary analysis. The MAS thesis is focused on studying, for example, the interdependence of architectural, social, spatial and urban planning considerations, and shifting demand and usage patterns related to housing.

Objective

Against the backdrop of jointly developed theoretical ideas, the students job-related skills and accomplishments in the fields of drawing up concepts, analysis, interpretation, and conversion as well in oral and written conveying are consolidated and expanded in discussions and in joint work. The course of study does not strive to train generalists. Instead it deals with the formulation of questions and procedures elaborated by the students in a generalistic or interdisciplinary way. This is the decisive factor in the qualitative added value of methods which span over several disciplines.

MAS in Housing - Key for Type

<table>
<thead>
<tr>
<th>Code</th>
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<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
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</table>

Key for Hours

<table>
<thead>
<tr>
<th>Code</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
MAS in Landscape Architecture

The Master of Advanced Studies in Landscape Architecture is a one-year full time postgraduate diploma programme delivered in English. It deals mainly with a scale of landscape that is between that of project design and landscape planning. The focus is on peripheral landscapes and their integration into our cities. In the context of the MAS LA these are discussed and developed in respect to their contemporary functional, ecological and aesthetic potentials. Language: English, contact hours: 600h.

For further information please visit: http://www.girot.arch.ethz.ch/

Courses Offered

The programme is a one-year full time master programme, structured a-round two main poles: a landscape design studio (laboratory), and a theory seminar (oratory). Emphasis within the programme on Landscape Video will also help provide a strong analytical basis in both theory and design. The studies are held during the semester from Tuesday to Friday. The programme will conclude with an individual thesis work.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>065-0063-00L</td>
<td>MAS-Programme &quot;Landscape Architecture&quot;</td>
<td>E-</td>
<td>0 credits</td>
<td>16K</td>
<td>P. C. Fricker</td>
</tr>
</tbody>
</table>

Abstract

Within the "Master of Advanced Studies in Landscape Architecture" (MAS LA), the use of the latest modeling and visualization possibilities as well as the actual 3D depiction of landscape architecture make up the core emphasis. Here, the focus lies on the integration of CAD/CAM technologies as a design-supporting medium.

Objective

Through an intensive investigation of the latest software and techniques, the students are capable of the following:
- Represent complex design tasks
- Develop spatial perception at different levels of scales
- Handle current problems efficiently and experimentally
- Develop new visualization and communication techniques using new media
- Communicate design ideas professionally

Content

The MAS LA is a one-year (academic) postgraduate diploma programme delivered in English. It is divided into themed modules and a concluding synthesis module. The chosen CAD programs (i.e. Rhino) are particularly appropriate for the visualization of large-scale landscape designs and offer the possibility for export to computer-steered milling machines.

In addition, superior competency enhancement in the area of 3D GIS and the use of photography as a design tool and video as tool for illustration and design round off the goal-oriented program.

MAS in Landscape Architecture - Key for Type

| O | Compulsory |
| W+ | Eligible for credits and recommended |
| W | Eligible for credits |

Key for Hours

| V | lecture |
| G | lecture with exercise |
| U | exercise |
| S | seminar |
| K | colloquium |
| P | practical/laboratory course |
| A | independent project |
| D | diploma thesis |
| R | revision course / private study |

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
After taking the lecture, students should have knowledge on...

Objectives of the course include:

1. Know the definition and role of marketing (marketing basics)
2. Creating marketing insights - understanding customer behavior
   - Theoretical concepts in customer behavior (customer behavior)
   - Analytical means to extend knowledge on customer behavior (marketing research)
3. Strategic marketing - translating marketing insights into actionable marketing strategies
   - Segmentation, Targeting, and Positioning
   - Attracting customers (marketing mix, 4Ps)
4. Maintaining profitable customer relationships (CRM)
   - Strategic choices for work design
   - Work design: From Adam Smith to job crafting
   - Effects of work design on performance and well-being

Additional information is available on the Tim Group Chair’s website:
http://www.timgroup.ethz.ch/en/courses

Selected readings from the book and additional learning materials will be available on the course Moodle:

All the materials uploaded on Moodle must be considered as required readings.

### Strategy, Technology and Innovation Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>363-0403-00L</td>
<td>Introduction to Marketing</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>F. von Wangenheim</td>
</tr>
<tr>
<td></td>
<td>The course is designed to convey a profound understanding of marketing’s role in modern firms, its interactions and interfaces with other disciplines, its main instruments and recent trends. Particular attention is given to emerging marketing concepts and instruments, and the role of marketing in technology firms.</td>
<td></td>
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</tbody>
</table>
|              | After taking the lecture, students should have knowledge on:
|              | 1) The definition and role of marketing (marketing basics)
|              | 2) Creating marketing insights - understanding customer behavior
|              | 3) Strategic marketing - translating marketing insights into actionable marketing strategies |
|              | Content                                    |
|              | The course is designed to convey a profound understanding of marketing’s role in modern firms, its interactions and interfaces with other disciplines, its main instruments and recent trends. Particular attention is given to emerging marketing concepts and instruments, and the role of marketing in technology firms. |
|              | The lecture features a short tutorial that is held at irregularly spaced intervals throughout the semester (approximately every third week). The tutorial is embedded within the lecture and consists of short sessions of about 30 minutes. It serves to illustrate theoretical and methodological concepts from the lecture by walking students through the analysis of real-world data from the telecommunications industry. The case data will be provided so that students practice and apply the concepts of the lecture on their own. The tutorial is held jointly by a Teaching Assistant (S. P. Brüggemann) and the professor (Prof. F. v. Wangenheim). |
|              | Literature                                  |

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### Work Design and Organizational Change

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<td>363-0301-00L</td>
<td>Work Design and Organizational Change</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>G. Grote</td>
</tr>
<tr>
<td></td>
<td>Good work design is crucial for individual and company effectiveness and a core element to be considered in organizational change. Meaning of work, organization-technology interaction, and uncertainty management are discussed with respect to work design and sustainable organizational change. As course project, students learn and apply a method for analyzing and designing work in business settings.</td>
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<td>Objective</td>
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<td>- Know effects of work design on competence, motivation, and well-being</td>
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<td></td>
<td>- Understand links between design of individual jobs and work processes</td>
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<td></td>
<td>- Know basic processes involved in systematic organizational change</td>
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<td>- Understand the interaction between organization and technology and its impact on organizational change</td>
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<td></td>
<td>- Understand relevance of work design for company performance and strategy</td>
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<td></td>
<td>- Know and apply methods for analyzing and designing work</td>
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<td></td>
<td>Content</td>
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<td></td>
<td>- Work design: From Adam Smith to job crafting</td>
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<td>- Effects of work design on performance and well-being</td>
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<td>- Approaches to analyzing and designing work</td>
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<td>- Modes of organizational change and change methods</td>
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<td></td>
<td>- Balancing stability and flexibility in organizations as design criterion</td>
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<td>- The organization-technology interaction and its impact on work design and organizational change</td>
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<td></td>
<td>- Example Flexible working arrangements</td>
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<td></td>
<td>- Strategic choices for work design</td>
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<tr>
<td></td>
<td>Literature</td>
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<td>A list of required readings will be provided at the beginning of the course.</td>
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### Supplementary Seminar to Introduction to Marketing

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>365-1061-00L</td>
<td>Supplementary Seminar to Introduction to Marketing</td>
<td>W+</td>
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<td></td>
<td>M. Zimmer</td>
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<tr>
<td></td>
<td>B2B Marketing</td>
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<tr>
<td></td>
<td>Exclusively for MAS MTEC students (first semester).</td>
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</tbody>
</table>

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The seminar extends the "Introduction to Marketing" course by taking a look at the characteristics of B2B markets, particularly at the situation of manufacturing firms.

The presentation containing the course outline is available in the section "learning material".

The business model part of the seminar is based on the "Business Model Canvas" and the "Value Proposition Canvas" frameworks by Osterwalder et al. The reading of the underlying books ("Business Model Generation" and "Value Proposition Design") is not mandatory but highly recommended. More information about the frameworks can be found here: http://www.businessmodelgeneration.com/canvas/bmc and: http://www.businessmodelgeneration.com/canvas/vpc

Previews for the first 72 pages (BMC) and 100 pages (VPC) are available after registration on this website: https://strategyzer.com/books

The focus of the seminar is on B2B companies. Therefore, the employer of the participants should primarily serve business customers (as opposed to end consumers, e.g. for fast moving consumer goods). Manufacturing and service companies are equally suitable. Students should have a basic understanding of their firm's business model.

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Content
Uber, Airbnb, Nest and Jawbone - A wide range of innovative companies exist, which successfully implemented ICT enabled business models and continue to grow at a rapid pace. Examples, illustrating how digitalization, including the "Internet of Things" currently fosters business model innovation across various industries. This course is designed to help students to understand and critically assess such newly immersing (digital) business models.

For the lecture students will get access to one of the leading online teaching platforms (called edX) also offered by other top universities (incl. MIT, Harvard, Berkeley, etc.). Using the edX platform, will allow students to collaborate in online discussions, solve online exercises and present a short educational video as part of a group project.

Key Topics:
Business model innovation; (digital) business model patterns; business value of IT; the concept of integration; transaction cost perspective; network economics perspective; essentials and impact of web 2.0, internet of things, mobile computing, market places, social analytics and big data; IT governance and portfolio management; entrepreneurship in the digital space, etc.

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0541-00L</td>
<td>Systems Dynamics and Complexity</td>
<td>W+</td>
<td>3 credits</td>
<td>3G</td>
<td>F. Schweitzer, P. Mavrodiev</td>
</tr>
</tbody>
</table>

Implementing solutions: project management, critical path method, quality control feedback loop.

Controlling solutions: Vensim software, feedback cycles, control parameters, instabilities, chaos, oscillations and cycles, supply and demand, production functions, investment and consumption

Objective
A successful participant of the course is able to:

- understand why most real problems are not simple, but require solution methods that go beyond algorithmic and mathematical approaches
- apply the problem solving cycle as a systematic approach to identify problems and their solutions
- calculate project schedules according to the critical path method
- setup and run systems dynamics models by means of the Vensim software
- identify feedback cycles and reasons for unintended systems behavior
- analyse the stability of nonlinear dynamical systems and apply this to macroeconomic dynamics

Content
Why are problems not simple? Why do some systems behave in an unintended way? How can we model and control their dynamics? The course provides answers to these questions by using a broad range of methods encompassing systems oriented management, classical systems dynamics, nonlinear dynamics and macroeconomic modeling.

The course is structured along three main tasks:
1. Finding solutions
2. Implementing solutions
3. Controlling solutions

PART 1 introduces complexity as a system immanent property that cannot be simplified. It introduces the problem solving cycle, used in systems oriented management, as an approach to structure problems and to find solutions.

PART 2 discusses selected problems of project management when implementing solutions. Methods for identifying the critical path of subtasks in a project and for calculating the allocation of resources are provided. The role of quality control as an additional feedback loop and the consequences of small changes are discussed.

PART 3, by far the largest part of the course, provides more insight into the dynamics of existing systems. Examples come from biology (population dynamics), management (inventory modeling, technology adoption, production systems) and economics (supply and demand, investment and consumption). For systems dynamics models, the software program VENSIM is used to evaluate the dynamics. For economic models analytical approaches, also used in nonlinear dynamics and control theory, are applied. These together provide a systematic understanding of the role of feedback loops and instabilities in the dynamics of systems. Emphasis is on oscillating phenomena, such as business cycles and other life cycles.

Lecture notes
The lecture slides are provided as handouts - including notes and literature sources - to registered students only. All material is to be found on the Moodle platform. More details during the first lecture

Prerequisites / notice
Self-study tasks (discussion exercises, Vensim exercises) are provided as home work. Weekly exercise sessions (45 min) are used to discuss selected solutions. Regular participation in the exercises is an efficient way to understand the concepts relevant for the final exam.

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>363-0565-00L</td>
<td>Principles of Macroeconomics</td>
<td>W+</td>
<td>3 credits</td>
<td>2V</td>
<td>J.E. Sturm</td>
</tr>
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</table>

This course examines the behaviour of macroeconomic variables, such as gross domestic product, unemployment and inflation rates. It tries to answer questions like: How can we explain fluctuations of national economic activity? What can economic policy do against unemployment and inflation. What significance do international economic relations have for Switzerland?

Objective
This lecture will introduce the fundamentals of macroeconomic theory and explain their relevance to everyday economic problems.

Content
This course helps you understand the world in which you live. There are many questions about the macroeconomy that might spark your curiosity. Why are living standards so meagre in many African countries? Why do some countries have high rates of inflation while others have stable prices? Why have some European countries adopted a common currency? These are just a few of the questions that this course will help you answer.

Furthermore, this course will give you a better understanding of the potential and limits of economic policy. As a voter, you help choose the policies that guide the allocation of society's resources. When deciding which policies to support, you may find yourself asking various questions about economics. What are the burdens associated with alternative forms of taxation? What are the effects of free trade with other countries? What is the best way to protect the environment? How does the government budget deficit affect the economy? These and similar questions are always on the minds of policy makers.

Lecture notes
The course webpage (to be found at http://www.kof.ethz.ch/en/events/teaching/) contains announcements, course information and lecture slides.

Literature

We advise you to also buy access to Aplia. This internet platform will support you in learning for this course. To save money, you should buy the book together with Aplia. This is sold as a bundle (ISBN: 9781473715998).

Besides this textbook, the slides and lecture notes will cover the content of the lecture and the exam questions.
The course introduces basic principles, problems and approaches of microeconomics.

The course includes the following main topics:

- Basic principles of demand and supply, market and state in a modern economy, externalities, cost analysis, consumer behaviour, economies of scale and economies of scope, perfect competition, monopoly, oligopoly, monopolistic competition, mathematical treatment of some basic concepts.

Lecture notes
Lecture notes, exercises and reference material can be downloaded from Moodle.

Literature
N. Gregory Mankiw and Mark P. Taylor (2014), "Economics", 3rd edition, South-Western Cengage Learning. The book can also be used for the course 'Principles of Macroeconomics' (Sturm)

For students taking only the course 'Principles of Microeconomics' there is a shorter version of the same book:

Complementary:

### Financial Management

<table>
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<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>363-0711-00L</td>
<td>Accounting for Managers</td>
<td>W+</td>
<td>3</td>
<td>2V</td>
<td>J.P. Chardonnens</td>
</tr>
</tbody>
</table>

Abstract
Overview of financial and managerial accounting
Accounting for current and fixed assets
Liabilities and owners equity
Recording change in balance sheet
Measuring financial performance
Managing financial reporting
Full and variable costing system
Using accounting information for decision making purposes

Objective
Understand the different procedures involved in the accounting system
Record change in financial position
Measure business income
Prepare final accounts
Understand the principles of cost accounting
Calculate the different product costs
Make decisions about the acceptance or rejection of a particular product

Content
Financial Accounting: Balance sheet, income statement, double-entry accounting, journal and ledger, accounting for merchandising activities, value-added tax, adjustments before final accounts, provisions, depreciation, valuation,

Managerial Accounting: Full costing, variable costing, cost-volume profit, break-even analysis, activity-based costing

Exercises
This course is a prerequisite for the course Financial Management.

### 3. Semester

#### Core Courses

##### Strategy, Technology and Innovation Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>363-0392-00L</td>
<td>Strategic Management</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>G. von Krogh</td>
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</table>

Abstract
This course conveys concepts and methods in strategic management, with a focus on competitive strategy. Competitive strategy aims at improving and establishing position of firms within an industry.

Objective
The lecture "strategic management" is designed to teach relevant competences in strategic planning and -implementation, for both professional work-life and further scientific development. The course provides an overview of the basics of strategy and the most prevalent concepts and methods in strategic management. The course is given as a combination of lectures about concepts/methods, and case studies where the students are asked to solve strategic issues of the case companies. In two sessions, the students will also be addressing real-time strategic issues of firms that are represented by executives.

Content
- a. Introduction to strategy
- b. Industry dynamics I: Industry analysis
- c. Industry dynamics II: Analysis of technology and innovation
- d. The resource-based theory of the firm
- e. The knowledge-based theory of the firm
The goal of the course is that participants are able to transfer and use the concepts and methods from the Strategic Management lecture to Corporate sustainability is a complex concept. Although many companies now report on their corporate sustainability actions, few sessions will be interactive, will include small group discussions and will be complementary to the Corporate Sustainability lecture.

This lecture is a special course for MAS students which supplements the Strategic Management course. Participants work on real-life this course, we will discuss in detail a selection of case studies of companies from different sectors facing a variety of environmental and social challenges. The case studies will allow us to explore from multiple perspectives (e.g. stakeholder, institutional, managerial) why corporate sustainability is so complex, how and why businesses respond in the ways that they do, how existing sustainability strategies could be improved, as well as what it means to be a leader in corporate sustainability. Students will have the opportunity to familiarise themselves with the case study material in detail before each session. The sessions will be interactive, will include small group discussions and will be complementary to the Corporate Sustainability lecture.

For more information please see: http://www.smi.ethz.ch/education/practicing-strategy.html

### Prerequisites / notice

**Session #0:** (September 29) Organizational Issues & How to Solve a Case
**Session #1:** (October 6) Introduction
**Session #2:** (October 13) Industry Dynamics I
**Session #3:** (October 27) Guest Lecture
**Session #4:** (November 3) Industry Dynamics II
**Session #5:** (November 10) Resource-Based Theory
**Session #6:** (November 24) Knowledge-based Theory
**Session #7:** (December 1) Guest Lecture

For participants of the MAS-MTEC program we offer a complentary course Practicing Strategy in which students will apply the concepts of Strategic Management to their real-life contexts and organizations. Please register simultaneously for both courses if you want to take part in this course.

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<tr>
<td>365-1059-00L</td>
<td>Practicing Strategy</td>
<td>W+</td>
<td>1 credit</td>
<td>1S</td>
<td>G. von Krogh, Z. Erden Özko</td>
</tr>
<tr>
<td>363-0387-00L</td>
<td>Corporate Sustainability</td>
<td>W+</td>
<td>3 credits</td>
<td>2G</td>
<td>V. Hoffmann</td>
</tr>
<tr>
<td>365-1060-00L</td>
<td>Case Studies in Corporate Sustainability</td>
<td>W+</td>
<td>1 credit</td>
<td>1S</td>
<td>V. Hoffmann</td>
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</tbody>
</table>

### Notice

- **Prerequisites:** Successful registration and prior/parallel enrollment in "363-0392-00 G Strategic Management" required (see course catalogue page for details).
- **Number of participants:** a minimum of 10 persons and a maximum of 25 persons.
- **Limited number of participants:** a minimum of 10 persons.
- **Session #0:** (September 29) Organizational Issues & How to Solve a Case
- **Session #1:** (October 6) Introduction
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Information Management, Operations Management
The globalization of the world leads to an increasingly faster pace in business transformation. Enterprises have to adapt faster and even faster to the environmental changes in a global economy to remain competitive and to make sure they stay in business. In todays information age this does not only mean to adapt business strategy and business processes but also to adapt information systems to the new circumstances. The fast adaptation trough large scale corporate transformation projects that change strategy, business processes and information systems is critical to ensure competitiveness for tomorrow. The introduction of new business processes and information systems typically takes years in very complex large scale projects. Many projects fail because of insufficient alignment between decision makers in business and IT. Unclear understanding of the overall project scope, undefined roles and responsibilities, unclear project processes, quality problems and resistance to change are some typical problems found in such projects. The lecture is subdivided into following modules:

Corporate development introduction and motivation,
Parallelization of corporate development and complexity reduction,
Planning process and project portfolio management in corporate development,
Management of large scale projects integration of strategy, processes and information systems,
Quality management in large scale projects,
Project management in large scale projects,
Change management within projects. The lecture is accompanied by four case studies that are used to exemplify the contents of the lecture by applying the concepts to real situations in corporate life.

363-0453-00L Strategic Supply Chain Management W+ 3 credits 2G S. Wagner

Abstract
The course offers an introduction to the theory and practice of supply chain management. Students will learn how to develop supply chain strategies and supply chain networks based on firms competitive strategies and marketing priorities.

Objective
The task of designing and managing supply chains requires that managers apply strategic, decision making and leadership skills in a supply chain context. The goal of this course is to develop and practice these skills.

Content
Effective supply chains ought to be aligned with and support the achievement of the firms corporate, business and product strategies, taking into account future opportunities and risks. This course will familiarize students with modern supply chain management theory and practice to develop and manage supply chains. The topics covered range from fundamental logistics and supply chain concepts (e.g. push vs. pull, postponement) to the development of supply chain strategies, relationships and networks.

Lecture notes
Course material will be available for download from the homepage of the Chair of Logistics Management:

http://www.scm.ethz.ch/teaching/courses.html

Literature
The following textbook is mandatory:

The following textbook is supplementary:

Prerequisites / notice
The final course grade will be a weighted average of the following:
Exam (semester end): 70%
Case studies (during the semester): 30%

Students (at least in groups of two) must bring a laptop with MS Excel and the Excel Solver installed to class.

Quantitative and Qualitative Methods

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<tr>
<td>363-0305-00L</td>
<td>Empirical Methods in Management</td>
<td>W+</td>
<td>3 credits</td>
<td>2G</td>
<td>A. Scherer</td>
</tr>
</tbody>
</table>

Abstract
Evidence-based management requires valid empirical research. In this course, students will learn the basics of research design, fundamentals of data collection and statistical methods to analyze the data acquired in social science research. Students are expected to apply their knowledge in class discussions and out-of-class assignments.

Objective
- Ability to formulate research questions and designing an appropriate study
- Ability to collect and analyze data using a variety of methods
- Ability to critically assess the quality of empirical research in management
- Applied knowledge of empirical methods through out-of-class assignments

Content
1) Introduction to empirical management research
2) Research designs: exploratory, descriptive, experimental
3) Measurement and scaling
4) Data collection and sampling
5) Data analysis methods
6) Reporting and presenting empirical research

Bi-weekly out-of-class assignments and projects on covered subjects
Assignments and projects: This course includes out-of-class assignments and projects to give students some hands-on experience in conducting empirical research in management. Projects will focus on one particular aspect of empirical research, like the formulation of a research question or the design of a study. Students will have at least one week to work on each assignment. Students are expected to work on these assignments individually. Duplicate answers will receive no credit and will be subject to a disciplinary review. Assignments will be graded and need to be turned-in on time. Exemplary answers to the assignments will be posted online after the submission date for students to review. Some assignments will also be discussed in class.

Class participation: Class participation is encouraged and can greatly improve students’ learning in this class. Class participation will not be graded; however, it will be considered favorably if a student is between grades. Note, however, that quality is more important than quantity. In this spirit, students are expected to attend class regularly and come to class prepared.

### Economics

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<tr>
<td>363-1004-00L</td>
<td>Operations Research</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>M. Laumanns</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course provides an introduction to operations research methods in the fields of management science and economics. Requisite mathematical concepts are introduced with a practical, problem-solving perspective.</td>
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| Objective | - Introduction to building and using quantitative models in a business / industrial environment  
- Introduction to basic optimization techniques (Linear Programming and extensions, network flows, integer programming, dynamic and stochastic optimization)  
- Understanding the integration of quantitative models into the managerial decision process |
| Content  | The following topics are covered: Systems and models, linear models and the importance of linear programming, duality theory and shadow prices, integer programming, optimization under uncertainty and applications in inventory management. |
| Lecture notes | A printed script will be made available. |
| Literature | Any standard textbook in Operations Research is a useful complement to the course. |
| Prerequisites / notice | Undergraduate calculus, linear algebra, probability and statistics are a prerequisite. |

#### Topics are:
- Introduction to resource and environmental economics
- Importance of resource and environmental economics
- Main issues of resource and environmental economics
- Normative basis
- Utilitarianism
- Fairness according to Rawls
- Economic growth and environment
- Externalities in the environmental sphere
- Governmental internalisation of externalities
- Private internalisation of externalities: the Coase theorem
- Free rider problem and public goods
- Types of public policy
- Efficient level of pollution
- Tax vs. permits
- Command and Control Instruments
- Empirical data on non-renewable natural resources
- Optimal price development: the Hotelling-rule
- Effects of exploration and Backstop-technology
- Effects of different types of markets.
- Biological growth function
- Optimal depletion of renewable resources
- Social inefficiency as result of over-use of open-access resources
- Cost-benefit analysis and the environment
- Measuring environmental benefit
- Measuring costs
- Concept of sustainability
- Technological feasibility
- Conflicts sustainability / optimality
- Indicators of sustainability
- Problem of climate change
- Cost and benefit of climate change
- Climate change as international ecological externality
- International climate policy: Kyoto protocol
- Implementation of the Kyoto protocol in Switzerland
- Economy and natural environment, welfare concepts and market failure, external effects and public goods, measuring externalities and contingent valuation, internalising external effects and environmental policy, economics of non-renewable resources, renewable resources, cost-benefit-analysis, sustainability issues, international aspects of resource and environmental problems, selected examples and case studies.

### Financial Management

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<tbody>
<tr>
<td>363-0561-00L</td>
<td>Financial Market Risks</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>D. Sornette</td>
</tr>
<tr>
<td>Abstract</td>
<td>I aim to introduce students to the concepts and tools of modern finance and to make them understand the limits of these tools, and the many problems met by the theory in practice. I will put this course in the context of the on-going financial crises in the US, Europe, Japan and China, which provide fantastic opportunities to make the students question the status quo and develop novel solutions.</td>
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#### Notice
- Undergraduate calculus, linear algebra, probability and statistics are a prerequisite.
Objective
The course explains the key concepts and mechanisms of financial economics, their depth and then stresses how and why the theories and models fail and how this is impacting investment strategies and even a global view of citizenship, given the present developing crises in the US since 2007 and in Europe since 2010.

- Development of the concepts and tools to understand these risks and master them.
- Working knowledge of the main concepts and tools in finance (Portfolio theory, asset pricing, options, real options, bonds, interest rates, inflation, exchange rates)
- Strong emphasis on challenging assumptions and developing a systemic understanding of financial markets and their many dimensional risks

Content
1- The Financial Crises: what is really happening? Historical perspective and what can be expected in the next decade(s). Bubbles and crashes. The illusion of the perpetual money machine.

2- Risks in financial markets
- What is risk?
- Measuring risks of financial assets
- Introduction to three different concepts of probability
- History of financial markets, diversification, market risks

3- Introduction to financial risks and its management.
- Relationship between risk and return
- Portfolio theory: the concept of diversification and optimal allocation
- How to price assets: the Capital Asset Pricing Model
- How to price assets: the Arbitrage Pricing Theory, the factor models and beyond

4- Financial markets: role and efficiency
- What is an efficient market?
- Financial markets as valuation engines: exogeneity versus endogeneity (reflexivity)
- Deviations from efficiency, puzzles and anomalies in the financial markets
- Financial bubbles, crashes, systemic instabilities

5- An introduction to Options and derivatives
- Calls, Puts and Shares and other derivatives
- Financial alchemy with options (options are building blocks of any possible cash flow)
- Determination of option value; concept of risk hedging

6- Valuation and using options
- A first simple option valuation model
- The Binomial method for valuing options
- The Black-scholes model and formula
- Practical examples and implementation
- Realized prices deviate from these theories: volatility smile and real option trading
- How to imperfectly hedge with real markets?

7- Real options
- The value of follow-on investment opportunities
- The timing option
- The abandonment option
- Flexible production
- Conceptual aspects and extensions

8- Government bonds and their valuation
- Relationship between bonds and interest rates
- Real and nominal rates of interest
- Term structure and Yields to maturity
- Explaining the term structure
- Different models of the term structure

9- Managing international risks
- The foreign exchange market
- Relations between exchanges rates and interest rates, inflation, and other economic variables
- Hedging currency risks
- Currency speculation
- Exchange risk and international investment decisions

Lecture notes
Lecture slides will be available on the site of the lecture

Literature
Corporate finance
Brealey / Myers / Allen
Eight edition

+ Additional paper reading provided during the lectures

Prerequisites / notice
None

<table>
<thead>
<tr>
<th>Abstract</th>
<th>Corporate Finance</th>
<th>W+</th>
<th>3 credits</th>
<th>2G</th>
<th>M. Neuhaus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>Corporate Finance, investment management, business valuation, value based management &amp; compensation, financial reporting today &amp; in future, financial reporting value chain, reporting on non-financial measures, such as corporate sustainability reporting, mergers &amp; acquisitions, legal aspects, taxes, corporate governance - risk management - internal controls &amp; mgmt. information systems, turnaround.</td>
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<td>Content</td>
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The syllabus includes the following topics:
- understand basic components of risk management in organizations
- resilient organizational processes for managing uncertainty
- risk perception
- decision-making under uncertainty
- risk communication
- risk mitigation
- know psychological foundations of risk perception, decision-making under risk, and risk communication
- know organizational principles for managing uncertainty
- apply theoretical foundations to applied issues such as safety management, regulatory activities, and technology design and implementation in different domains (e.g. transport systems, IT, insurance)

Using uncertainty management by organizations and individuals as conceptual framework, risk management and risk implications of new technologies are treated. Three components of risk management (risk identification/evaluation, risk mitigation, risk communication) and underlying psychological and organizational processes are discussed, using company case studies to promote in-depth understanding.

This course will cover how to prepare and deliver your future presentations. The following contents will be covered: the most important elements of a powerful presentation, structure of prepared presentations, do’s and don’ts of a professional presentation, dealing with nervousness, how to work with Power Point, body language (gestures, facial expressions, voice, eye contact), handling of Q&A, speaking elements of a powerful presentation, structure of prepared presentations, do’s and don’ts of a professional presentation, dealing with nervousness.

There are texts for each of the course topics made available before the lectures.

The course is restricted to 40 participants who will work closely with the lecturers on case studies prepared by the lecturers on topics relevant in their own companies (Swiss Re, Skyguide, Swisscom).

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Abstract
This course focuses on the challenges in managing multi-business corporations, and covers topics related to the vertical and horizontal scope of business activities.

Objective
Course Topic and Learning Objectives:
Large- and medium-sized corporations play a central role in the economic activity of most developed and developing countries. Many of these organizations perform multiple business activities in multiple markets. In the face of increasing international competition, globalization, technological development, deregulation, and the emergence of new markets and industries, operating such a portfolio of business activities poses important managerial challenges forcing corporations to continuously re-consider their vertical and horizontal scope and boundaries.

The course Corporate Strategy draws from a wide range of theories and methods to develop an understanding of the conceptual frameworks, debates, and developments concerning decisions associated with the management of multi-business corporations. We will cover the key questions driving a firm's corporate strategy, including:
- In what markets to compete with which businesses?
- Which activities should be performed by the firm and which should be outsourced (i.e. "make" or "buy" decisions)?
- What are the most appropriate approaches to growth and divestiture?
- How do institutional forces impact corporate strategy?

Specifically, we will examine how organizations manage their portfolio of business activities and markets to achieve competitive advantage through vertical integration, cooperative strategies such as strategic alliances and joint ventures, corporate diversification, mergers and acquisitions, divestitures, and globalization/international strategies, and strategic renewal.

Format:
The course is a combination of lectures about concepts/methods, guest lectures, case studies/assignments, and group debates.

The course homepage can be found at: http://www.smi.ethz.ch/education/courses/corporatestrategy

Learning outcomes professional competence
- The students learn and understand the management basics of inter-firm cooperation and organizational networks (business models, incl. risk, communication, etc.)
- Realize the value creation potentials of alliances (added value)
- Understand underlying theoretical models (Transaction cost theory, principal agent, game theory)
- Identify and understand specific forms of collaboration (Strat. All., JV, Networks, M&A, etc.)
- Apply tools hands on in real companies (in coll. with companies)

Learning outcomes methodological competence
- Writing academic papers
- Developing structured documentation of interviews
- Transferring theory directly into application
- Contributing to the learning journey

Learning outcomes social competence
- Work together with industrial partners
- Improving communication skills as basics for collaboration
- Developing and applying team work skills
- Coping with conflicts resolution in teams

Content
The constantly augmenting complexity of technologies and systems, the increased pressure caused by competition, the need for shortening time-to-market and the thereby implied growing risks force organizations to increasingly focus on core competencies. Collaboration with external partners is a key value creation opportunity for successful ventures. This type of cooperation also has implications on daily management activities. This lecture will provide a better understanding of special requirements needed for management of cooperation issues.

Content:
- Introduction to theory and management of inter-firm collaboration and networks.
- Description of the formation, management and evolution of collaborations and networks.
- Collaborations in marketing, development, manufacturing (e.g. NUMMI).
- Special forms of collaborations: mergers & acquisition (e.g. pre- and post-merger activities, joint venture, strategic alliances (e.g. Doz & Hamel, networks, virtual communities)

Learning journey:
In an introductory lecture we will give an overview of the theoretical framework and explain the concept of the lecture (Sept. 18, 2014). In weeks 2-5 you will work on a first assignment on six different aspects of the underlying framework: strategy and activities, structure and process, culture and people orientation, interaction and roles, risk and trust, knowledge and learning. This first assignment will give you the basics to participate in the second part (Oct.30-31.2014, 2014) of this seminar. There you will present the results of the first assignment and get additional theoretical input to perform the 2nd assignment. The second assignment will be to analyze real alliance projects in the partner companies. The final lesson will be used as a best practice exchange together with our industrial partners (Dec.18, 2014).

Lecture notes
- Lecture script
- Current course material
- Harvard Case Studies
- Reader with current papers

Literature
A list with recommended publications will be distributed in the lecture.

Additional Books:
HBR Collaborating Effectively ISBN 978-1-4221-6264-4
HBR on Mergers and Acquisitions: ISBN 1-57851-555-6

Prerequisites / notice
The number of students participating in the lecture is limited to 30.
Abstract
The course introduces the students to the long-standing tradition of actively involving users of technology and other knowledge-intensive products in the development and production process, and through own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies.

Objective
The course includes both lectures and exercises alternately. The goal is to understand the opportunity of user innovation for management and develop strategies to harness the value of user-developed ideas and contributions for firms and other organizations.

The students actively participate in discussions during the lectures and contribute presentations of case studies during the exercises. The combination should allow to compare theory with practical cases from various industries.

The course presents and builds upon recent research and challenges the students to devise innovation strategies that take into account the availability of user expertise, free and public knowledge, and the interaction with communities that span beyond one organization.

Content
This course on user innovation extends courses on knowledge management and innovation as well as marketing. The students are introduced to the long-standing tradition of actively involving users of technology and other knowledge-intensive products in the development and production process, and through own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies. Theoretical underpinnings taught in the course include models of innovation, the structuration of technology, and an introduction to entrepreneurship.

Lecture notes
The slides of the lectures are made available and updated continuously through the SMI website:

Literature
Relevant literature for the exam includes the slides and the reading assignments. The corresponding papers are either available from the author online or distributed during class.

363-0777-00L Technology Transfer
Number of participants limited to 50.

W 2 credits 2V

Abstract
Goals of technology transfer with focus on spin-off and start-up creation. Start-up ecosystem, business model innovation, intellectual property, early stage financing and negotiation. Visit to Technopark and Hub Zurich. Guest speakers, meetings with start-up founders.

Objective
- Ability to take successful actions in a technology transfer process either in your own start-up or within a larger organization
- Get familiar with the start-up ecosystem
- Foster entrepreneurial thinking!

Content
Technology Transfer is a powerful tool to foster economic growth. From the macro-economic perspective, funds invested into basic research flow back to the society through the creation of new jobs, the establishment of talent pools and tax substrates. Spin-off companies and start-ups play a major role in implementing technology transfer. The lecture focuses on the significance and goals of technology transfer and the success factors for technology-oriented spin-off and start-up companies. The major challenge is to bridge the gap between technology push and market pull. Hence the innovation value chain and start-up ecosystem will be thoroughly discussed and the key aspects for building successful start-ups will be analyzed. Special topics addressed include securing intellectual property, business model innovation, early stage financing, as well as negotiation strategies. The course hosts selected speakers from the industry and endorses personal meetings and presentations with start-up founders. This includes a visit to the Hub and Technopark Zurich. The course requirements are active participation and completion of the case study group work, based on real start-ups and presented in class. Strong link between theory and practical examples.

The course is offered in 3 block days.

Blockday 1 - 27.10.15: Introduction and science push
- Introduction to Technology Transfer (Lesley Spiegel)
- Presentation of the case study group work (Balint Dioszegi)
- From science to market (Dr. Marjan Kraak, ETH Transfer, Head Start-ups)
- Securing intellectual property (Dr. Claudius Dietzsch, Medela)

Blockday 2 - 10.11.15: Start-up ecosystem and market pull
- The start-up ecosystem (Lesley Spiegel)
- Innovation in a mature start-up (Dr. Eikehard Zwicker, CEO Alstom Inspection Robotics)
- Getting started with your venture: ETH Entrepreneur Club (President ETH Entrepreneur Club)
- Negotiation and conflict management (Prof. Dr. Michael Ambühl)
- Early stage financing models (Erika Puyal, Head Start-up Finance, Zurich Kantonalbank)

Blockday 3 - 24.11.15: Presentation of student case study group work and visit to the Hub and Technopark Zurich
- Student presentations of case study group work (Lesley Spiegel)
- Success story: South Pole Carbon Asset Management - from spin-off to world leader (Thomas Camerata, Co-Founder)
- Visit of the Hub Zurich and presentation of Hub Start-up
- Visit of the Technopark Zurich and presentation of 3 start-ups
- ICT: Rayner Entertainment (Oliver Flückiger)
- Foodtech: Eatemy (Judith Ellens)
- Medtech: Ability (Mario Thomman)

Lecture notes
Slides in English will be available for download.

For further information, please visit:
http://www.timgroup.ethz.ch/education/Courses_at_TIMGROUP

Prerequisites / notice
Syllabus will be presented during lecture.
- Case study (group work)
- Maximal number of students: 50
- Course registration open until 19.10.15.
- In case of non-attendance: Mandatory de-registration until 19.10.15!
- Contact: Balint Dioszegi, bdioszegi@ethz.ch (D-MTEC)

363-0884-00L Industrial Engineering and Management Methodology for Theses in Companies

Abstract
This is a preparation course for theses in industry: Criteria of scientific work, writing the final report, using research resources at ETH. Using case studies, content of other lectures is discussed with regard to the special challenges during theses: Systems Engineering, Social science methods for empirical data collection and analysis, project management, presentation technique.
The objective of this course is to provide students with a practical toolset of techniques, procedures and hints for a successful scientific thesis (Bachelor/Master/MAS Thesis) in industry. The course is held by assistants of professorships at D-MTEC.


Project Management: tasks plan, milestones, roles, communication
Scientific work: research, resources, citation, argumentation
Presentation: techniques, procedure, handouts, significance
Final report: organization, layout, figures, formal requirements, appendix

Further reading: http://www.timgroup.ethz.ch/education/Courses_at_TIMGROUP
Handouts of the presentations / course materials have to be downloaded and printed out before the course (see link above).

The course is intended for students who want to carry out a thesis in industry, in general these are:

(1) MSc-students MTEC or MAVT with master thesis (MA) during the next term and supervised by MTEC, (corresponds to 3rd or 4th semester Master) and
(2) BSc-students MAVT with bachelor thesis (BA) in industry and supervised by MTEC, as well as with full MTEC focus (corresponds to 5th or 6th semester Bachelor) or
(3) MAS MTEC students in 3rd semester for MA during the next term.

Important note: Credits will only be awarded to students according to (1), (2) or (3). Prerequisites for obtaining the credit or "Testat": being present during the whole course (presence list) and prior study of documents provided on the Internet and of the book Züst, R.: Einstieg ins Systems Engineering. 3. Aufl., Verlag Industrielle Organisation, Zürich 2004.

Other students on request (limited places).

Important: the chair coaching your BA/MA defines whether the course is mandatory. Please contact your chair!

Electronic enrollment until 08.09.2015 required. Without electronic enrollment participation in the course can't be confirmed. The course is held "en bloc" at the beginning of the semester.

Date: Friday 11.09.2015 (13:15-17:00), location: HG E33.1 (ETH main building) and Saturday, 12.09.2015 (09:15-17:00), location: HG E33.1 (ETH main building). Participation at both days required (Friday afternoon and Saturday whole day).

The course is held in English; handouts are available in English.

Besonderes (deutsche Version):
Der Kurs richtet sich an Studierende, welche an einer Professor des D-MTEC eine Arbeit in der Wirtschaft schreiben werden. Im Allgemeinen sind dies:

(1) MSc-Studierende MTEC oder MAVT mit Masterarbeit (MA) im kommenden Semester, die vom MTEC betreut wird, (entspricht 3. oder 4. Semester Master) sowie
(2) BSc-Studierende MAVT mit Bachelorarbeit (BA) in der Wirtschaft, die vom MTEC betreut wird, sowie mit vollem MTEC Fokus (entspricht 5. oder 6. Semester Bachelor) oder
(3) MAS MTEC-Studierende im 3. Semester für MA im kommenden Semester.


Andere Studierende auf Anfrage (beschränkte Anzahl Plätze).

Wichtig: die Professor, welche die jeweilige BA/MA betreut, legt fest, ob der Besuch der Veranstaltung obligatorisch ist. Bitte informieren Sie sich dort!

Elektronische Einschreibung bis zum 08.09.2015 notwendig. Ohne elektronische Einschreibung kann Ihre Teilnahme am Kurs nicht bestätigt werden.

Der Kurs wird als Blockkurs zu Beginn des Semesters gehalten.

Termin: Freitag, den 11.09.2015 (13:15-17:00) im HG E33.1 und Samstag, 12.09.2015 (09:15- ca. 17:00) im HG E33.1 (ETH Hauptgebäude). Anwesenheitspflicht an beiden Tagen (Freitagabend und Samstag ganztags).

Die Veranstaltung wird auf Englisch gehalten; Handouts sind in Englisch verfügbar.
Technology ventures are significantly changing the global economic picture. Technological skills increasingly need to be complemented by entrepreneurial understanding.

This course offers the fundamentals in theory and practice of entrepreneurship in new technology ventures. Main topics covered are success factors in the creation of new firms, including founding, financing and growing a venture.

See course website

Lecture slides and case material

This course provides theory-grounded knowledge and practice-driven skills for founding, financing, and growing new technology ventures. A critical understanding of dos and don'ts is provided through highlighting and discussing real life examples and cases.

This course teaches students about the basic principles of scientific work in the field of social sciences. The goal is to motivate students to develop an own thesis design and write scientific articles.

The course is mandatory for MSc. students and recommended for MAS students who write their Master Thesis at the Chair of Strategic Management and Innovation.

Participation to both sessions are mandatory to receive the credit, there will be no exceptions.

If a student can't take part in one of the sessions, the course has to be taken the following semester.

This course teaches students about the basic principles of scientific work in the field of social sciences. The goal is to motivate students to develop an own thesis design and write scientific articles.

The course is mandatory for MSc. students and recommended for MAS students who write their Master Thesis at the Chair of Strategic Management and Innovation - those who will be served first.

- The course will be given once every semester by Dr. Zeynep Erden Özkol and the PhD students of the chair
- The course takes two days, one for lecture, one for student paper presentations. Participation to both sessions are mandatory to receive the credit, there will be no exceptions.
- Students who participate in the lecture and present a paper receive 1 credit point. The course and the presentations will be given in English.

This course has a number of objectives: (i) To outline the problem of climate change (ii) to discuss and compare the theoretical economic solutions to combating climate change (iii) to present existing climate change mitigation actions in an economic context and (iv) to outline possible future climate policy issues.


Nicolay Siggelkow (2007) Persuasion with Case Studies, AMJ Vol. 50, No. 1


Perman et al. (2003), Natural Resource and Environmental Economics, Pearson Addison Wesley.

Does not take place this semester.


Bayerischer Verlag für Wirtschaftswissenschaften.

Die diesjährigen Veranstaltung trägt den Titel "Wertbeitrag der Beschaffung - bewährte und neue Ansätze".

Does not take place this semester.


Prerequisites / notice

Prerequisites: The course relies heavily on the concepts and techniques used in basic game theory. Therefore prior knowledge is recommended.
Based on several core Human Resource Management processes (e.g. recruiting, performance management, reward, training and development), this seminar teaches practical skills in HRM and leadership in teams from a managerial point of view. Using a variety of interactive methods and discussions of real-life situations, it provides a highly practice-oriented approach to dealing with potential HRM- and team-related conflicts at work.

Participants are able to cope with potentially difficult HRM-related situations they may encounter as line managers and team leaders.

The main aim of this course is to analyse the goals of monetary policy and to review the instruments available to central banks in order to pursue these goals. It will focus on the transmission mechanisms of monetary policy and the differences between monetary policy rules and discretionary policy. It will also make connections between theoretical economic concepts and current real world issues.

The number of participants is limited. Please send an email to bms@ethz.ch by 03.08.15 for your registration.

**365-1019-00L**  
**Human Resource Management: Skills in Practice**  
Exclusively for MAS MTEC students (third semester).

- Limited number of participants: a minimum of 10 persons and a maximum of 25 persons. Please register by 15.10.2015 at the latest via myStudies

**Abstract**  
Based on several core Human Resource Management processes, this seminar teaches practical skills in HRM and leadership in teams. Using a variety of interactive methods and discussions of real-life situations, it provides a highly practice-oriented approach to dealing with potential HRM- and team-related conflicts at work.

**Objective**  
Participants are able to cope with potentially difficult HRM-related situations they may encounter as line managers and team leaders.

**Content**  
Based on several core Human Resource Management processes (e.g. recruiting, performance management, reward, training and development), this seminar teaches practical skills in HRM and leadership in teams from a managerial point of view. Using a variety of interactive methods (e.g. role plays) and discussions of real-life situations, it provides a highly practice-oriented approach to dealing with potential HRM- and team-related conflicts at work. The course also includes a guest lecture on diversity and gender issues at work.

**Literature**  
Will be announced and published ahead of each session.

**Prerequisites / notice**  
Prior participation in Prof. Grote's lecture 'Human Resource Management: Leading Teams' is highly recommended.

**363-1028-00L**  
**Entrepreneurial Leadership**  
Limited number of participants.

**Abstract**  
This seminar provides the most ambitious and best performing master students at MTEC with the challenging opportunity of a real case on strategy, innovation and leadership in close collaboration with the top management of an outstanding company - in 2015: PwC Switzerland

**Objective**  
In your team, you will work on a specific assignment that flows from the current strategic agenda of the board. While gaining substantial insights into the structure, dynamics and challenges of the advisory and assurance industry, you immerse into the business model and strategic landscape of the corporate partner. You visit their headquarter, conduct interviews with members of the management team, experienced consultants as well as internal and external experts before you discuss your ideas with top executives. To secure impact, it is key that you formulate your recommendations from a deep understanding of the authentic leadership culture of the corporate partner.

**Content**  
In this endeavour you are coached and supported by:
- Guidela Grote, Chair of Work and Organizational Psychology
- Stefano Brusoni, Chair of Technology and Innovation Management
- Claude Siegenthaler, HSE / St. Gallen MBA
- Georg von Krogh, Chair of Strategic Management and Innovation
- Pius Baschera, Chair of Entrepreneurship

**Prerequisites / notice**  
Please apply for this course via the official website (www.mtec.ethz.ch) and send your application form together with a CV and transcript of records to andreakurath@ethz.ch. Apply no later than August 25. Yet early registrations are welcomed.

The number of participants is limited to 18.

**ECTS**: 4

**363-1021-00L**  
**Monetary Policy**  
Limited number of participants.

**Abstract**  
The main aim of this course is to analyse the goals of monetary policy and to review the instruments available to central banks in order to pursue these goals. It will focus on the transmission mechanisms of monetary policy and the differences between monetary policy rules and discretionary policy. It will also make connections between theoretical economic concepts and current real world issues.

**Objective**  
This lecture will introduce the fundamentals of monetary economics and explain the working and impact of monetary policy.

**Literature**  
The course will be based on chapters of:

**Prerequisites / notice**  
Basic knowledge in international economics and a good background in macroeconomics. The course website can be found at: http://www.kof.ethz.ch/en/events/teaching/
365-1029-00L Harvard Business School: Financial Accounting
Online
Exclusively for MAS MTEC students (first semester).
The online course will be open from 14.09.2015 to 14.02.2016. Within this time, students can proceed through the course at their own convenience. Seat time is about 25 hours.

All MAS MTEC students will receive further information by e-mail on 14.09.2015.

Abstract
This course is a web-based, online, interactive introduction to financial accounting within the context of management requirements. It has been developed by Harvard Business Publishing.

Objective
The online course uses the case study "Global Grocer" to guide the students from company foundation with a simple balance sheet towards more complex balance sheets, income and cash flow statements. This ensures an integrated understanding of company transactions.

Content
1. Introductory Section
   1.1 Terms and Concepts
   1.2 The Balance Sheet
   1.3 Income Statement
   1.4 Accounting Records
   1.5 The Statement of Cash Flows
2. Advanced Section
   2.1 Revenue & Receivables
   2.2 Inventories and Cost of Sales
   2.3 Depreciation and non-current Assets
   2.4 Liabilities and Financing Costs
   2.5 Investment & Investment Income
   2.6 Deferred Taxes and Tax Expense
   2.7 Owner's Equity

Lecture notes
The Financial Accounting online-course is an ideal complement to the lectures "Accounting for Managers (363-071-00)" as well as "Financial Management (363-0560-00)" with the purpose to further deepen the student's knowledge of accounting. Parts of the course content are overlapping, however, it is provided in a different context. Not covered in the online course is managerial accounting which is an important topic in the lecture "Accounting for Managers".

Literature
Needles & Powers (2010), Financial Accounting, 11e, South-Western College Pub

Prerequisites / notice
The online course will be open from 14.09.2015 to 14.02.2016. Within this time, students can proceed through the course at their own convenience. Seat time is about 25 hours. The online course should be accessed and activated only if students wish to take and complete it.

No lectures are offered for this course. Specific course topics can be discussed with other course participants, and any questions regarding the course content will be answered by an expert on the learning platform Moodle.

363-1044-00L Applied Negotiation Seminar
Due to didactics reasons, the number of participants is limited to 30.

Prerequisites: Successful completion of lectures "363-1039-00L Introduction to Negotiation".

Abstract
The block-seminar combines lectures introducing negotiation, negotiation engineering and specific aspects of successful negotiation with the respective application through in-class negotiation case studies and games.

Objective
Students obtain a concentrated insight into key aspects of the field of negotiations, negotiation engineering and specific aspects of successful negotiation. Multiple opportunities to apply that knowledge in different negotiation situations allow for an in-depth learning experience.

365-1035-00L Quality Management
Exclusively for MAS MTEC students (third semester).

Limited number of participants: a minimum of 10 persons and a maximum of 30 persons. Please register by 16.09.2015 at the latest via myStudies.

Attendance on the first course day is highly recommended.

Abstract
The design of this course is intended to introduce quality management from an operations and manufacturing viewpoint. Many of the key topics covered throughout the course can be located in the Content section below:

Objective
This course will provide students with the underlying principles and techniques surrounding Quality Management with an emphasis on the application in manufacturing and services settings. Students will develop a working knowledge of the best practices in Quality and Process Management. Students will learn to view quality from a variety of functional perspectives and in the process, gain a better understanding of the problems associated with improving quality. The course aims to impart knowledge on the quality management process and key quality management activities. Specifically it aims to: compare and contrast the various tools used in quality management, comprehend the concepts of customer’s value, discuss the emerging tendencies toward global competitiveness, understand different perspectives on quality, explore six-sigma management and its tools, demonstrate how to design quality into product and services, describe the importance of developing a strategic plan for Quality Management, and discuss the importance of ‘benchmarking’ as a means of identifying the choice of markets.
Content

Major Topics:

- Total Quality Management (TQM): Excellence in manufacturing/service, factors of excellence, applications of TQM
- Process Management: Quality function development (QFD) and quality assurance systems, factors affecting process management
- Benchmarking Procedures
- Statistical Process Control (SPC) and failure mode and effect analysis (FMEA) procedures
- Demming's 14 points of Management
- Continuous Improvement
- Supplier Evaluation: Managing Supplier Quality
- Manufacturing capabilities: Quality as a core focus, cost management, competencies
- Environmental Factors: Turbulent environments, manufacturing intensity, uncertainty
- Quality Systems Certification Policy:
  - Six Sigma
  - ISO 9001, 9002, 9003 / ISO 14001 (Environmental quality policies)

Literature

Readings:

Required:

Recommended:

363-1049-00L  Contemporary Conflict Management  W  3 credits  2V  M. Ambühl

Abstract

The course provides students with theoretical background and practical insights in conflict management in the 3 areas international, business and interpersonal (legal) relations. Students are introduced into theoretical concepts related to the research field and real world case studies including examples of international conflicts, WWI, old and new regional conflicts, business and mediation.

Objective

Students will gain:
- knowledge of history of conflict management;
- comprehension of major ideas in the theory and practice of conflict management, mediation, transformation and resolution;
- application of theoretical concepts to current conflict situations;
- evaluation of conflict situations in international relations and business.

Content

The following topics will be covered:
- history of international and regional conflicts;
- theoretical concepts of conflict management;
- theoretical models of arms races and conflict escalation;
- case studies in international conflicts, as well as in business.

Distinguished guest speakers will be invited.

Literature

- Peter Wallenstein (2012): Understanding Conflict Resolution. SAGE, London, UK

365-1067-00L  (Un)ethical Decision Making: Alternative and Critical Thinking in Management  W  1 credit  1S  A. Vaccaro

Exclusively for MAS MTEC students (third semester).

Limited number of participants: a minimum of 10 persons and a maximum of 40 persons.

Abstract

This course is about decision making processes in complex situations involving financial, relational and ethical problems. First, it provides fundamental tools for addressing problematic situations. Second, it discusses how stakeholders' ethical expectations and social responsibility issues can be effectively implemented and integrated in organizational systems and strategic planning processes.

Objective

- Become familiar with tools and procedures to prevent, identify and resolve corporate fraud and crime in organizations
- Understanding the mutual relationship between financial, relational and ethical drivers in managerial decision making
- Become familiar with tools and procedures to prevent and resolve corporate crises and scandals
- Understanding the opportunities associated with the corporate social responsibility (CSR) movement and how to integrate CSR in organizational and strategic planning
- Create an effective CSR strategic planning process to successfully develop and implement a CSR package
- Understand a variety of strategic CSR planning tools
- Become familiar with creating deep destructive change in pursuit of dual economic and social value
- Fraud and corruption in organizations
- Crisis management
- Personnel problems: Preventing and managing mobbing and sexual harassment
- Global criminal networks

Content

- Lecture notes

Most classes are taught through a series of mini-cases and notes that represent real management decisions.

Some classes are complemented with readings from prominent media resources, guest speakers and experimental exercises.
This course is based on mini-cases that will be distributed during the classes.

Moodle of the course: https://moodle-app2.let.ethz.ch/course/view.php?id=1425

This is an interactive course.

### Master Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>365-0899-00L</td>
<td>Master's Thesis in a Company</td>
<td>O</td>
<td>12 credits</td>
<td>24D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

**Abstract**
In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is supervised by the tutor and is performed within a private company.

**Objective**
In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is supervised by the tutor and is performed within a private company.

---

**MAS in Management, Technology, and Economics - Key for Type**

- **O**: Compulsory
- **W+**: Eligible for credits and recommended
- **W**: Eligible for credits

<table>
<thead>
<tr>
<th>Code</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
</tr>
</tbody>
</table>

**Key for Hours**

- **V**: lecture
- **G**: lecture with exercise
- **U**: exercise
- **S**: seminar
- **K**: colloquium

<table>
<thead>
<tr>
<th>Code</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
<td>P</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
</tr>
</tbody>
</table>

**ECTS**

- European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
### MAS in Medical Physics

#### Specialisation A: Radiation Therapy

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>465-0957-00L</td>
<td>Physiology and Anatomy for Medical Physicists I</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>not available</td>
</tr>
<tr>
<td></td>
<td>Does not take place this semester.</td>
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</tr>
<tr>
<td>Abstract</td>
<td>Introduction into the functions and structural properties of tissues, organs, systems of organs and the human body as an organism.</td>
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<tr>
<td>Objective</td>
<td>Grundlagen in Physiologie und Anatomie des menschlichen Körpers sowie Kenntnisse und korrekte Anwendung der medizinischen Fachsprache</td>
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<tr>
<td>Content</td>
<td>“Physiology and Anatomy for Medical Physicists I &amp; II” provides an introduction into the functions and structural properties of tissues, organs, systems of organs and the human body as an organism. The major part of the course is dedicated to the most important systems of organs. Anatomy and physiology are discussed integrated in the thematical order. Each topic is preceded by some comments concerning evolution and/or embryology. The content of the lessons is adapted to engineers and an emphasis is set to medical terminology. In a supplementary part of the course a few topics in applied physiology will be presented.</td>
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<tr>
<td>465-0953-00L</td>
<td>Biostatistics</td>
<td>W</td>
<td>2 credits</td>
<td>2V+1U</td>
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<td></td>
<td>Does not take place this semester.</td>
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<tr>
<td>Abstract</td>
<td>The course deals with simple quantitative and graphical as well as more complex methods of biostatistics. Contents: Descriptive statistics, probability theory and design of experiments, testing hypotheses, confidence intervals, correlation, simple and multiple linear regression, analysis of variance, logistic regression, survival analysis (Kaplan-Meier curves and Cox-regression).</td>
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<tr>
<td>Objective</td>
<td>This 1-week theory and practical class offers the possibility to enjoy a variety of research and clinical areas in diagnostic and nuclear medicine. It gives insight into practical concepts and techniques that are discussed thoroughly as the class is performed within actual laboratories with real radiation sources.</td>
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<tr>
<td>Content</td>
<td>The course starts with the physical basis of radiography (from X-ray production to image detectors) and continues with the basic parameters of image quality in radiography (contrast, resolution, noise) and their measurement methods. Specific applications of radiation diagnostic are then considered separately. The physics of fluoroscopy and mammography is presented with emphasis on the type of detectors. Computer tomography starts from mono- to multi-detector row technology and finishes with the dose indicators and the impacts of acquisition parameters on patient dose. Nuclear medicine is approached through the production and labeling of radiopharmaceuticals before explaining the aspects related to quality control like the stability of the compounds, nuclide- and radionuclide purity as well as apyrogenicity and sterility. Imaging aspects of nuclear medicine are treated in details for SPECT and PET through the instrumentation, the reconstruction algorithms and the corresponding image quality. Finally, the aspects related to patient dose and radiation protection of the personnel are considered separately for diagnostic radiology and nuclear medicine. The general frameworks of external as well as internal irradiation are presented and practical examples of dose calculations are explained.</td>
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<tr>
<td>227-0385-10L</td>
<td>Biomedical Imaging</td>
<td>W</td>
<td>6 credits</td>
<td>5G</td>
<td>S. Kozerke, U. Moser, K. P. Prüssmann, M. Rudin</td>
</tr>
<tr>
<td></td>
<td>New course. Not to be confused with 227-0385-00L of fall 2014.</td>
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<tr>
<td>Abstract</td>
<td>Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography and ultrasound imaging techniques.</td>
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<tr>
<td>Objective</td>
<td>To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.</td>
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<tr>
<td>Content</td>
<td>- X-ray imaging</td>
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<tr>
<td></td>
<td>- Computed tomography</td>
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<td></td>
<td>- Single photon emission tomography</td>
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<td></td>
<td>- Positron emission tomography</td>
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<td></td>
<td>- Magnetic resonance imaging</td>
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<td></td>
<td>- Ultrasound/Doppler imaging</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes and handouts</td>
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</tr>
<tr>
<td>Literature</td>
<td>Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011</td>
<td></td>
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<tr>
<td>Prerequisites / notice</td>
<td>Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming</td>
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<tr>
<td>227-0943-00L</td>
<td>Radiobiology</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>M. Pruschny</td>
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<tr>
<td></td>
<td>The purpose of this course is to impart basic knowledge in radiobiology in order to handle ionizing radiation and to provide a basis for predicting the radiation risk.</td>
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<tr>
<td>Abstract</td>
<td>By the end of this course the participants will be able to: a) interpret the 5 Rs of radiation oncology in the context of the hallmarks of cancer b) understand factors which underpin the differing radiosensitivities of different tumors c) follow rational strategies for combined treatment modalities of ionizing radiation with targeted agents d) understand differences in the radiation response of normal tissue versus tumor tissue e) understand different treatment responses of the tumor and the normal tissue to differential clinical-related parameters of radiotherapy (dose rate, LET etc.).</td>
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</tr>
<tr>
<td>Content</td>
<td>Einführung in die Strahlenbiologie ionisierender Strahlen: Allgemeine Grundlagen und Begriffsbestimmungen; Mechanismen der biologischen Strahleneinwirkung; Strahleneinwirkung auf Zellen, Gewebe und Organe; Modifikation der biologischen Strahleneinwirkung; Strahlenzytogenetik: Chromosomenveränderungen, DNA-Defekte, Reparaturprozesse; Molekulare Strahlenbiologie: Bedeutung inter- und intrazellulärer Signalübermittlungsprozesse, Apoptose, Zellzyklus-Checkpoints; Strahlenrisiko: Strahlensyndrome, Krebsinduktion, Mutationsauslösung, pränatale Strahlenwirkung; Strahlenbiologische Grundlagen des Strahlenschutzes; Nutzen-Risiko-Abwägungen bei der medizinischen Strahlenanwendung; Prädiktive strahlenbiologische Methoden zur Optimierung der therapeutischen Strahlenanwendung.</td>
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<tr>
<td>Lecture notes</td>
<td>Beilagen mit zusammenfassenden Texten, Tabellen, Bild- und Grafikdarstellungen werden abgegeben</td>
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<td>Prerequisites / notice</td>
<td>The former number of this course unit is 465-0951-00L.</td>
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Scanning probe and diffraction techniques allow studying activated atomic processes during early stages of epitaxial growth. For dosimetry, physics in medical research: from atoms to cells, hours 2V+1U, title 3 credits, understanding the functional chain from primary physical effects of ionizing radiation to clinical radiation effects. Dealing with dose as a quantitative measure of medical exposure. Getting familiar with methods to generate ionizing radiation in medicine and learn how they are applied for medical purposes. Eventually, the lecture aims to show the students that medical physics is a fascinating and evolving discipline where physics can directly be used for the benefits of patients and the society.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostuctures which could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure’s shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue’s anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

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<td>W</td>
<td>6</td>
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<td>P. Manser</td>
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<tr>
<td>402-0674-00L</td>
<td>Physics in Medical Research: From Atoms to Cells</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>B. K. R. Müller</td>
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**Specialisation B: General Medical Physics and Biomedical Engineering**

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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

Abstract

Dosimetry in radiotherapy. Planning and implementation of a percutaneous radiation exposure on an anthropomorphic phantom. Verification of the resulting dose distribution.

Objective

Praktische Umsetzung der Lerninhalte der Vorlesungen Medizinphysik I & II bezüglich Dosimetrie bei perkutanen Strahlenexpositionen.

Content

Die Kursunterlagen werden im Blockkurs abgegeben.

Notice

Voraussetzung: Besuch der Vorlesung Medizinische Physik I

Autumn Semester 2015
The course is dedicated to introduce MAS students from Medical Physics to the field of radiodiagnostic and nuclear medicine. Dedicated practicals will illustrate the theory with an emphasis on the relationship between dose and image quality as well as the security problems related to the work with radiations.

Objective

This 1-week theory and practical class offers the possibility to enjoy a variety of research and clinical areas in diagnostic and nuclear medicine. It gives insight into practical concepts and techniques that are discussed thoroughly as the class is performed within actual laboratories with real radiation sources.

Content

The course starts with the physical basis of radiography (from X-ray production to image detectors) and continues with the basic parameters of image quality in radiography (contrast, resolution, noise) and their measurement methods. Specific applications of radiation diagnostic are then considered separately.

The physics of fluoroscopy and mammography is presented with emphasis on the type of detectors. Computer tomography starts from mono- to multi-detector row technology and finishes with the dose indicators and the impacts of acquisition parameters on patient dose.

Nuclear medicine is approached through the production and labeling of radiopharmaceuticals before explaining the aspects related to quality control like the stability of the compounds, nuclide- and radionuclide purity as well as apyrogenicity and sterility.

Imaging aspects of nuclear medicine are treated in details for SPECT and PET through the instrumentation, the reconstruction algorithms and the corresponding image quality.

Finally, the aspects related to patient dose and radiation protection of the personnel are considered separately for diagnostic radiology and nuclear medicine. The general frameworks of external as well as internal irradiation are presented and practical examples of dose calculations are explained.

551-0307-00L  Biomolecular Structure and Mechanism I: Protein Structure and Function

D-BIOL BSc students are obliged to take part I and part II (next semester) as a two-semester course

Abstract

Biophysics of protein folding, membrane proteins and biophysics of membranes, enzymatic catalysis, catalytic RNA and RNAi, current topics in protein biophysics and structural biology.

Objective

Understanding of structure-function relationships in proteins and in protein folding, detailed understanding of biophysics and physical methods as well as modern methods for protein purification and microanalytics.

Lecture notes

Scripts on the individual topics can be found under http://www.mol.biol.ethz.ch/teaching.

Literature

Basics:
- Creighton, T.E., Proteins, Freeman, (1993)
- Fersht, A., Enzyme Structure and Mechanism in Protein Science (1999), Freeman.

Current topics: References will be given during the lectures.

529-0004-00L  Computer Simulation in Chemistry, Biology and Physics

Abstract

Molecular models, Force fields, Boundary conditions, Electrostatic interactions, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, validation of molecular dynamics simulation.

For more information: www.csms.ethz.ch/education/CSCBP

Objective

Introduction to computer simulation of (bio)molecular systems, development of skills to carry out and interpret computer simulations of biomolecular systems.

Content

Molecular models, Force fields, Spatial boundary conditions, Calculation of Coulomb forces, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, validation of molecular dynamics simulation.

Lecture notes

Available (copies of powerpoint slides distributed before each lecture)

Literature

See: www.csms.ethz.ch/education/CSCBP

Prerequisites / notice

Since the exercises on the computer do convey and test essentially different skills as those being conveyed during the lectures and tested at the oral exam, the results of the exercises are taken into account when evaluating the results of the exam.

For more information about the lecture: www.csms.ethz.ch/education/CSCBP

227-0385-10L  Biomedical Imaging

New course. Not to be confused with 227-0385-00L of fall 2014.

Abstract

Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.

Objective

To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

Content

- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

Lecture notes

Lecture notes and handouts

Literature

Webb A, Smith N.B. Introduction to Medical Imaging: Physics, Engineering and Clinical Applications; Cambridge University Press 2011

Prerequisites / notice

Analysis, Linear Algebra, Physics, Basics of Signal Theory, Basic skills in Matlab programming

227-0386-00L  Biomedical Engineering

Abstract

Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.
Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monocolures of physics, math, computer science, engineering, biology, psychology, and even philosophy and history, to discover the encheinments and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions.

**272-0674-00L Introduction to Computational Neuroscience**

**Objective**
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

**Content**

**Lecture notes**
Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino

**AND**

https://www1.ethz.ch/lbb/Education/BME
Objective

The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocyte behaviour.

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxidic and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure's shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

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### 376-1791-00L Introductory Course in Neuroscience I

**Abstract**
The course gives an introduction to the development and anatomical structure of nervous systems. Furthermore, it discusses the basics of cellular neurophysiology and neuropharmacology. Finally, the nervous system is described on a system level with a particular emphasis on the visual system.

**Content**
1) Neuroanatomy I
2) Neuroanatomy II
3) Neurogenesis
4) Axon guidance
5) Action and language development
6) Circadian rhythms
7) Synaptic plasticity
8) Synaptic transmission
9) Neural circuits in vivo
10) Visual pathways and visual processing
11) Somatosensory system
12) Vestibular system
13) Sleep
14) Learning and Memory, mice and human

**Prerequisites / notice**
For doctoral students of the Neuroscience Center Zurich (ZNZ).

### 376-1795-00L Advanced Course in Neurobiology I (Functional Anatomy of the Rodent Brain)

**Abstract**
The goal of this Advanced Course in Neurobiology is to provide students with a broader knowledge in several important areas of neurobiology. The course consists of four parts: Part I deals with various topics in developmental neurobiology, Part II is devoted to aspects of signal transduction. Part III focuses on synaptic transmission. Part IV gives deeper insights into systems neuroscience.

**Objective**
This credit point course is designed for doctoral students who have successfully completed the Introductory Course in Neuroscience at the Neuroscience Center Zurich. The goal is to provide students with a broader and deeper knowledge in several important areas of neurobiology.

**Prerequisites / notice**

### 227-0980-00L Seminar on Biomedical Magnetic Resonance

**Abstract**
Actuel developments and problems of magnetic resonance imaging (MRI)

**Objective**
Getting insight to advanced topics in Magnetic Resonance Imaging

### MAS in Medical Physics - Key for Type

<table>
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<th></th>
<th>Compulsory</th>
<th>Eligible for credits and recommended</th>
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### Key for Hours

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**ECTS**

European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
K. Christiaanse

Significant tasks for spatial development in the future involve the internal development of existing areas, the development of integrated

B. Scholl

Detect, assess and classify the main conflicts of spatial developments and detect need for planning action. Concentrate resources and

Lecture Week 04: Landscape Architecture

ECTS

Compulsory

Type

9U

L. Bühlmann, A. Schneider

115-0300-00L

Preliminary Course: Introduction to Swiss Spatial Planning

Only for MAS, DAS and CAS in Spatial Planning

Tasks of spatial planning; objectives and principles; instruments of spatial planning; federal planning; cantonal structural planning; constructing outside of building zones; communal planning; land use planning; compensation of benefits released by planning; environmental protection and spatial planning; review of the spatial planning act; case studies and exercises.

Objective

The preliminary course introduces students to the fundamentals of formal spatial planning in Switzerland. It gives a first overview over background and context of spatial planning as well as instruments of spatial planning.

115-0341-00L

Lecture Week 01: Introduction to the Programme

Only for MAS and DAS in Spatial Planning.

Discussion of the individual basic understanding of spatial planning; Personal preconditions for and expectations of MAS-program; program concept; knowledge portfolio and learning contract; work environments and tools; introduction to study project 1 with excursion; theoretical background for interdisciplinary team work and spatial design.

Objective

Aim of the first week is, to give participants a first overview over the programme and the first study project, to clarify the above mentioned topics of the individual positions and expectations towards the course as well as to acquire basic knowledge about teamwork and design.

115-0303-00L

Lecture Week 02: Spatial Planning: Function and Methods

Only for MAS, DAS and CAS in Spatial Planning.

Significant tasks for spatial development in the future involve the internal development of existing areas, the development of integrated solutions in cross-cutting areas of housing, transportation, and landscape as well as addressing transboundary tasks in the context of European and global perspectives; fundamental methods in spatial planning for exploring, clarifying and solving spatial tasks.

Objective

Aim of the course unit is the acquaintance and the comprehension of important tasks and principles in spatial planning; important methodical modules like assessment of the situation, concentration on important tasks as well as designing, decision-making and arguing are providing also a base for working on both study projects of the MAS programme.

115-0315-00L

Lecture Week 03: Urban Planning and Urban Design I

Only for MAS, DAS and CAS in Spatial Planning.

Modern urban phenomena and their application to urban design as methods and tools. Lectures are accompanied by design exercises. They are used to project desirable futures and at the same time, they are thought experiments that investigate the qualities of the present reality.

Objective

Introduction in current problems and methods of urban design; insights in current tasks, discussions, projects and basic definitions of city, urban design and urban planning.

115-0337-00L

Lecture Week 04: Landscape Architecture

Only for MAS, DAS and CAS in Spatial Planning.

Information technology and its possibilities for the integration in design; drawing, model and video camera for application in methods for analysis, design and visualisation; recording and visualisation of landscape with geobased data; topology; the regulating power of landscape architecture for the current requirements on the ambient space.

Objective

Introduction in theory and methods of landscape architecture; illustration of a landscaping approach in urban planning; critical examination and reflection about landscape and tools as well as the objectives of its designers; providing fundamentals for a reflected understanding of design.

115-0339-00L

Lecture Week 05: Landscape and Environmental Planning

Only for MAS, DAS and CAS in Spatial Planning.

Discussion of the proposition of sustainability in landscape and environmental planning; comprehending landscape development with a system dynamics approach; planning of landscape development across cantonal and communal boundaries; negotiating various stakeholder interests on the example of watercourse corridors; instruments and approaches for sustainable development of urban landscapes.

Objective

Overview of tasks of landscape and environmental planning as well as essential theories; insights in planning approaches and application of new instruments related to current problems for a sustainable landscape development.

Projects and Individual Work

Number

Title

Type

ECTS

Hours

Lecturers

115-0355-00L

Study Project 1 (Part 1)

Only for MAS in Spatial Planning.

Project 1 takes 2 semesters, continuation in the following spring semester, taking part 2 is obligatory.

Abstract

Development of strategies for sustainable development in the City of Berne: spatial planning analysis of the situation (goals and problems, potentials and risks, strengths and weaknesses); concept design (goals and measures); program development (objective and temporal priorities); preparation for implementation (instruments and procedures), independent group work.

Objective

Detect, assess and classify the main conflicts of spatial developments and detect need for planning action. Concentrate resources and design and evaluate different solutions and demonstrate their feasibility exemplarily. Recognize possibilities and limits of formal and informal planning and applying them practically. Efficient and interdisciplinary work in groups, using individual knowledge and skills of the group members optimally.

MAS in Spatial Planning - Key for Type

<table>
<thead>
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Data: 06.02.2019 13:00 Autumn Semester 2015 Page 880 of 1434
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### ECTS
European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
The Seminar Series features invited experts from a wide range of disciplines, who will present their experiences working with water related topics in international settings. The students will be exposed to many different perspectives, and will be asked to apply the information they learn to specific case studies.

The Seminar Series will provide students with background information on the wide range of topics related to water resources. The lectures challenge the students to evaluate water resources and water resource management in new ways, using tools that have been successfully implemented in real case scenarios. The seminars will include theory, interactive discussions, and the assessment of methodologies. Student participation will be highly encouraged.

The Seminar Series is aimed at offering students the opportunity to learn about water resources in a multi-disciplinary fashion, with a focus on international examples. Selected topics will include: Water & Sanitation, Urban Water Management, Politics & International Water Management, Water Resources & Agriculture, Water Hazards (floods), Water Resources & Ecosystem Services, Integrated Water Resource Management, and Adaptation to Climate Change. For additional details see the course website http://www.ifu.ethz.ch/MAS_SWR/programme/Seminars.

For further information, contact the MAS coordinator, Darcy Molnar (darcy.molnar@ifu.baug.ethz.ch)

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### Compulsory Courses

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<th>Number</th>
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<td>3</td>
<td>2G</td>
<td>P. Molnar, P. Burlando, further speakers</td>
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<td>Number of participants limited to 16. Automatic admittance given to the MAS students.</td>
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<td>Prerequisites / notice</td>
<td>For further information, contact the MAS coordinator, Darcy Molnar (<a href="mailto:darcy.molnar@ifu.baug.ethz.ch">darcy.molnar@ifu.baug.ethz.ch</a>)</td>
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### 102-0287-00L Fluvial Systems

- **Abstract**: The course presents an integrated view of the river basin and fluvial system. The fluvial system is viewed in terms of the dynamics in the transfer of water and sediment, the resulting geomorphology of the river network and streams, and finally the basin and river management options for conservation and restoration.
- **Objective**: The goal of the course is to develop process-understanding of fluvial systems and to introduce the students to appropriate analysis tools.
- **Content**: In the first section, the estimation of basin sediment supply from upland sheet, rill and gully erosion, and basin sediment yield are discussed. The second section focuses on sediment transport in rivers in general, e.g., basic mechanics of sediment laden flows, bedforms, flow resistance, sediment type and load measurement and estimation, the morphology of rivers. It is illustrated how the river network can be analysed in terms of its connectivity and topological characteristics, Channel stability and channel erosion modelling are discussed. The third section looks at fluvial system management in terms of engineering and nonstructural sediment (e.g. upland and channel erosion protection) and water (e.g. the importance of the natural streamflow regime on riverine ecosystem integrity, river rehabilitation) resource management.
- **Lecture notes**: There is no script.
- **Literature**: Study materials (lecture handouts and selected papers) are distributed in class and available on the web.
- **Prerequisites / notice**: Prerequisites: Hydrology 1 and Hydrology 2 (or contact instructor).

### 102-0237-00L Hydrology II

- **Abstract**: The course presents advanced hydrological analyses of rainfall-runoff processes. The course is given in English.
- **Objective**: Tools for hydrological modelling are discussed at the event and continuous scale. The focus is on the description of physical processes and their modelling with practical examples.
- **Lecture notes**: Parts of the script for "Hydrology I" are used. Also available are the overhead transparencies used in the lectures. The semester project consists of a two part instruction manual.
- **Literature**: Additional literature is presented during the course.

### 101-0267-01L Numerical Hydraulics

- **Abstract**: The course presents advanced hydrological analyses of rainfall-runoff processes. The course is given in English.
- **Objective**: Tools for hydrological modelling are discussed at the event and continuous scale. The focus is on the description of physical processes and their modelling with practical examples.
- **Lecture notes**: Parts of the script for "Hydrology I" are used. Also available are the overhead transparencies used in the lectures. The semester project consists of a two part instruction manual.
- **Literature**: Additional literature is presented during the course.

### 103-0237-00L GIS III

- **Abstract**: The course deals with advanced topics in GIS: GIS project lifecycle, Managing GIS, Legal issues, GIS assets & constraints; Geospatial Web Services: technical basics, architecture, functions, interoperability, standards, mashups, portals, applications; Geostatistics; Sensor Web Enablement; Human-Computer Interaction; Cognitive Issues in GIS.
- **Objective**: Students will get a detailed overview of advanced GIS topics. They will go through all steps of setting up a Web-GIS application in the labs and perform other practical tasks relating to Sensor Web Enablement, Human-Computer Interaction, Geostatistics, and Web Processing Services.
- **Lecture notes**: There is no script.

### 102-0227-00L Systems Analysis and Mathematical Modeling in Water Resources

- **Abstract**: The course deals with advanced topics in GIS: GIS project lifecycle, Managing GIS, Legal issues, GIS assets & constraints; Geospatial Web Services: technical basics, architecture, functions, interoperability, standards, mashups, portals, applications; Geostatistics; Sensor Web Enablement; Human-Computer Interaction; Cognitive Issues in GIS.
- **Objective**: Students will get a detailed overview of advanced GIS topics. They will go through all steps of setting up a Web-GIS application in the labs and perform other practical tasks relating to Sensor Web Enablement, Human-Computer Interaction, Geostatistics, and Web Processing Services.
- **Lecture notes**: There is no script.
Urban Water Management
This course supports the course in Biological Wastewater Treatment (102-0217-00L). It is therefore advantageous to follow both courses simultaneously.

Abstract

Objective
The goal of this course is to provide the students with an understanding and the tools to develop their own mathematical models, to plan experiments, to evaluate error propagation and to test simple process control strategies in the field of process engineering in urban water management.

Content
The course will provide a broad introduction into the fundamentals of modeling water treatment systems. The topics are:
- Introduction into modeling and simulation
- The material balance equations, transport processes, transformation processes (kinetics, stoichiometry, conservation)
- Ideal reactors
- Hydraulic residence time distribution and modeling of real reactors
- Dynamic behavior of reactor systems
- Systems analytical tools: Sensitivity, parameter identification, error propagation, Monte Carlo simulation
- Introduction to process control (PID controller, fuzzy control)

Lecture notes
Copies of overheads will be made available.

Literature
There will be a required textbook that students need to purchase:

Prerequisites / notice
This course will be offered together with the course Process Engineering I. It is advantageous to follow both courses simultaneously.

701-1551-00L Sustainability Assessment O 3 credits 2G P. Krüttli, C. E. Pohl

Objective
At the end of the course students should
Know:
- core concepts of sustainable development, and;
- the concept of social justice - normatively and empirically - as a core element of social sustainability;
- important empirical methods for the analysis and assessment of local / regional sustainability issues.

Understand and reflect on:
- the challenges of trade-offs between the different goals of sustainable development;
- and the respective impacts on individual and societal decision-making.

Content
The course is structured as follows:
- Overview of rationale, objectives, concepts and origins of sustainable development;
- Importance and application of sustainability in science, politics, society, and economy;
- Sustainable (local / regional) development in different national / international contexts;
- Analysis and evaluation methods of sustainable development with a focus on social justice;
- Tradeoffs in selected examples.

Lecture notes
Handouts.

Literature
Selected scientific articles & book chapters

102-0217-00L Process Engineering I (Biological Processes) O 3 credits 2G E. Morgenroth

Abstract
Introduction of kinetic models for activated sludge systems and biological nutrient removal as a basis for design and dynamic simulation: Nitrification, denitrification, biological phosphorus removal (ASM1 to ASM3). Kinetics of biofilms, application to full scale reactors. Anaerobic treatment schemes, industrial waste, biogas production, sludge handling. Aerobic thermophilic processes.

Objective
The goal of this unit is to provide the background for the understanding, design and simulation of today's biological wastewater treatment and sludge stabilization processes. The students shall be capable to apply and recognize the limits of the kinetic models which have been developed to simulate these systems.

Content
Microbial transformation processes
Introduction to the activated sludge process
Modeling activated sludge systems
Nitrification / denitrification / biological P elimination
Enrichment, selectors, filamentous growth
Biofilm kinetics and application to full scale plants
Anaerobic processes, industrial applications, sludge stabilization
Aerobic thermophilic processes

Lecture notes
Copies of overheads will be made available.

Literature
There will be a required textbook that students need to purchase (see http://www.ifu.ethz.ch/SWW/education/lectures/Proc_Eng_I for further information).

Prerequisites / notice
This course will be offered together with the course Systems Analysis and Mathematical Modeling. It is advantageous to follow both courses simultaneously. For detailed information on prerequisites and information needed from Systems Analysis and Mathematical Modeling the student should consult the lecture program and important information (syllabus) of Process Engineering I that can be downloaded at http://www.ifu.ethz.ch/SWW/education/lectures/Proc_Eng_I.

651-4031-00L Geographic Information Systems O 3 credits 4G A. Baltensweiler, M. Hägeli-Golay

Abstract
Number of participants limited to 60.
Introduction to the architecture and data processing capabilities of geographic information systems (GIS). Practical application of spatial data modeling and geoprocessing functions to a selected project from the earth sciences.

Objective
Knowledge of the basic architecture and spatial data handling capabilities of geographic information systems.

Content
Theoretical introduction to the architecture, modules, spatial data types and spatial data handling functions of geographic information systems (GIS). Application of data modeling principles and geoprocessing capabilities using ArcGIS: Data design and modeling, data acquisition, data integration, spatial analysis of vector and raster data, particular functions for digital terrain modeling and hydrology, map generation and 3D-visualization.

Lecture notes
Introduction to Geographic Information Systems, Tutorial: Introduction to ArcGIS Desktop
The participants understand the specific challenges of inter- and transdisciplinary research in general and in the context of sustainable development. They know methods and concepts to address these challenges and apply them to their research projects.

**Objective**
To provide understanding of how sustainability can be made operational in an organisation. To do so, students will understand how to integrate sustainability thinking into the typical current organisational environment and processes, such as planning, implementing and controlling.

**Content**
We meet for five 3-hour-lectures, with discussions and case studies during course time. Additionally, small case studies in-between courses will be given at most course days.

Course topics are:
- Sustainable Development and its meaning for Management
- Management Standards for Sustainability (ISO and others)
- Sustainability Opportunities and Innovation
- Organisation and Implementation
- The concept of 'Continuous Improvement'
- Environmental Performance Measurement (Concepts, Standards, Methods)
- Life Cycle Costing, Life Cycle Management
- (Sustainable) Supply Chain Management
- Communication of Sustainability Issues

**Lecture notes**
Course documentation as well as case study descriptions will be provided during the course via the "Ilias" repository.

**Prerequisites / notice**
If you have specific interests or questions, let me know at arthurb@ethz.ch. Maybe I can include your issues - or I can’t :-)

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**Literature**


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**102-0327-01L**

**Implementation of Environmental and other Sustainability Goals**

**Abstract**
How to make sustainability operational - in industry, services and other organisations: You will learn how to put sustainability into practice by integrating environmental, social and economic aspects into organisations' management and processes. The course contains both a management view, as well as a sustainability view - and how to combine them.

**Objective**
To provide understanding of how sustainability can be made operational in an organisation. To do so, students will understand how to integrate sustainability thinking into the typical current organisational environment and processes, such as planning, implementing and controlling.

**Content**
We meet for five 3-hour-lectures, with discussions and case studies during course time. Additionally, small case studies in-between courses will be given at most course days.

Course topics are:
- Sustainable Development and its meaning for Management
- Management Standards for Sustainability (ISO and others)
- Sustainability Opportunities and Innovation
- Organisation and Implementation
- The concept of 'Continuous Improvement'
- Environmental Performance Measurement (Concepts, Standards, Methods)
- Life Cycle Costing, Life Cycle Management
- (Sustainable) Supply Chain Management
- Communication of Sustainability Issues

**Prerequisites / notice**
If you have specific interests or questions, let me know at arthurb@ethz.ch. Maybe I can include your issues - or I can’t :-)

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**701-0015-00L**

**Seminar on Transdisciplinary Research for Sustainable Development**

**Abstract**
The seminar is designed for students and researchers (MA, PhD, PostDoc) who use inter- and transdisciplinary elements in their projects. It addresses the challenges of this research: How to integrate disciplines? How (and in what role) to include societal actors? How to bring results to fruition? We discuss these questions based on case studies and theories and on the participant's projects.

**Objective**
The participants understand the specific challenges of inter- and transdisciplinary research in general and in the context of sustainable development in particular. They know methods and concepts to address these challenges and apply them to their research projects.

**Content**
The seminar covers the following topics:
1. Theories and concepts of inter- and transdisciplinary research
2. The specific challenges of inter- and transdisciplinary research
3. Involving stakeholders
4. Collaborating disciplines
5. Exploration of tools and methods
6. Analysing participants' projects to improve inter- and transdisciplinary elements

**Prerequisites / notice**
The seminar is specifically suitable for PhD or PostDoc researchers. It is open to master students (minor "global change and sustainability") and further interested people, who preferably are preparing, or working on, a project/thesis.
Using R for Data Analysis and Graphics (Part I)  W  1 credit  1G  A. J. Papritz, C. B. Schwierz

Abstract
The course provides the first part an introduction to the statistical software R for scientists. Topics covered are data generation and selection, graphical and basic statistical functions, creating simple functions, basic types of objects.

Objective
The students will be able to use the software R for simple data analysis.

Content
The course provides the first part of an introduction to the statistical software R for scientists. R is free software that contains a huge collection of functions with focus on statistics and graphics. If one wants to use R one has to learn the programming language R - on very rudimentary level. The course aims to facilitate this by providing a basic introduction to R.

Part I of the course covers the following topics:
- What is R?
- R Basics: reading and writing data from/to files, creating vectors & matrices, selecting elements of dataframes, vectors and matrices, arithmetics;
- Types of data: numeric, character, logical and categorical data, missing values;
- Simple (statistical) functions: summary, mean, var, etc., simple statistical tests;
- Writing simple functions;
- Introduction to graphics: scatter-, boxplots and other high-level plotting functions, embellishing plots by title, axis labels, etc., adding elements (lines, points) to existing plots.

The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www.rstudio.org

Note: Part I of UsingR is complemented and extended by Part II, which is offered during the second part of the semester and which can be taken independently from Part I.

Lecture notes
An Introduction to R. http://stat.ethz.ch/CRAN/doc/contrib/Lam-IntroductionToR_LHL.pdf

Prerequisites / notice
The course resources will be provided via the Moodle web learning platform Please login (with your ETH (or other University) username+password) at https://moodle-app2.let.ethz.ch/enrol/users.php?id=1145
Choose the course "Using R for Data Analysis and Graphics" and follow the instructions for registration.

Quantification and Modeling of the Cryosphere: Dynamic Processes (University of Zurich)  W  3 credits  1V  University lecturers

Abstract
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
UZH Module Code: GEO815
Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

Objective
Overview of the most important earth surface processes and landforms in cold regions (regions with glaciers and intense frost) with emphasis on high-mountain aspects. Discussion of present research challenges.

Content
Knowledge of the most prominent climate-related geomorphological processes and phenomena in high-mountain regions, understanding of primary research challenges.

Lecture notes
Glacial and periglacial geomorphodynamics in high-mountain regions. Ca. 100 pages.

Literature
references in skript

Prerequisites / notice
Basic knowledge about geomorphology and glaciers/permafrost from corresponding courses at ETH/UZH or from the related lecture notes


Abstract
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Natural processes, anthropogenic pollution, legislation of groundwater and surface water and of drinking water as well as water treatment will be discussed for industrialized and developing countries.

Objective
The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality.

Content
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. The various water resources, particularly groundwater and surface water, are discussed as part of the natural water cycle influenced by anthropogenic activities such as agriculture, industry, urban water systems. Furthermore legislation related to water resources and drinking water will be discussed. The lecture is focused on industrialized countries, but also addresses global water issues and problems in the developing world. Finally unit processes for drinking water treatment (filtration, adsorption, oxidation, disinfection etc.) will be presented and discussed.

Lecture notes
Handouts will be distributed

Analysis of Climate and Weather Data  W  3 credits  2G  C. Frei

Abstract
Observation networks and numerical climate and forecasting models deliver large primary datasets. The use of this data in practice and in research requires specific techniques of statistical data analysis. This lecture introduces a range of frequently used techniques, and enables students to apply them and to properly interpret their results.

Objective
Observation networks and numerical climate and forecasting models deliver large primary datasets. The use of this data in practice and in research requires specific techniques of statistical data analysis. This lecture introduces a range of frequently used techniques, and enables students to apply them and to properly interpret their results.

Content
Introduction into the theoretical background and the practical application of methods of data analysis in meteorology and climatology.

Topics: exploratory methods, hypothesis tests, analysis of climate trends, measuring the skill of climate and forecasting models, analysis of extreme events, principal component analysis and maximum covariance analysis.

The lecture also provides an introduction into R, a programming language and graphics tool frequently used for data analysis in meteorology and climatology. During hands-on computer exercises the student will become familiar with the practical application of the methods.

Lecture notes
Documentation and supporting material include:
- documented view graphs used during the lecture
- exercise sets and solutions
- R-packages with software and example datasets for exercise sessions

All material is made available via the lecture web-page.
This course combines Limnology (the study of inland waters in its broad sense) with Ecological and Evolutionary concepts. It deals with land surface processes (vegetation, soil moisture dynamics, land energy and water balances) for the climate system. The course consists of 2 contact hours per week, including 2 computer exercises.

**Objective**

The students can understand the role of land processes and associated feedbacks for the climate system.

**Prerequisites**

Atmosphäre, Mathematik IV: Statistik, Anwendungsnahes Programmieren.

**Lecture notes**

Powerpoint slides will be made available and/or Climate systems -> http://www.vwz.ethz.ch/Vorlesungsverzeichnis/lerneinheitPre.do?lerneinheitId=61924&semkez=2009W&lang=en

**Suggested literature:**


**Literature**


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This course introduces the broad variety of conflicts that arise in projects focusing on sustainable management of natural resources. It explores case studies of ecosystem management approaches and considers their practicability, their achievements and possible barriers to their uptake.

**Objective**

Students should be able to

a) propose appropriate and realistic solutions to ecosystem management problems that integrate ecological, economic and social dimensions across relevant temporal and spatial scales.

b) identify important stakeholders, their needs and interests, and the main conflicts that exist among them in the context of land and resource management.

**Prerequisites / notice**

- Introductory lectures in atmospheric and climate science

**Lecture notes**

http://people.ee.ethz.ch/~luethim/teaching.html

**Content**

- The purpose of this course is to provide fundamental background on the role of land surface processes (vegetation, soil moisture dynamics, land energy and water balances) for the climate system. The course consists of 2 contact hours per week, including 2 computer exercises.

- The students can understand the role of land processes and associated feedbacks for the climate system.

- Prerequisites: Introductory lectures in atmospheric and climate science


- Good high school mathematics and physics knowledge required.

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This course combines Limnology (the study of inland waters in its broad sense) with Ecological and Evolutionary concepts. It deals with land surface processes (vegetation, soil moisture dynamics, land energy and water balances) for the climate system. The course consists of 2 contact hours per week, including 2 computer exercises.

**Objective**

The purpose of this course is to provide fundamental background on the role of land surface processes (vegetation, soil moisture dynamics, land energy and water balances) for the climate system. The course consists of 2 contact hours per week, including 2 computer exercises.

**Prerequisites**

- Institutional knowledge in limnology or aquatic ecotoxicology.
- Familiarity with basic statistical methods for data analysis of limnological datasets.

**Lecture notes**

Course notes and power point presentations provided during the course.

**Content**

- The course contains a lecture part, an experimental part and 1-day excursions.

- The course covers ecology and evolution of aquatic organisms in lentic and lotic waters. Topics include: Adaptations, distribution patterns, biotic interactions, and conceptual paradigms in freshwater ecosystems. Important aspects regarding ecosystem metabolism and habitat properties of freshwater ecosystems. Applied case studies and scientific research in freshwater ecosystems. The lectures are given by Piet Spaak (Eawag), Florian Altermatt (UNI, Eawag), Tom Gonser (Eawag), Katja Räsänen (Eawag) and Chris Robinson (Eawag), specialists from the Aquatic Ecology department of Eawag and University of Zurich.

- The practical part contains 1-day excursions to a lake (Greifensee) and rivers (Sense, Töss) as well as research projects in small groups within research groups at Eawag.

- The practical aspect includes an assessment of the ecological state of lake Greifensee and the streams Glatt and Chriesbach. On this practical part you will work with survey methods used in research and practice.

- The course can only be taken together with " 701-1437-01 Bestimmungskurs aquatische Makroinvertebraten" and "701-1437-02 Bestimmungskurs aquatische Mikroinvertebraten und Kryptogamen".

**Prerequisites / notice**

- Good high school mathematics and physics knowledge required.

**Lecture notes**

http://people.ee.ethz.ch/~luethim/teaching.html

**Content**

- The course contains a lecture part, an experimental part and field excursions.

- The lecture part covers ecology and evolution of aquatic organisms in lentic and lotic waters. Topics include: Adaptations, distribution patterns, biotic interactions, and conceptual paradigms in freshwater ecosystems. Important aspects regarding ecosystem metabolism and habitat properties of freshwater ecosystems. Applied case studies and scientific research in freshwater ecosystems. The lectures are given by Piet Spaak (Eawag), Florian Altermatt (UNI, Eawag), Tom Gonser (Eawag), Katja Räsänen (Eawag) and Chris Robinson (Eawag), specialists from the Aquatic Ecology department of Eawag and University of Zurich.

- The practical part contains 1-day excursions to a lake (Greifensee) and rivers (Sense, Töss) as well as research projects in small groups within research groups at Eawag.

- The practical part includes an assessment of the ecological state of lake Greifensee and the streams Glatt and Chriesbach. On this practical part you will work with survey methods used in research and practice.

**Prerequisites / notice**

- Good high school mathematics and physics knowledge required.

**Lecture notes**

http://people.ee.ethz.ch/~luethim/teaching.html
Content

Traditional management systems focus on extraction of natural resources, and their manipulation and governance. However, traditional management has frequently resulted in catastrophic failures such as, for example, the collapse of fish stocks and biodiversity loss. These failures have stimulated the development of alternative ecosystem management approaches that emphasise the functionality of human-dominated systems. Inherent to such approaches are system-wide perspectives and a focus on ecological processes and services, multiple spatial and temporal scales, as well as the need to incorporate diverse stakeholder interests in decision making. Thus, ecosystem management is the science and practice of managing natural resources, biodiversity and ecological processes, to meet multiple demands of society. It can be local, regional or global in scope, and addresses critical issues in developed and developing countries relating to economic and environmental security and sustainability.

This course provides an introduction to ecosystem management, and in particular the importance of integrating ecology into management systems to meet multiple societal demands. The course explores the extent to which human-managed terrestrial systems depend on underlying ecological processes, and the consequences of degradation of these processes for human welfare and environmental well-being.

Building upon a theoretical foundation, the course will tackle issues in resource ecology and management, notably forests, agriculture and wild resources within the broader context of sustainability, biodiversity conservation and poverty alleviation or economic development. Case studies from tropical and temperate regions will be used to explore these issues. Dealing with ecological and economic uncertainty, and how this affects decision making, will be discussed. Strategies for conservation and management of terrestrial ecosystems will give consideration to landscape ecology, climate change and biodiversity, and community management, paying particular attention to alternative livelihood options and marketing strategies of common pool resources.

Lecture notes
No Script

Literature

701-0727-00L Politics of Environmental Problem Solving in Developing Countries

Abstract
The course focuses on processes and drivers of decision-making on natural resources management issues in developing countries. It gives insights into the relevance of ecological aspects in developing countries. It covers concepts, instruments, processes and actors in environmental politics at the example of specific environmental challenges of global importance.

Objective
After completion of the module, students will be able to:
- Identify and appraise ecological aspects in development cooperation, development policies and developing countries' realities
- Analyze the forces, components and processes, which influence the debate, the implementation and the outcome of ecological measures
- Characterize concepts, instruments and drivers of environmental politics and understand, how policies are shaped, both at national level and in multilateral negotiations
- Study changes (improvements) in environmental politics over time as the result of the interaction of processes and actors, including international development organizations

- Analyze politics and design approaches to influence them, looking among others at governance, social organization, legal issues and institutions

Content
Key issues and basic concepts related to environmental politics are introduced. Then the course predominantly builds on case studies, providing information on the context, specifying problems and potentials, describing processes, illustrating the change management, discussing experiences and outcomes, successes and failures. The analysis of the cases elucidates factors for success and pitfalls in terms of processes, key elements and intervention strategies.

Different cases not only deal with different environmental problems, but also focus on different levels and degrees of formality. This ranges from local interventions with resource user groups as key stakeholders, to country level policies, to multi- and international initiatives and connections. Linkages and interaction of the different system levels are highlighted. Special emphasis is given to natural resources management.

The cases address the following issues:
- Land use and soil fertility enhancement: From degradation to sustainable use
- Common property resource management (forest and pasture): Collective action and property rights, community-based management
- Ecosystem health (integrated pest management, soil and water conservation)
- Payment for environmental services: Successes in natural resources management
- Climate change and agriculture: Adaptation and mitigation possibilities
- Biodiversity Convention: Implications for conservations and access to genetic resources
- Biodiversity as a means for more secure livelihoods: Agroforestry and intercropping
- The Millennium Development Goals: Interactions between poverty and the environment
- Poverty and natural resources management: Poverty reduction strategies, the view of the poor themselves
- Food security: Policies, causes for insecurity, the role of land grabbing
- Biofuels and food security: Did politics misfire?
- Strategy development at global level: IAASTD and World Development Report 2008
- Study changes (improvements) in environmental politics over time as the result of the interaction of processes and actors
- Analyze politics and design approaches to influence them, looking among others at governance, social organization, legal issues and institutions

Lecture notes
Information concerning the case studies and specific issues illustrated therein will be provided during the course (uploaded on Moodle)

Literature

Prerequisites / notice
The performance assessment will consist of an individual essay to be written by each student based on at least five references in addition to the sources provided in the course. Students can choose from a list of topics. Criteria for assessment will be communicated at the beginning of the course.

701-0535-00L Environmental Soil Physics/Vadose Zone Hydrology

Abstract
The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.

Objective
Students are able to
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media,
- quantify driving forces and resulting fluxes of water, solute, and heat in soils.
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges

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Weeks 1 to 3: Physical Properties of Soils and Other Porous Media

Units and dimensions, definitions and basic mass-volume relationships between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay behavior.

Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity.

Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing.

Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:

Part 1 - Laminar flow in tubes (Poisuelle's Law); Darcy's Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement.

Lab #1: Measurement of saturated hydraulic conductivity in uniform and layered soil columns using the constant head method.

Part 2 - Unsaturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.

Midterm exam

Lab #2: Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip's approximations; infiltration rates and wetting front propagation.

Part 3 - Use of Hydrus model for simulation of unsaturated flow

Week 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface evaporation.

Week 12 to 13: Solute Transport in Soils - Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion eq.; solutions for pulse and step solute application; parameter estimation; salt balance.

Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

Additional topics:

Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.

Biological Processes in the Vadose Zone - An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

Lecture notes:

Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller (available at the beginning of the semester)

http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology

Literature:

Supplemental textbook (not mandatory) - Environmental Soil Physics, by: D. Hillel

102-0617-00L

Basics and Principles of Radar Remote Sensing for Environmental Applications

The course will provide the basics and principles of Radar Remote Sensing (specifically Synthetic Aperture Radar (SAR)) and its imaging techniques for the use of environmental parameter estimation.

Objective

The course should provide an understanding of SAR techniques and the use of the imaging tools for bio/geophysical parameter estimation. At the end of the course the student has the understanding of:

1. SAR basics and principles,
2. SAR polarimetry,
3. SAR interferometry and
4. environmental parameter estimation from multi-parametric SAR data

Content

The course is giving an introduction into SAR techniques, the interpretation of SAR imaging responses and the use of SAR for different environmental applications. The outline of the course is the following:

1. Introduction into SAR basics and principles
2. Introduction into electromagnetic wave theory
3. Introduction into scattering theory and decomposition techniques
4. Introduction into SAR interferometry
5. Introduction into polarimetric SAR interferometry
6. Introduction into bio/geophysical parameter estimation (classification/segmentation, soil moisture estimation, earth quake and volcano monitoring, forest height inversion, wood biomass estimation etc.)

Lecture notes:

Handouts for each topic will be provided

Literature:

First readings for the course:


Complete literature listing will be provided during the course.

Prerequisites / notice

This course in combination with 102-0627-00-G: Applied Radar Remote Sensing for Environmental Parameter Estimation is providing a profound basis for independent data analysis. It is recommended to take both courses together.

401-0649-00L

Applied Statistical Regression

This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning "good practice" that can be applied in every student's own projects and daily work life.

Objective

The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 888 of 1434
Get to know possibilities and limitations of numerical modelling in fluvial hydraulics and river engineering. Students will have a broad understanding of the hydrological, biogeochemical, and geomorphological functioning of mountain catchments.

2G

Hours

Title

A script will be available.

Students propose relevant research topics from their home countries, or from Latin American research projects, around which individual study programmes are devised, and on which they write their thesis. The Master thesis is supervised by scientific staff at ETH and collaborating institutions, and is based on the student's academic or professional experience.

Prerequisites / notice

The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

701-1644-00L Mountain Forest Hydrology

W 5 credits

3G J. W. Kirchner

Mountain Forest Hydrology

Content

This course presents a process-based view of the hydrology, biogeochemistry, and geomorphology of mountain streams. Students learn how to integrate process knowledge, data, and models to understand how landscapes regulate the fluxes of water, sediment, nutrients, and pollutants in streams, and to anticipate how streams will respond to changes in land use, atmospheric deposition, and climate.

Objective

Students will have a broad understanding of the hydrological, biogeochemical, and geomorphological functioning of mountain catchments. They will practice using data and models to frame and test hypotheses about connections between streams and landscapes.

Literature

Faraway (2005): Linear Models with R
Faraway (2006): Extending the Linear Model with R
Draper & Smith (1998): Applied Regression Analysis
Fox (2008): Applied Regression Analysis and GLMs
Montgomery et al. (2006): Introduction to Linear Regression Analysis

Prerequisites / notice

The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

Using a combination of lectures, field exercises, and data analysis, we explore the processes controlling the delivery of water, solutes, and sediment to streams, and how those processes are affected by changes in land cover, land use, and climate. We review the connections between process understanding and predictive modeling in these complex environmental systems. How well can we understand the processes controlling watershed-scale phenomena, and what uncertainties are unavoidable? What are the relative advantages of top-down versus bottom-up approaches? How much can "black box" analyses reveal about what is happening inside the black box? Conversely, can small-scale, micro-mechanistic approaches be successfully "scaled up" to predict whole-watershed behavior? Practical problems to be considered include the effects of land use, atmospheric deposition, and climate on streamflow, water quality, and sediment transport.

Lecture notes

Slides of lecture are available for download as PDF. Supplementary material will be provided during lecture.

Handouts will be available as they are developed.

Literature

Relevant books and citations will be mentioned.

Recommended and required reading will be specified at the first class session (with possible modifications as the semester proceeds).

101-0269-00L Numerical Modelling in Fluvial Hydraulics and River Engineering

W 3 credits

2G D. F. Vetsch, A. Siviglia

Numerical Modelling in Fluvial Hydraulics and River Engineering

Abstract

The basics of numerical modelling of fluvial hydraulics and river engineering problems are presented. The governing equations for flow and sediment transport in open channels and corresponding numerical solution strategies are introduced. The theoretical parts are discussed by examples.

Objective

Get to know possibilities and limitations of numerical modelling in fluvial hydraulics and river engineering.

Content

- Governing equations and modelling approaches
- Initial and boundary conditions
- Simulation process and grid generation
- Numerical methods: basics, accuracy and stability
- Examples of numerical schemes, 1D and 2D models

Lecture notes

Slides of lecture are available for download as PDF. Supplementary material will be provided during lecture.

Literature

Montgomery et al. (2006): Introduction to Linear Regression Analysis
Fox (2008): Applied Regression Analysis and GLMs
Faraway (2006): Extending the Linear Model with R

Prerequisites / notice

Exercises are based on the simulation software BASEMENT (www.basement.ethz.ch), the open-source GIS Qgis (www.qgis.org) and code examples written in MATLAB. The applications comprise one- and two-dimensional approaches for the modelling of flow and sediment transport.


Master Thesis

Number

118-0121-00L

Master's Thesis

Title

Number

Type

ECTS

Hours

Lecturers

Abstract

Students propose relevant research topics from their home countries, or from Latin American research projects, around which individual study programmes are devised, and on which they write their thesis. The Master thesis is supervised by scientific staff at ETH and collaborating institutions, and is based on the student's academic or professional experience.

Objective

The Master Thesis research takes place throughout the duration of the MAS Programme (12 months), complimented by Master level coursework and Seminars focusing on Water Resources and Sustainability. Students become familiar with new research techniques, and receive guidance from experts. The topic of the research should address a relevant water resources problem in the student's home country, and is designed at enhancing collaboration between academics and professionals in Latin America and in Switzerland.

MAS in Sustainable Water Resources - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td></td>
<td></td>
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<tr>
<td>W</td>
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</table>

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 889 of 1434
### Key for Hours

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

**ECTS**

- European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
# MAS in Urban Design

## Courses Offered

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>065-0070-00L</td>
<td>MAS Programme “Urban Transformation in Developing Territories”*</td>
<td>E-</td>
<td>0 credits</td>
<td>16S</td>
<td>M. Angélil</td>
</tr>
</tbody>
</table>

*After successful completion the students achieve 65 Creditpoints.

### Abstract

The MAS programme is structured around an investigation of transforming urban conditions as they pertain to global phenomena, and the development of practical tools for operating within such domains.

### Objective

- The programme aims at developing a culture of urban research and design that will enable the participant to actively engage in envisioning future urban scenarios. Secondly, a strong emphasis is put on methodology, process design and communication in order to prepare for the interdisciplinary negotiating agenda of the urban designer as future member of professional design offices, academic research teams, public services or communication agencies.

### Content

Each year, the MAS studio will focus on two specific topics of urban research and two existing sites on which to intervene in the form of two design research studios. The sites are preferably territories under development pressure with existing groups of urban actors to engage with.

## MAS in Urban Design - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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</table>

## Key for Hours

<table>
<thead>
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<th>Description</th>
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<td>lecture</td>
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<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

### ECTS

- European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
The course offers additional exercises and case studies concerning Open- and User Innovation.

Abstract
The course introduces the students to the long-standing tradition of actively involving users of technology and other knowledge-intensive products in the development and production process, and through own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies.

Objective
The course includes both lectures and exercises alternately. The goal is to understand the opportunity of user innovation for management and develop strategies to harness the value of user-developed ideas and contributions for firms and other organizations. The students actively participate in discussions during the lectures and contribute presentations of case studies during the exercises. The combination should allow to compare theory with practical cases from various industries.

The course presents and builds upon recent research and challenges the students to devise innovation strategies that take into account the availability of user expertise, free and public knowledge, and the interaction with communities that span beyond one organization.

Grading is based on the final exam, the class presentations (including the slides) as well as class participation.
This course on user innovation extends courses on knowledge management and innovation as well as marketing. The students are introduced to the long-standing tradition of actively involving users of technology and other knowledge-intensive products in the development and production process, and through own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies. Theoretical underpinnings taught in the course include models of innovation, the structuration of technology, and an introduction to entrepreneurship.

Lecture notes
The slides of the lectures are made available and updated continuously through the SMI website:

Reading assignments: please consult the SMI website:

Literature
Relevant literature for the exam includes the slides and the reading assignments. The corresponding papers are either available from the author online or distributed during class.

Abstract
Managerial Economics applies economic theory and methods to business and economic decision-making. Economic ideas related to optimization, the theory of consumer demand, the theory of the firm, industrial organization and decision making under uncertainty are studied using methods of numerical analysis, statistical estimation, game theory and constrained optimization.

Objective
The objective of the course is to provide undergraduate and graduate students in MAVT with an understanding of the use of economic concepts for firm-level management decisions. The course covers a number of models and methods of analysis which are commonly employed in business decisions. The course covers the economic theory of choice, models of oligopoly and industrial organization, applications of game theory to contract design and agency theory, and the theory of decision making under uncertainty focusing specifically on long-term investment decisions. The course will include three lectures by Professor Volker Hoffmann focusing on related case-studies in management.

Literature
Mikroökonomie (Pearson Studium - Economic VWL) Gebundene Ausgabe, August 2013, Robert S. Pindyck, Dr. Daniel L. Rubinfeld.

Prerequisites / notice
The course acquaints students who have previous not studied economics to economic concepts and quantitative methods which can be used to solve management decision problems.

Management, Technology and Economics (General Courses) - Key for Type

<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>V lecture</th>
<th>G lecture with exercise</th>
<th>U exercise</th>
<th>S seminar</th>
<th>K colloquium</th>
<th>P practice/laboratory course</th>
<th>A independent project</th>
<th>D diploma thesis</th>
<th>R revision course / private study</th>
</tr>
</thead>
</table>

Key for Credits

<table>
<thead>
<tr>
<th>Key for Credits</th>
<th>O Compulsory</th>
<th>W+ Eligible for credits and recommended</th>
<th>W Eligible for credits</th>
<th>Z Courses outside the curriculum</th>
<th>Dr Suitable for doctorate</th>
<th>E- Recommended, not eligible for credits</th>
</tr>
</thead>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### 1. Semester, Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0341-00L</td>
<td>Introduction to Management</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>S. Brusoni, P. Baschera, N. Rosenkranz</td>
</tr>
</tbody>
</table>

**Abstract**
This course is an introduction to the critical management skills involved in planning, structuring, controlling and leading an organization. We look at organizations as part of an industry context, which is affected by different elements like strategy, structure, culture, tasks, people and outputs. We consider how managerial decisions are made in any one of these domains affect decisions in each of the others.

**Content**
Further information is available on the Tim Group Chair’s website:
http://www.timgroup.ethz.ch/en/courses
and on the Moodle of the course: https://moodle-app2.let.ethz.ch/course/view.php?id=1287

**Lecture notes**

Selected readings from the book and additional learning materials will be available on the course Moodle: https://moodle-app2.let.ethz.ch/course/view.php?id=1287

All the materials uploaded on Moodle must be considered as required readings.

<table>
<thead>
<tr>
<th>Number</th>
<th>Corporate Sustainability</th>
<th>W+</th>
<th>3</th>
<th>2G</th>
<th>V. Hoffmann</th>
</tr>
</thead>
</table>

**Abstract**
We introduce the concept of corporate sustainability; discuss its implications focusing on strategy, technology, and financial markets; and offer e-modules to train relevant critical thinking skills. With this input, students explore the practical challenges of corporate sustainability in a group project, focusing on one of the four sustainability challenges of water, energy, mobility, and food.

**Objective**
Understand the limits and the potential of corporate sustainability for sustainable development

**Content**
Overview of the grand sustainability challenges of Water, Energy, Mobility, and Food

Business implications of sustainable development, in particular for corporate strategy, marketing & leadership, technology & innovation, and financial markets.

**Lecture notes**
Presentation slides will be distributed prior to lectures.

**Literature**
Literature recommendations will be distributed during the lecture

<table>
<thead>
<tr>
<th>Number</th>
<th>Strategic Management</th>
<th>W+</th>
<th>3</th>
<th>2G</th>
<th>G. von Krogh</th>
</tr>
</thead>
</table>

**Abstract**
Due to didactic reasons originating from the case based approach, the number of participants is limited to 80. 
Registration through myStudies (first come, first served).
If you are unable to sign up through myStudies, please contact the course assistant.

**Objective**
The lecture "strategic management" is designed to teach relevant competences in strategic planning and -implementation, for both professional work-life and further scientific development. The course provides an overview of the basics of strategy and the most prevalent concepts and methods in strategic management. The course is given as a combination of lectures about concepts/methods, and case studies where the students asked to solve strategic issues of the case companies. In two sessions, the students will also be addressing real-time strategic issues of firms that are represented by executives.

**Content**
Contents:
- Introduction to strategy
- Industry dynamics I: Industry analysis
- Industry dynamics II: Analysis of technology and innovation
- The resource-based theory of the firm
- The knowledge-based theory of the firm

**Prerequisites / notice**
Session #0: (September 29) Organizational Issues & How to Solve a Case
Session #1: (October 6) Introduction
Session #2: (October 13) Industry Dynamics I
Session #3: (October 27) Guest Lecture
Session #4: (November 3) Industry Dynamics II
Session #5: (November 10) Resource-Based Theory
Session #6: (November 24) Knowledge-based Theory
Session #7: (December 1) Guest Lecture

For participants of the MAS-MTEC program we offer a complentary course Practicing Strategy in which students will apply the concepts of Strategic Management to their real-life contexts and organizations. Please register simultaneously for both courses if you want to take part in this course.

For more information please see:
http://www.smi.ethz.ch/education/practicing-strategy.html

<table>
<thead>
<tr>
<th>Number</th>
<th>Introduction to Marketing</th>
<th>W+</th>
<th>3</th>
<th>2G</th>
<th>F. von Wangenheim</th>
</tr>
</thead>
</table>
**Content**

The course is designed to convey a profound understanding of marketing's role in modern firms, its interactions and interfaces with other disciplines, its main instruments and recent trends. Particular attention is given to emerging marketing concepts and instruments, and the role of marketing in technology firms.

The lecture features a short tutorial that is held at irregularly spaced intervals throughout the semester (approximately every third week). The tutorial is embedded within the course and consists of short sessions of about 30 minutes. It serves to illustrate theoretical and methodological concepts from the lecture by walking students through the analysis of real-world data from the telecommunications industry. The case data will be provided so that students practice and apply the concepts of the lecture on their own. The tutorial is held jointly by a Teaching Assistant (S.N. Brüggemann) and the professor (Prof. F. v. Wangenheim). The course is designed to convey a profound understanding of marketing's role in modern firms, its interactions and interfaces with other disciplines, its main instruments and recent trends. Particular attention is given to emerging marketing concepts and instruments, and the role of marketing in technology firms.

### Literature


Weekly readings, distributed in class (via Moodle)

### 363-0421-00L Management Information Systems

**Objective**

After taking the lecture, students should have knowledge on

1. The definition and role of marketing (marketing basics)
2. Creating marketing insights - understanding customer behavior
   - Theoretical concepts in customer behavior (customer behavior)
   - Analytical means to extend knowledge on customer behavior (marketing research)
   - Strategic tools to quantify customer behavior (CLV, CE)
3. Strategic marketing - translating marketing insights into actionable marketing strategies
   - Segmentation, Targeting, and Positioning
   - Attracting customers (marketing mix, 4Ps)
   - Maintaining profitable customer relations (CRM)

### Content

- Definition and classification of business models
- Digital business model patterns
- Theoretical frameworks that explain why and how digital business models function
- Impact of digital business model patterns on P&L and balance sheet

Students know how to measure & evaluate investments into the digital space as

- a decision maker in an established company (should I invest in project A or B?)
- an entrepreneur (should I pursue this venture?)
- an investor (should I invest in start-up xy?)

B. The student knows different tools to design digital business model patterns.

### Literature

Uber, Airbnb, Nest and Jawbone - A wide range of innovative companies exist, which successfully implemented ICT enabled business models and continue to grow at a rapid pace. Examples, illustrating how digitalization, including the "Internet of Things" currently fosters business model innovation across various industries. This course is designed to help students to understand and critically assess such newly emerging (digital) business models.

For the lecture students will get access to one of the leading online teaching platforms (called edX) also offered by other top universities (incl. MIT, Harvard, Berkeley, etc.). Using the edX platform, will allow students to collaborate in online discussions, solve online exercises and present a short educational video as part of a group project.

Key Topics:

- Business model innovation; (digital) business model patterns; business value of IT; the concept of integration; transaction cost perspective;
- network economics perspective; essentials and impact of web 2.0, internet of things, mobile computing, market places, social analytics and big data; IT governance and portfolio management; entrepreneurship in the digital space, etc.

### 363-0445-00L Logistics, Operations and Supply Chain Management I

**Objective**

Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.

### Content

- An effective and efficient flow of goods, data, and control in and between companies contributes significantly to the value added for the customer. Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.
- Strategic and tactical concepts in logistics, operations, and supply chain management: Conflicts of objectives and strategies and in the entrepreneurial context; business process analysis and fundamental logistics concepts; the MRP II / ERP concept: business processes and methods; the lean / just-in-time and repetitive manufacturing; concepts for product families and one-of-a-kind production; concepts for the process industry.

### Literature

- This book also serves as textbook for LOS II (spring term) as well as ERP and SCM software systems (autumn term). In addition powerpoint-handouts and documents for case studies.

### Prerequisites / notice

As for the lecture of the 3rd week (BEMAD, a much-liked Business Engineering and Management Ability Development game), this lecture (of Oct. 1) will follow a specific schedule in specific rooms. The schedule will be presented at Sept. 17 during the 1st lecture.

Due to the big number of students, about half of the students will play this game, instead of Oct. 1, at Friday afternoon, Oct. 2. Please be available. Thank you for your help in this matter.

### 363-0453-00L Strategic Supply Chain Management

**Objective**

The task of designing and managing supply chains requires that managers apply strategic, decision making and leadership skills in a supply chain context. The goal of this course is to develop and practice these skills.
Systems Dynamics and Complexity

This course will familiarize students with modern supply chain management theory and practice to develop and manage supply chains. The topics covered range from fundamental logistics and supply chain concepts (e.g. push vs. pull, postponement) to the development of supply chain strategies, relationships and networks.

Lecture notes
Course material will be available for download from the homepage of the Chair of Logistics Management:

http://www.scm.ethz.ch/teaching/courses.html

Literature
The following textbook is mandatory:

The following textbook is supplementary:

Prerequisites / notice
The final course grade will be a weighted average of the following:
Exam (semester end): 70%
Case studies (during the semester): 30%

Students (at least in groups of two) must bring a laptop with MS Excel and the Excel Solver installed to class.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Prerequisites / Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0541-00L</td>
<td>Systems Dynamics and Complexity</td>
<td>3</td>
<td>F. Schweitzer, P. Mavrodiev</td>
</tr>
</tbody>
</table>

Abstract
Finding solutions: what is complexity, problem solving cycle.

Objective
A successful participant of the course is able to:
- understand why most real problems are not simple, but require solution methods that go beyond algorithmic and mathematical approaches
- apply the problem solving cycle as a systematic approach to identify problems and their solutions
- calculate project schedules according to the critical path method
- setup and run systems dynamics models by means of the Vensim software
- identify feedback cycles and reasons for unintended systems behavior
- analyse the stability of non-linear dynamical systems and apply this to macroeconomic dynamics

Content
Why are problems not simple? Why do some systems behave in an unintended way? How can we model and control their dynamics? The course provides answers to these questions by using a broad range of methods encompassing systems oriented management, classical systems dynamics, nonlinear dynamics and macroeconomic modeling.

The course is structured along three main tasks:
- Finding solutions
- Implementing solutions
- Controlling solutions

PART 1 introduces complexity as a system immanent property that cannot be simplified. It introduces the problem solving cycle, used in systems oriented management, as an approach to structure problems and to find solutions.

PART 2 discusses selected problems of project management when implementing solutions. Methods for identifying the critical path of subtasks in a project and for calculating the allocation of resources are provided. The role of quality control as an additional feedback loop and the consequences of small changes are discussed.

PART 3, by far the largest part of the course, provides more insight into the dynamics of existing systems. Examples come from biology (population dynamics), management (inventory modeling, technology adoption, production systems) and economics (supply and demand, investment, production and consumption). For systems dynamics models, the software program VENSIM is used to evaluate the dynamics. For economic models analytical approaches, also used in nonlinear dynamics and control theory, are applied. These together provide a systematic understanding of the role of feedback loops and instabilities in the dynamics of systems. Emphasis is on oscillating phenomena, such as business cycles and other life cycles.

Lecture notes
The lecture slides are provided as handouts - including notes and literature sources - to registered students only. All material is to be found on the Moodle platform. More details during the first lecture

Prerequisites / notice
Self-study tasks (discussion exercises, Vensim exercises) are provided as home work. Weekly exercise sessions (45 min) are used to discuss selected solutions. Regular participation in the exercises is an efficient way to understand the concepts relevant for the final exam.

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Credits</th>
<th>Prerequisites / Literature</th>
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</thead>
<tbody>
<tr>
<td>363-1004-00L</td>
<td>Operations Research</td>
<td>3</td>
<td>M. Laumanns</td>
</tr>
</tbody>
</table>

Abstract
This course provides an introduction to operations research methods in the fields of management science and economics. Requisite mathematical concepts are introduced with a practical, problem-solving perspective.

Objective
- Introduction to building and using quantitative models in a business / industrial environment
- Introduction to basic optimization techniques (Linear Programming and extensions, network flows, integer programming, dynamic and stochastic optimization)
- Understanding the integration of quantitative models into the managerial decision process

Content
The following topics are covered: Systems and models, linear models and the importance of linear programming, duality theory and shadow prices, integer programming, optimization under uncertainty and applications in inventory management.

Lecture notes
Any standard textbook in Operations Research is a useful complement to the course. A printed script will be made available.

Prerequisites / notice
Undergraduate calculus, linear algebra, probability and statistics are a prerequisite.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Prerequisites / Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0503-00L</td>
<td>Principles of Microeconomics</td>
<td>3</td>
<td>M. Filippini</td>
</tr>
</tbody>
</table>

Abstract
The course introduces basic principles, problems and approaches of microeconomics. The course includes the following main topics:
- Basic principles of demand and supply, market and state in a modern economy, externalities, cost analysis, consumer behaviour, economies of scale and economies of scope, perfect competition, monopoly, oligopoly, monopolistic competition, mathematical treatment of some basic concepts.

Lecture notes
Lecture notes, exercises and reference material can be downloaded from Moodle.

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Literature

N. Gregory Mankiw and Mark P. Taylor (2014), "Economics", 3rd edition, South-Western Cengage Learning. The book can also be used for the course 'Principles of Macroeconomics' (Sturm)

For students taking only the course 'Principles of Microeconomics' there is a shorter version of the same book:

Complementary:


363-0537-00L

Resource and Environmental Economics

W+ 3 credits 2G  L. Bretschger, A. Brausmann

Abstract

Understanding of the basic issues and methods in resource and environmental economics; ability to solve typical problems in the field using the appropriate tools, which are concise verbal explanations, diagrams or mathematical expressions.

Objective

This course examines the behaviour of macroeconomic variables, such as gross domestic product, unemployment and inflation rates. It tries to answer questions like: How can we explain fluctuations of national economic activity? What can economic policy do against unemployment and inflation. What significance do international economic relations have for Switzerland?

Content

This course helps you understand the world in which you live. There are many questions about the macroeconomy that might spark your curiosity. Why are living standards so meagre in many African countries? Why do some countries have high rates of inflation while others have stable prices? Why have some European countries adopted a common currency? These are just a few of the questions that this course will help you answer. Furthermore, this course will give you a better understanding of the potential and limits of economic policy. As a voter, you help choose the policies that guide the allocation of society's resources. When deciding which policies to support, you may find yourself asking various questions about economics. What are the burdens associated with alternative forms of taxation? What are the effects of free trade with other countries? What is the best way to protect the environment? How does the government budget deficit affect the economy? These and similar questions are always on the minds of policy makers.

Lecture notes

Learning material and script can be found here: https://moodle-app2.let.ethz.ch/course/view.php?id=328

Literature


363-0565-00L

Principles of Macroeconomics

W+ 3 credits 2V  J.E. Sturm

Abstract

This course examines the behaviour of macroeconomic variables, such as gross domestic product, unemployment and inflation rates. It tries to answer questions like: How can we explain fluctuations of national economic activity? What can economic policy do against unemployment and inflation. What significance do international economic relations have for Switzerland?

Objective

This course will introduce the fundamentals of macroeconomic theory and explain their relevance to everyday economic problems.

Content

This course helps you understand the world in which you live. There are many questions about the macroeconomy that might spark your curiosity. Why are living standards so meagre in many African countries? Why do some countries have high rates of inflation while others have stable prices? Why have some European countries adopted a common currency? These are just a few of the questions that this course will help you answer. Furthermore, this course will give you a better understanding of the potential and limits of economic policy. As a voter, you help choose the policies that guide the allocation of society's resources. When deciding which policies to support, you may find yourself asking various questions about economics. What are the burdens associated with alternative forms of taxation? What are the effects of free trade with other countries? What is the best way to protect the environment? How does the government budget deficit affect the economy? These and similar questions are always on the minds of policy makers.

Lecture notes

The course webpage (to be found at http://www.kof.ethz.ch/en/events/teaching/) contains announcements, course information and lecture slides.

Literature


We advise you to also buy access to Aplia. This internet platform will support you in learning for this course. To save money, you should buy the book together with Aplia. This is sold as a bundle (ISBN: 9781473715998).

Besides this textbook, the slides and lecture notes will cover the content of the lecture and the exam questions.
Abstract
Overview of financial and managerial accounting
Accounting for current and fixed assets
Liabilities and owners equity
Recording change in balance sheet
Measuring financial performance
Managing financial reporting
Full and variable costing system
Using accounting information for decision making purposes

Objective
Understand the different procedures involved in the accounting system
Record change in financial position
Measure business income
Prepare final accounts
Understand the principles of cost accounting
Calculate the different product costs
Make decisions about the acceptance or rejection of a particular product

Content
Financial Accounting: Balance sheet, income statement, double-entry accounting, journal and ledger, accounting for merchandising activities, value-added tax, adjustments before final accounts, provisions, depreciation, valuation,

Managerial Accounting: Full costing, variable costing, cost-volume profit, break-even analysis, activity-based costing

Prerequisites / notice
This course is a prerequisite for the course Financial Management.

▶ 3. Semester, Core Courses

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>363-0305-00L</td>
<td>Empirical Methods in Management</td>
<td>W+</td>
<td>3</td>
<td>2G</td>
<td>A. Scherer</td>
</tr>
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</table>

Abstract
Evidence-based management requires valid empirical research. In this course, students will learn the basics of research design, fundamentals of data collection and statistical methods to analyze the data acquired in social science research. Students are expected to apply their knowledge in class discussions and out-of-class assignments.

Objective
- Ability to formulate research questions and designing an appropriate study
- Ability to collect and analyze data using a variety of methods
- Ability to critically assess the quality of empirical research in management
- Applied knowledge of empirical methods through out-of-class assignments

Content
1) Introduction to empirical management research
2) Research designs: exploratory, descriptive, experimental
3) Measurement and scaling
4) Data collection and sampling
5) Data analysis methods
6) Reporting and presenting empirical research

Prerequisites / notice
Assignments and projects: This course includes out-of-class assignments and projects to give students some hands-on experience in conducting empirical research in management. Projects will focus on one particular aspect of empirical research, like the formulation of a research question or the design of a study. Students will have at least one week to work on each assignment. Students are expected to work on these assignments individually. Duplicate answers will receive no credit and will be subject to a disciplinary review. Assignments will be graded and need to be turned-in on time. Exemplary answers to the assignments will be posted online after the submission date for students to review. Some assignments will also be discussed in class.

Class participation: Class participation is encouraged and can greatly improve students' learning in this class. Class participation will not be graded; however, it will be considered favorably if a student is between grades. Note, however, that quality is more important than quantity. In this spirit, students are expected to attend class regularly and come to class prepared.

363-0389-00L| Technology and Innovation Management  | W+    | 3    | 2G    | S. Brusoni|

Abstract
This course focuses on the analysis of innovation as a pervasive process that cut across organizational and functional boundaries. It looks at the sources of innovation, at the tools and techniques that organizations deploy to routinely innovate, and the strategic implications of technical change.

Objective
- understand the core concepts necessary to analyze how innovation happens
- master the most common methods and tools organizations deploy to innovate
- develop the ability to critically evaluate the innovation process, and act upon the main obstacles to innovation

Content
This course looks at technology and innovation management as a process. Continuously, organizations are faced with a fundamental decision: they have to allocate resources between well-known tasks that reliably generate positive results; or explore new ways of doing things, new technologies, products and services. The latter is a high risk choice. Its rewards can be high, but the chances of success is small.

How do firms organize to take these decisions? What kind of management skills are necessary to take them? What kind of tools and methods are deployed to sustain managerial decision-making in highly volatile environments? These are the central questions on which this course focuses, relying on a combination of lectures, case-based discussion, guest speakers, simulations and group work.

Lecture notes
Slides will be available on the TIMGROUP website.

Literature
Readings will be available on the TIMGROUP website.

Prerequisites / notice
No specific background in economics or management is required.

363-0561-00L| Financial Market Risks                 | W+    | 3    | 2G    | D. Sornette|

Abstract
I aim to introduce students to the concepts and tools of modern finance and to make them understand the limits of these tools, and the many problems met by the theory in practice. I will put this course in the context of the on-going financial crises in the US, Europe, Japan and China, which provide fantastic opportunities to make the students question the status quo and develop novel solutions.
Objective

The course explains the key concepts and mechanisms of financial economics, their depth and then stresses how and why the theories and models fail and how this is impacting investment strategies and even a global view of citizenship, given the present developing crises in the US since 2007 and in Europe since 2010.

- Development of the concepts and tools to understand these risks and master them.
- Working knowledge of the main concepts and tools in finance (Portfolio theory, asset pricing, options, real options, bonds, interest rates, inflation, exchange rates)
- Strong emphasis on challenging assumptions and developing a systemic understanding of financial markets and their many dimensional risks

Content

1- The Financial Crises: what is really happening? Historical perspective and what can be expected in the next decade(s). Bubbles and crashes. The illusion of the perpetual money machine.

2- Risks in financial markets
- What is risk?
- Measuring risks of financial assets
- Introduction to three different concepts of probability
- History of financial markets, diversification, market risks

3- Introduction to financial risks and its management.
- Relationship between risk and return
- Portfolio theory: the concept of diversification and optimal allocation
- How to price assets: the Capital Asset Pricing Model
- How to price assets: the Arbitrage Pricing Theory, the factor models and beyond

4- Financial markets: role and efficiency
- What is an efficient market?
- Financial markets as valuation engines: exogeneity versus endogeneity (reflexivity)
- Deviations from efficiency, puzzles and anomalies in the financial markets
- Financial bubbles, crashes, systemic instabilities

5- An introduction to Options and derivatives
- Calls, Puts and Shares and other derivatives
- Financial alchemy with options (options are building blocks of any possible cash flow)
- Determination of option value; concept of risk hedging

6- Valuation and using options
- A first simple option valuation model
- The Binomial method for valuing options
- The Black-scholes model and formula
- Practical examples and implementation
- Realized prices deviate from these theories: volatility smile and real option trading
- How to imperfectly hedge with real markets?

7- Real options
- The value of follow-on investment opportunities
- The timing option
- The abandonment option
- Flexible production
- Conceptual aspects and extensions

8- Government bonds and their valuation
- Relationship between bonds and interest rates
- Real and nominal rates of interest
- Term structure and Yields to maturity
- Explaining the term structure
- Different models of the term structure

9- Managing international risks
- The foreign exchange market
- Relations between exchange rates and interest rates, inflation, and other economic variables
- Hedging currency risks
- Currency speculation
- Exchange risk and international investment decisions

Lecture notes
Lecture slides will be available on the site of the lecture

Literature
Corporate finance
Brealey / Myers / Allen
Eight edition

Prerequisites / notice
None

Electives

Recommended Elective Courses

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<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tr>
<td>363-0301-00L</td>
<td>Work Design and Organizational Change</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>G. Grote</td>
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</table>

Good work design is crucial for individual and company effectiveness and a core element to be considered in organizational change. Meaning of work, organization-technology interaction, and uncertainty management are discussed with respect to work design and sustainable organizational change. As course project, students learn and apply a method for analyzing and designing work in business settings.
Objective

- Know effects of work design on competence, motivation, and well-being
- Understand links between design of individual jobs and work processes
- Know basic processes involved in systematic organizational change
- Understand the interaction between organization and technology and its impact on organizational change
- Understand relevance of work design for company performance and strategy
- Know and apply methods for analyzing and designing work

Content

- Work design: From Adam Smith to job crafting
- Effects of work design on performance and well-being
- Approaches to analyzing and designing work
- Modes of organizational change and change methods
- Balancing stability and flexibility in organizations as design criterion
- The organization-technology interaction and its impact on work design and organizational change
- Example Flexible working arrangements
- Strategic choices for work design

Literature

A list of required readings will be provided at the beginning of the course.

Prerequisites / notice

The course includes the completion of a course project to be conducted in groups of four students. The project entails applying a particular method for analyzing and designing work processes and is carried out by means of interviews and observations in companies chosen by the students.

363-0311-00L  Psychological Aspects of Risk Management and Technology

W 3 credits 2V  G. Grote, S. A. Maurer, J. Schmutz, R. Schneider, M. Zumbühl

Abstract

Using uncertainty management by organizations and individuals as conceptual framework, risk management and risk implications of new technologies are treated. Three components of risk management (risk identification/evaluation, risk mitigation, risk communication) and underlying psychological and organizational processes are discussed, using company case studies to promote in-depth understanding.

Objective

- understand basic components of risk management in organizations
- know and apply methods for risk identification/evaluation, risk mitigation, risk communication
- know psychological foundations of risk perception, decision-making under risk, and risk communication
- know organizational principles for managing uncertainty
- apply theoretical foundations to applied issues such as safety management, regulatory activities, and technology design and implementation in different domains (e.g. transport systems, IT, insurance)

Content

The syllabus includes the following topics:

- Elements of risk management
  - risk identification and evaluation
  - risk mitigation
  - risk communication

Psychological and organizational concepts relevant in risk management

- decision-making under uncertainty
- risk perception
- resilient organizational processes for managing uncertainty

Case studies on different elements of risk management (e.g., rule making, training, managing project risks, automation)

Group projects related to company case studies

Lecture notes

There is no script, but slides will be made available before the lectures.

Literature

There are texts for each of the course topics made available before the lectures.

Prerequisites / notice

The course is restricted to 40 participants who will work closely with the lecturers on case studies prepared by the lecturers on topics relevant in their own companies (Swiss Re, Skyguide, Swisscom).

363-0393-00L  Corporate Strategy

W 3 credits 2V  S. Ben-Menahem

Abstract

This course focuses on the challenges in managing multi-business corporations, and covers topics related to the vertical and horizontal scope of business activities.

70% of the final grade consists of a final closed-book written exam and 30% of the final grade will consist of individual assignments and group debates.

Objective

Course Topic and Learning Objectives:

Large- and medium-sized corporations play a central role in the economic activity of most developed and developing countries. Many of these organizations perform multiple business activities in multiple markets. In the face of increasing international competition, globalization, technological development, deregulation, and the emergence of new markets and industries, operating such a portfolio of business activities poses important managerial challenges forcing corporations to continuously re-consider their vertical and horizontal scope and boundaries.

The course Corporate Strategy draws from a wide range of theories and methods to develop an understanding of the conceptual frameworks, debates, and developments concerning decisions associated with the management of multi-business corporations. We will cover the key questions driving a firm's corporate strategy, including:

- In what markets to compete with which businesses?
- Which activities should be performed by the firm and which should be outsourced (i.e. "make" or "buy" decisions)?
- What are the most appropriate approaches to growth and divestiture?
- How do institutional forces impact corporate strategy?

Specifically, we will examine how organizations manage their portfolio of business activities and markets to achieve competitive advantage through vertical integration, cooperative strategies such as strategic alliances and joint ventures, corporate diversification, mergers and acquisitions, divestitures, and globalization/international strategies, and strategic renewal.

Format:

The course is a combination of lectures about concepts/methods, guest lectures, case studies/assignments, and group debates.

Prerequisites / notice

Having participated in the course Strategic Management by Prof. Georg von Krogh/Dr. Zeynep Erden is an advantage but not a requirement.
The lecture treats the main challenges of business transformation and the alignment of corporate development and IT activities. It presents a holistic approach to business transformation projects by introducing an integrated model dealing with three main design areas "strategy", "processes" and "information systems" and applying this model to various case studies.

Objective
The goal of the lecture is to understand the main challenges of corporate transformation and to demonstrate the application of a holistic project procedure model for corporate transformation projects with special emphasis on the alignment of business and IT.

The student should understand and be able to explain the main reasons for corporate transformation, the relevant management processes to manage corporate transformation, the interdependencies between strategy, processes and information systems, especially how this three levels interrelate, the critical success factors for the successful accomplishment of large scale corporate transformation projects, the main instruments of project, quality and change management and the different types of resulting IT projects.

Content
The globalization of the world leads to an increasingly faster pace in business transformation. Enterprises have to adapt faster and even faster to the environmental changes in a global economy to remain competitive and to make sure they stay in business. In todays information age this does not only mean to adapt business strategy and business processes but also to adapt information systems to the new circumstances. The fast adaptation trough large scale corporate transformation projects that change strategy, business processes and information systems is critical to ensure competitiveness for tomorrow. The introduction of new business processes and information systems typically takes years in very complex large scale projects. Many projects fail because of insufficient alignment between decision makers in business and IT. Unclear understanding of the overall project scope, undefined roles and responsibilities, unclear project processes, quality problems and resistance to change are some typical problems found in such projects. The lecture is subdivided into following modules:

Corporate development introduction and motivation, Parallelization of corporate development and complexity reduction, Planning process and project portfolio management in corporate development, Management of large scale projects integration of strategy, processes and information systems, Quality management in large scale projects, Project management in large scale projects, Change management within projects. The lecture is accompanied by four case studies that are used to exemplify the contents of the lecture by applying the concepts to real situations in corporate life.

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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Semester</th>
<th>Instructor</th>
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<tbody>
<tr>
<td>363-0427-00L</td>
<td>Business-IT Alignment</td>
<td>W</td>
<td>3</td>
<td>L. Goutas</td>
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<tr>
<td></td>
<td>Attending the lectures is imperative to complete the assignments.</td>
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<tr>
<td>Abstract</td>
<td>What, how, and outcomes of Business-IT Alignment. This course will introduce tools for strategically aligning business and IT, managing the alignment process, and evaluating the alignment outcomes.</td>
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<tr>
<td>Objective</td>
<td>Students will not only learn about the tools and frameworks to align business and IT, but also learn how to apply the tools / frameworks to real cases.</td>
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<tr>
<td>Content</td>
<td>Lecture 1: IT potential and IT Strategy, business process change, IT portfolio and IT HR management (with case examples)</td>
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<td>Lecture 2: Evaluating IT investment and alignment maturity assessment, Digital Strategy</td>
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<td>Lecture 3: Case Presentations</td>
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<td></td>
<td>Lecture notes</td>
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<td>Check the course website: <a href="http://www.mis.ethz.ch/teaching/HS13/BsnsIT2013">http://www.mis.ethz.ch/teaching/HS13/BsnsIT2013</a></td>
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<tr>
<td>363-0562-01L</td>
<td>Economics of Innovation and Growth</td>
<td>W</td>
<td>3</td>
<td>O. Tejada Pinyol</td>
</tr>
<tr>
<td>Abstract</td>
<td>Overview how the world has developed. Understanding the role of innovation for economic growth. Design of policies to foster innovation and growth.</td>
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<tr>
<td>Objective</td>
<td>The first three goals of the lecture. First, understanding how the world has developed over the last centuries and the proximate and fundamental causes of economic growth. Second, understanding and application of the basic models of economic growth. Third, design of policies to foster innovation and growth to reduce the large wealth differences in the world.</td>
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<tr>
<td>Content</td>
<td>1. Introduction</td>
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<td>2. Neoclassical Growth Theory</td>
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<td>3. Innovations and Growth (New Growth Theory)</td>
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<td>4. Growth Policy</td>
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<td>5. Institutions and Growth</td>
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<tr>
<td>Literature</td>
<td>The transparencies used in the lectures will be distributed to the participants.</td>
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</table>

Core literature:

Additional literature:
The Economics of Climate Change

Does not take place this semester.
Particularly suitable for students of D-ITET, D-MATL, D-MAVT, D-USYS

Abstract
Climate change is one of the most pressing issues that governments and the global community have to face. This course outlines the problem of climate change and discusses the economic solutions (both domestic and international) to this problem.

Objective
This course has a number of objectives: (i) To outline the problem of climate change (ii) to discuss and compare the theoretical economic solutions to combating climate change (iii) to present existing climate change mitigation actions in an economic context and (iv) to outline possible future climate policy issues.

Content
Economics of pollution, Optimal level of greenhouse gases, International Environmental Agreements, Tradable pollution permit markets, Carbon Taxes, Technological innovation and R&D. The optimal approach to control Climate change, The future of Climate change policy

Literature
Required reading: Perman et al. (2003), Natural Resource and Environmental Economics, Pearson Addison Wesley. Also, Journal articles will be cited

Prerequisites / notice
Prerequisites: The course relies heavily on the concepts and techniques used in basic game theory. Therefore prior knowledge is recommended

Intermediate Econometrics

The idea of this course is to familiarize students with instrumental variables estimation of linear regression models and the estimation of models with limited dependent variables as well as of nonlinear regression models. While most of the material covered will pertain to cross-sectional data, we will also work on selected issues with panel data.

Objective
I will provide STATA programs and show the execution thereof. After having participated in this course, students will be able to carry out simple research projects and understand the basics of intermediate econometrics. In particular, they will be able to write simple programs in STATA and to qualify their own and others’ regression output relating to problems covered.

Literature

Corporate Finance

Corporate Finance, investment management, business valuation, value based management & compensation, financial reporting today & in future, financial reporting value chain, reporting on non-financial measures, such as corporate sustainability reporting, mergers & acquisitions, legal aspects, taxes, corporate governance - risk management - internal controls & mgmt. information systems, turnaround.

Objective
Introduction in theory and practical application of Corporate Finance, with a particular focus on financing of operations and transactions, analysed from multiple aspects, including legal and tax.

Content
Corporate Finance, investment management, business valuation, value based management and compensation, financial reporting today and in future, financial reporting value chain, reporting on non-financial measures, such as corporate sustainability reporting, mergers and acquisitions, legal aspects, taxes, corporate governance - risk management - internal controls and management information systems, turnaround.

Lecture notes

Literature

Prerequisites / notice
The lecture will be supported by the Chair of Entrepreneurial Risks. Please refer to the chair’s website for more detailed information regarding the course (www.er.ethz.ch/teaching).

Technology Transfer

Goals of technology transfer with focus on spin-off and start-up creation. Start-up ecosystem, business model innovation, intellectual property, early stage financing and negotiation. Visit to Technopark and Hub Zurich. Guest speakers, meetings with start-up founders. Case study group work with real start-ups. Block lecture (3 days) with strong link between theory and practical examples.

Objective
-Ability to take successful actions in a technology transfer process either in your own start-up or within a larger organization
-Get familiar with the start-up ecosystem
-Foster entrepreneurial thinking!
Content
Technology transfer is a powerful tool to foster economic growth. From the macro-economic perspective, funds invested into basic 
research flow back to the society through the creation of new jobs, the establishment of talent pools and tax substrates. Spin-off companies 
and start-ups play a major role in implementing technology transfer. The lecture focuses on the significance and goals of technology 
transfer and the success factors for technology-oriented spin-off and start-up companies. The major challenge is to bridge the gap between 
technology push and market pull. Hence the innovation value chain and start-up ecosystem will be thoroughly discussed and the key 
aspects for building successful start-ups will be analyzed. Special topics addressed involve securing intellectual property, business model 
innovation, early stage financing, as well as negotiation strategies. The course hosts selected speakers from the industry and endorses 
personal meetings and presentations with start-up founders. This includes a visit to the Hub and Technopark Zurich. The course 
requirements are active participation and completion of the case study group work, based on real start-ups and presented in class. Strong 
link between theory and practical examples.

The course is offered in 3 block days.

Blockday 1 - 27.10.15: Introduction and science push
-Introduction to Technology Transfer (Lesley Spiegel)
-Presentation of the case study group work (Balint Diosozegi)
-From science to market (Dr. Marjan Kraak, ETH Transfer, Head Start-ups)
-Securing intellectual property (Dr. Claudius Dietzsch, Medela)

Blockday 2 - 10.11.15: Start-up ecosystem and market pull
-The start-up ecosystem (Lesley Spiegel)
-Innovation in a mature start-up (Dr. Ekkehard Zwicker, CEO Alstom Inspection Robotics)
-Getting started with your venture: ETH Entrepreneur Club (President ETH Entrepreneur Club)
-Negotiation and conflict management (Prof. Dr. Michael Ambühl)
-Early stage financing models (Erika Puyal, Head Start-up Finance, Zurich Kantonalbank)

Blockday 3 - 24.11.15: Presentation of student case study group work and visit to the Hub and Technopark Zurich
-Student presentation of case study group work (Lesley Spiegel)
-Success story: South Pole Carbon Asset Management - from spin-off to world leader (Thomas Camerata, Co-Founder)
-Visit of the Hub Zurich and presentation of Hub Start-up
-Visit of the Technopark Zurich and presentation of 3 start-ups

ICT: Rayneer Entertainment (Oliver Flückiger)
Foodtech: Eaternity (Judith Ellens)
Medtech: Ability (Mario Thomman)

Lecture notes
Slides in English will be available for download.

For further information, please visit:
http://www.timgroup.ethz.ch/education/Courses_at_TIMGROUP

Literature

Prerequisites / notice

363-0887-00L Management Research (Basics of Scientific Work) W 1 credit 1S Z. Erden Özkol
The course is mandatory for MSc. students and recommended for MAS students who write their Master Thesis at the Chair of Strategic Management and Innovation.
Participation to both sessions are mandatory to receive the credit, there will be no exceptions.
If a student can't take part in one of the sessions, the course has to be taken the following semester.

This course teaches students about the basic principles of scientific work in the field of social sciences. The goal is to motivate students to develop an own thesis design and write scientific articles.

Objective
This course teaches students about the basic principles of scientific work in the field of social sciences. The goal is to motivate students to develop an own thesis design and write scientific articles.

Content
This course teaches students about the basic principles of scientific work in the field of social sciences. It is an introduction into the fascinating field of research. The course shows the power of theory and literature, helps formulating intriguing research questions, provides an overview of scientific methods and data analysis, and gives hints on how to derive insightful conclusions out of results. The goal is to motivate students to find and read research papers relevant to their field, develop an own thesis design and write scientific articles.

Literature
Nicola Siggelkow (2007) Persuasion with Case Study AMJ Vol. 50, No. 1

Prerequisites / notice
The course is mandatory for MSc. students and recommended for MAS students who write their Master Thesis at the Chair of Strategic Management and Innovation - those will be served first.

The course will be given once every semester by Dr. Zeynep Erden Özkol and the PhD students of the chair.
The course takes two days, one for lecture, one for student paper presentations. Participation to both sessions are mandatory to receive the credit, there will be no exceptions.
Students who participate in the lecture and present a paper receive 1 credit point. The course and the presentations will be given in English.
Students might benefit more if they take this course towards the end of their studies, before writing their master thesis.

363-1037-00L Fiscal Competition and Multinational Firms W 3 credits 2V M. Köthenbürger, F. Liberini
The course enables students to understand how multinational firms respond to differential tax regimes in a global economy and how countries strategically use the tax system to host multinationals. In particular, the course covers transfer pricing issues, internal financing decisions and agency problems and their relation to tax policy.
An effective and efficient flow of goods, data, and control in and between companies contributes significantly to the value added for the


Using theoretical models and empirical analysis to uncover regularities in how multinational firms respond to taxes

363-1044-00L  
**Objective**  
Developing models and analyzing empirical data to understand the impact of taxes on multinational firms' decision making.  

**Abstract**  
The course examines how taxes influence the strategic and operational decisions of multinational firms, focusing on the determination of effective tax planning strategies.

**Content**  
- Theoretical foundations of tax law and its application in multinational contexts
- Case studies illustrating the impact of taxes on multinational firms' strategic decisions
- Tax planning strategies and their effectiveness in reducing tax burdens

**Literature**  
- Philip D. Straffin (1993): Game theory and strategy. Mathematical Association of America, Washington, DC
- Peter Wallensteen (2012): Understanding Conflict Resolution. SAGE, London, UK

**Prerequisites**  
Successful completion of lectures “363-1059-00L Introduction to Negotiation”.

**Additional Electives Courses**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tbody>
<tr>
<td>363-0345-01L</td>
<td>Lecture Cycle Purchasing</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>S. Wagner, R. Boutellier</td>
</tr>
<tr>
<td>363-0445-02L</td>
<td>Logistics, Operations, and Supply Chain Management</td>
<td>W</td>
<td>1</td>
<td>2A</td>
<td>P. Schönsleben</td>
</tr>
<tr>
<td>363-0622-00L</td>
<td>Basic Management Skills</td>
<td>W</td>
<td>3</td>
<td>8G</td>
<td>R. Spechh</td>
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</tbody>
</table>

**Data:** 06.02.2019 13:00  
**Autumn Semester 2015**  
**Page 904 of 1434**
The constantly augmenting complexity of technologies and systems, the increased pressure caused by competition, the need for shortening time-to-market and the thereby implied growing risks force organizations to increasingly focus on core competencies. Collaboration with external partners is a key value creation opportunity for successful ventures. This type of cooperation also has implications on daily management activities. This lecture will provide a better understanding of special requirements needed for management of cooperation issues.

### Content

- Learning outcomes professional competence
  - The students learn and understand the management basics of inter-firm cooperation and organizational networks (business models, incl. risk, communication, etc.)
  - Realize the value creation potentials of alliances (added value)
  - Understand underlying theoretical models (Transaction cost theory, principal agent, game theory)
  - Identify and understand specific forms of collaboration (Strat. All., JV, Networks, M&A, etc.)
  - Apply tools hands on in real companies (in coll. with companies)

- Learning outcomes methodological competence
  - Writing academic papers
  - Developing structured documentation of interviews
  - Transferring theory directly into application
  - Contributing to the learning journey

- Learning outcomes social competence
  - Work together with industrial partners
  - Improving communication skills as basics for collaboration
  - Developing and applying team work skills
  - Coping with conflicts resolution in teams

- Collaboration with external partners is a key value creation opportunity for successful ventures. This type of cooperation also has implications on daily management activities. This lecture will provide a better understanding of special requirements needed for management of cooperation issues.

### Learning journey:

In an introductory lecture we will give an overview of the theoretical framework and explain the concept of the lecture (Sept. 18, 2014). In weeks 2 you will work on a first assignment on six different aspects of the underlying framework: strategy and activities, structure and process, culture and people orientation, interaction and roles, risk and trust, knowledge and learning. This first assignment will give you the basics to participate in the second part (Oct.30-31.2014, 2014) of this seminar. There you will present the results of the first assignment and get additional theoretical input to perform the 2nd assignment. The second assignment will be to analyze real alliance projects in the partner companies. The final lesson will be used as a best practice exchange together with our industrial partners (Dec.18, 2014).

### Prerequisites / notice

- The number of students participating in the lecture is limited to 30.
- HBR on Mergers and Acquisitions: ISBN 1-57851-555-6
- HBR Collaborating Effectively ISBN 978-1-4221-6264 4
- Additional Books:
  - HBR Collaborating Effectively ISBN 978-1-4221-6264 4
  - HBR on Mergers and Acquisitions: ISBN 1-57851-555-6
- A list with recommended publications will be distributed in the lecture.

Abstract
This course is a preparation course for theses in industry: Criteria of scientific work, writing the final report, using research resources at ETH. Using case studies, content of other lectures is discussed with regard to the special challenges during theses: Systems Engineering, Social science methods for empirical data collection and analysis, project management, presentation technique.

Objective
The objective of this course is to provide students with a practical toolset of techniques, procedures and hints for a successful scientific thesis (Bachelor/Master/MAS Thesis) in industry. The course is held by assistants of professorships at D-MTEC.

Content
Methodology: Systems Engineering, problem solving process, situation analysis, SWOT, objectives, solution finding, evaluation.

Social science methods for empirical data collection and analysis: how to develop a good research question: methodological awareness and practical considerations, criteria in social research: reliability and validity.

Research Designs and Strategies: qualitative and quantitative research.

Methods for data collection and analysis: observation, interview, questionnaire, document and literature analysis, and combinations.

Project Management: tasks plan, milestones, roles, communication
Scientific work: research, resources, citation, argumentation
Presentation: techniques, procedure, handouts, significance
Final report: organization, layout, figures, formal requirements, appendix

Lecture notes
http://www.timgroup.ethz.ch/education/Courses_at_TIMGROUP

Handouts of the presentations / course materials have to be downloaded and printed out before the course (see link above).

Literature
Further reading:

Prerequisites / notice

The course is intended for students who want to carry out a thesis in industry, in general these are:

(1) MSc-students MTEC or MAVT with master thesis (MA) during the next term and supervised by MTEC, (corresponds to 3rd or 4th semester Master) and
(2) BSc-students MAVT with bachelor thesis (BA) in industry and supervised by MTEC, as well as with full MTEC focus (corresponds to 5th or 6th semester Bachelor) or
(3) MAS MTEC students in 3rd semester for MA during the next term.

Important note: Credits will only be awarded to students according to (1), (2) or (3). Prerequisites for obtaining the credit or "Testat": being present during the whole course (presence list) and prior study of documents provided on the Internet and of the book Züst, R.: Einstieg ins Systems Engineering. 3. Aufl., Verlag Industrielle Organisation, Zürich 2004.

Other students on request (limited places).

Important: the chair coaching your BA/MA defines whether the course is mandatory. Please contact your chair!

Electronic enrollment until 08.09.2015 required. Without electronic enrollment participation in the course can't be confirmed. The course is held "en bloc" at the beginning of the semester.

Date: Friday 11.09.2015 (13:15-17:00), location: HG E33.1 (ETH main building) and Saturday, 12.09.2015 (09:15-17:00), location: HG E33.1 (ETH main building). Participation at both days required (Friday afternoon and Saturday whole day).

The course is held in English; handouts are available in English.

Besonderes (deutsche Version):

Der Kurs richtet sich an Studierende, welche an einer Professur des D-MTEC eine Arbeit in der Wirtschaft schreiben werden. Im Allgemeinen sind dies:

(1) MSc-Studierende MTEC oder MAVT mit Masterarbeit (MA) im kommenden Semester, die vom MTEC betreut wird, (entspricht 3. oder 4. Semester Master) sowie
(2) BSc-Studierende MAVT mit Bachelorarbeit (BA) in der Wirtschaft, die vom MTEC betreut wird, sowie mit vollem MTEC Fokus (entspricht 5. oder 6. Semester Bachelor) oder
(3) MAS MTEC -Studierende im 3. Semester für MA im kommenden Semester.


Andere Studierende auf Anfrage (beschränkte Anzahl Plätze).

Wichtig: die Professur, welche die jeweilige BA/MA betreut, legt fest, ob der Besuch der Veranstaltung obligatorisch ist. Bitte informieren Sie sich dort!

Elektronische Einschreibung bis zum 08.09.2015 notwendig. Ohne elektronische Einschreibung kann Ihre Teilnahme am Kurs nicht bestätigt werden.

Der Kurs wird als Blockkurs zu Beginn des Semesters gehalten.

Termin: Freitag, den 11.09.2015 (13:15-17:00) im HG E33.1 und Samstag, 12.09.2015 (09:15- ca. 17:00) im HG E33.1 (ETH Hauptgebäude). Anwesenheitspflicht an beiden Tagen (Freetagmorgen und Samstag ganztag).

Die Veranstaltung wird auf Englisch gehalten; Handouts sind in Englisch verfügbar.

<table>
<thead>
<tr>
<th>363-0881-00L</th>
<th>Semester Project Small</th>
<th>W</th>
<th>3 credits</th>
<th>6A</th>
<th>Professors</th>
</tr>
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<tbody>
<tr>
<td>Abstract</td>
<td>The semester project (90 hours) is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.</td>
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<tr>
<th>363-0883-00L</th>
<th>Semester Project Large</th>
<th>W</th>
<th>6 credits</th>
<th>13A</th>
<th>Professors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>The semester project (180 hours) is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.</td>
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<tr>
<th>363-1021-00L</th>
<th>Monetary Policy</th>
<th>W</th>
<th>3 credits</th>
<th>2V</th>
<th>J.E. Stumm, D. Kaufmann</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>The main aim of this course is to analyse the goals of monetary policy and to review the instruments available to central banks in order to pursue these goals. It will focus on the transmission mechanisms of monetary policy and the differences between monetary policy rules and discretionary policy. It will also make connections between theoretical economic concepts and current real world issues.</td>
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<tr>
<td>Objective</td>
<td>This lecture will introduce the fundamentals of monetary economics and explain the working and impact of monetary policy.</td>
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<tr>
<td>Prerequisites notice</td>
<td>Basic knowledge in international economics and a good background in macroeconomics. The course website can be found at: <a href="http://www.kof.ethz.ch/en/events/teaching/">http://www.kof.ethz.ch/en/events/teaching/</a></td>
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<tr>
<th>363-1024-00L</th>
<th>Economics of Regulation</th>
<th>W</th>
<th>3 credits</th>
<th>2V</th>
<th>W. Hu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>This course introduces the economic theories and practices of governmental market regulation. We review related theories in microeconomics and apply them to various industries such as energy, telecoms and finance. We discuss different types of market failure in these markets, the ideal interventions, the real life practices and their evolutions. And we also learn about how to evaluate the policies.</td>
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</table>
Objective - To deliver the understanding about why and when regulations are needed; to make students familiar with common regulatory policies; and to let students know about some very famous cases;

- To make a systematic review of the microeconomic theories that are related to regulation, specifically including game theory, industrial organization, environmental economics, and contract theory. Furthermore, by applying these theories to the regulatory problems, we want to show how one can use microeconomic theories to explain and solve real-life issues.

- By the end of the course, students are expected to have enhanced their understandings of the related microeconomic theories, and have strengthened the abilities to explain, to analyze, and to solve regulatory problems.

Content Topics include:
- Introduction (market efficiency and failure);
- Classical regulatory tools (Price regulations and more);
- Monopoly power and dominance;
- Regulating the utilities (Electricity and energy, Telecommunications, Environmental regulation, Financial regulation);
- Cost-benefit analysis;
- The asymmetric information problem in regulation.

Literature Lodge, M., M. Cave and R. Baldwin (eds.), The Oxford Handbook of Regulation, Oxford University Press, 2010. (accessible online via the school network)


Prerequisites / notice Cases will be announced during the course.

363-1027-00L Introduction to Health Economics and Policy W 3 credits 2V W. Mimra

Abstract Health expenditures constitute about 10% of GDP in OECD countries. Extensive government intervention is a typical feature in health markets. Risk factors to health have been changing with growing importance of lifestyle factors such as smoking, obesity and lack of physical activity. This course gives an introduction to the economic concepts and empirical findings in health economics.

Objective Introduce students without prior economics background to the main concepts of health economics and policy to enhance students understanding of how health care institutions and markets function.

Content The course gives an introduction to the economic concepts and empirical findings in health economics to enhance students understanding of how health care institutions and markets function. First, the three important decisions made by individuals will be analyzed: What determines the health behaviors, like the intensity of preventive measures like sport, that an individual undertakes? What types and amount of personal health care services does an individual demand? How much health insurance coverage will be purchased? In a second part, the major participants on the supply side of health care markets - physicians, hospitals, nurses and pharmaceutical manufacturers - will be discussed. E.g., how important are financial incentives in the choice of medicine as a career, specialty choice and practice location? What does it mean and imply that a physician is an agent for a patient? How do pharmaceutical firms decide on investments in new products and how can public policy encourage pharmaceutical innovation? The choices made by societies about how health care services are financed and about the types of organizations that supply health care will be addressed in a third part. One important choice is whether a country will rely on public financing of personal health care services or encourage private health care insurance markets. How could and should a public health insurance system be designed? What health care services should be included or excluded from a public system? Another important choice is whether a society relies on government provision of health care services, private provision by not-for-profit or for-profit organizations or some combination. The advantages and disadvantages of the alternatives will be discussed to provide a framework for analyzing specific types of health care systems.


363-1036-00L Empirical Innovation Economics W 3 credits 2G M. Wörter

Abstract The course focuses on important factors that drive the innovation performance of firms, like innovation capabilities, science-industry relationships, environmental policy and it shows how innovation activities relate to firm performance and to the technological dynamics of industries. Hence, the course provides an understanding of the relationship between technical change and industrial dynamics.

Objective The course provides students with the basic skills to understand and assess empirically the technological activities of firms and the technological dynamics of industries.

Content The course consists of two parts. Part I provides an introduction into important topics in the field of the economics of innovation. Part II consists of empirical exercises based on the KOF Innovation Data. In part I we will learn about ...a) market conditions that encourage firms to invest in R&D (Research and Development) and develop new products. ...b) the role of universities for the technological activities of a firm (technology transfer). ...c) how technologies diffuse among firms. ...d) how the R&D activities of firms are affected by economic crises and how firms finance their R&D activities. ...e) how we can measure the returns to R&D activities. ...f) how (environmental) policies affect the technological activities of a firm. In part II we will use the KOF Innovation Survey Data in order to assess empirically the technological activities of firms referring to the topics introduced in part I.

Lecture notes Will be provided in the course.

Literature Literature will be presented in the course. For an introduction into the economics of innovation see G.M. Peter Swann, The Economics of Innovation - an Introduction, Edward Elgar, 2009. For an overview of empirical innovation studies see W.M. Cohen (2010): Fifty Years of Empirical Studies of Innovation Activities and Performance, in: B.H Hall, N. Rosenberg (eds.), Handbook of Economics of Innovation, volume 1, Elsevier, pp. 129-213.

Prerequisites / notice Course is directed to advanced Master-Students and PhD Students with an interest in empirical work.

363-1042-00L Strategic Career Development Z 0 credits 1V P. Cettier

Abstract The offer Strategic Career Development has the goal to support students in the development and alignment of their personal & professional goals. Orientation, Goal setting, action plan development, motivation letter, CV, interview training

Objective We will discuss and develop answers to the following questions:

What do I want to achieve in my life?
Why is it to important to define goals?
What decision criteria can I use as a guide?
How do potential career paths look like? What are the possibilities?
How does the life cycle of a career look like? What are the alternatives?
How do I increase my chances of success/reaching my goals?
How did others do it? What kind of advice can experienced captains of industry give?
Why is a periodic check of my goals and my progress necessary?

Prerequisites / notice Students are expected to have taken at least one basic microeconomics course. Knowledge about game theory, industrial organization and public economics will be useful. Knowledge about contract theory is a plus.
A. Russo
This course aims to equip students with an in-depth knowledge of the sustainability-related challenges and problems within supply chain management, and suggests some tools for managing these challenges. Equally importantly, the course seeks to capacitate students for understanding and analyzing the tradeoffs and conflicts of target within sustainable supply chain management. The content of the course is closely linked to the latest research in the field, meaning that the absence of simple solutions will be the rule, rather than the exception. Moreover, the course will be highly interactive, and there will be intensive coursework during the course.

C. Busse
INTRODUCTION (7.10.2015)
Sustainable Supply Chain Management
In today’s world of everything is possible it becomes an every increasing challenge to find orientation, to define a goal for which it is worth to work for with focus and energy. But this is exactly what is so important in today’s work environment. Only with a definite goal one can decide if the taken path is right, one can develop enough motivation to go beyond the comfort zone. With a definite goal, one increases the chances of success of one’s education and career. The earlier one has defined what he/she wants to achieve, the bigger the effect.

2G
Course slides will be made available to students prior to each class.

The main objective of this course is to provide students with some basic tools to analyze transport policy decisions from an economic perspective. Can economics help us reduce road congestion problems? Should drivers be asked to pay for using urban roads? Should public transport tariffs depend on how roads are priced? How should the investment in transport infrastructure be financed? These are some of the questions that students should be able to tackle after completing the course.

W
The first part of the course will present some basic principles of transportation economics, applied to the main issues in urban transport policy (e.g. road pricing, public transport tariffs, investment in infrastructure etc.). The second part of the course will consider some case studies where we will apply the tools acquired in the first part to actual policy issues.

Part 1 to 5: textbook: Small and Verhoef (The economics of urban transportation, 2007).
Additional material:
Part 1 to 5: textbook: Small and Verhoef (The economics of urban transportation, 2007).

Part 6: Topics to be covered on research papers/case studies.

6. Topics:
   a. Political economy of road pricing: why do we see road pricing in so few cities (London, Stockholm...) and not in many other cities (NYC, Manchester, Paris...)?
   b. What are the alternatives to road pricing to reduce congestion? Parking tariffs, traffic regulation (speed bumps, low emission zones), road space reduction. Examples: Zurich, San Francisco (SFPark), Paris...
   c. Transport and land use: value of housing and transport services. Road congestion, transport subsidies and urban sprawl.

Lecture notes
Course slides will be made available to students prior to each class.

SYLLABUS (preliminary):
course slides will be made available to students.

External guest speaker: Dr. Alexandre Grêt, CEO, HaslerRail AG

INTRODUCTION (7.10.2015)
Sustainable Supply Chain Management
In today’s world of everything is possible it becomes an every increasing challenge to find orientation, to define a goal for which it is worth to work for with focus and energy. But this is exactly what is so important in today’s work environment. Only with a definite goal one can decide if the taken path is right, one can develop enough motivation to go beyond the comfort zone. With a definite goal, one increases the chances of success of one’s education and career. The earlier one has defined what he/she wants to achieve, the bigger the effect.

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   c. Transport and land use: value of housing and transport services. Road congestion, transport subsidies and urban sprawl.

Lecture notes
Course slides will be made available to students prior to each class.

SYLLABUS (preliminary):
course slides will be made available to students.

External guest speaker: Thomas Vellacott, CEO, WWF Switzerland

Economics of Urban Transportation
The first part of the course will present some basic principles of transportation economics, applied to the main issues in urban transport policy (e.g. road pricing, public transport tariffs, investment in infrastructure etc.). The second part of the course will consider some case studies where we will apply the tools acquired in the first part to actual policy issues.

Objective
The main objective of this course is to provide students with some basic tools to analyze transport policy decisions from an economic perspective. Can economics help us reduce road congestion problems? Should drivers be asked to pay for using urban roads? Should public transport tariffs depend on how roads are priced? How should the investment in transport infrastructure be financed? These are some of the questions that students should be able to tackle after completing the course.

Content
COURSE OUTLINE (preliminary):

1. Introduction
2. Travel demand:
   a. travel cost and value of time
   b. mode choice
3. Road congestion and first-best pricing
   a. Static congestion model
   b. Dynamic congestion models
   c. Examples: London Congestion Charge, Stockholm Congestion Charge
4. Second-best pricing
   a. Pricing roads with unpriced alternatives. Examples: tolled and toll-free highways
   b. Public transport: pricing with road congestion and with (or without) road tolls
5. Investment in infrastructure: public transport and roads
   a. Roads: Investment with and without pricing
   b. induced demand
   c. Economies of scale/density in public transport
6. Topics:
   a. Political economy of road pricing: why do we see road pricing in so few cities (London, Stockholm...) and not in many other cities (NYC, Manchester, Paris...)?
   b. What are the alternatives to road pricing to reduce congestion? Parking tariffs, traffic regulation (speed bumps, low emission zones), road space reduction. Examples: Zurich, San Francisco (SFPark), Paris...
   c. Transport and land use: value of housing and transport services. Road congestion, transport subsidies and urban sprawl.

Lecture notes
Course slides will be made available to students prior to each class.

SYLLABUS (preliminary):
course slides will be made available to students.

Additional material:
Part 1 to 5: textbook: Small and Verhoef (The economics of urban transportation, 2007).
Part 6: Topics to be covered on research papers/case studies.

Sustainable Supply Chain Management
The course focuses on the establishment of sustainability in firm's supply chains (that is, in their internal operations, in their logistics processes, and in their upstream supply chains). We will consider how supply chains can become more sustainable, as well as the extent to which firms are interested in such a development.

Objective
This course aims to equip students with an in-depth knowledge of the sustainability-related challenges and problems within supply chain management, and suggests some tools for managing these challenges. Equally importantly, the course seeks to capacitate students for understanding and analyzing the tradeoffs and conflicts of target within sustainable supply chain management.

Content
COURSE OUTLINE (preliminary):

1. Introduction
2. Travel demand:
   a. travel cost and value of time
   b. mode choice
3. Road congestion and first-best pricing
   a. Static congestion model
   b. Dynamic congestion models
   c. Examples: London Congestion Charge, Stockholm Congestion Charge
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   c. Transport and land use: value of housing and transport services. Road congestion, transport subsidies and urban sprawl.

Lecture notes
Course slides will be made available to students prior to each class.

SYLLABUS (preliminary):
course slides will be made available to students.

Additional material:
Part 1 to 5: textbook: Small and Verhoef (The economics of urban transportation, 2007).
Part 6: Topics to be covered on research papers/case studies.
Entrepreneurial Leadership
H. Gersbach,
The course material will be available for download from the homepage of the Chair of Logistics Management:


The preliminary course outline is as follows:

C. P. Siegenthaler
Workshop & Lecture Series on the Law & Economics
4 credits

Supplementary textbooks:
S. Brusoni, G. Grote, V. Hoffmann, A. Heinemann, G. Hertig

After the workshop and lecture series, participants should be acquainted with interdisciplinary approaches towards intellectual property,

The workshop and lecture series will present a mix of speakers who represent the wide range of current social science research methods

This series is a joint project by ETH Zurich and the University of Zurich. It provides an overview of interdisciplinary research on intellectual

Papers discussed in the workshop and lecture series are posted in advance on the course web page.

851-0735-09L Workshop & Lecture Series on the Law & Economics W 2 credits 2S S. Bechtold, H. Gersbach, A. Heinemann, G. Hertig

Suzanne Scotchmer, Innovation and Incentives, 2004

There are no formal prerequisites. However, to profit most from the course, it would be desirable if students attended the MTEC courses on

Prerequisites / notice

There are no formal prerequisites. However, to profit most from the course, it would be desirable if students attended the MTEC courses on

536-1028-00L Entrepreneurial Leadership of Innovation
Limited number of participants

Students apply with motivation letter, CV and a transcript of records no later than 25.8.2015. Earlier applications welcome. Send application to andreakuranth@ethz.ch. Once your application is confirmed, a registration in myStudies is possible.

Module 2: Supply chain sustainability topics and issues in an overview
- Types of issues
- Juxtaposing the three dimensions of the triple-bottom line
- Issue reporting
- Dilemmas for firms

Module 3: Sustainable operations management
- Lean and green
- CO2 avoidance
- Recycling
- Closed-loop SCM

Module 4: Sustainable logistics
- Forward vs. reverse logistics
- Sustainable transportation
- Sustainable warehousing
- Sustainable packaging
- Design of sustainable logistics networks

Module 5: Sustainable purchasing and supply management
- Management of the entire supply base in global sourcing contexts
- Sustainable supplier management processes
- Information processing prerequisites to sustainable supplier management processes
- Sustainability-oriented supply chain risk management

Module 6: Emerging topics in sustainable supply chain management

Wrap-up

Lecture notes
The course material will be available for download from the homepage of the Chair of Logistics Management:
http://www.scm.ethz.ch/teaching/Courses. The login will be announced in the first lecture. In addition, we will employ scientific publications and case studies as readings which are provided throughout the course. Supplementary textbooks are listed below in the literature section.


Prerequisites / notice
There are no formal prerequisites. However, to profit most from the course, it would be desirable if students attended the MTEC courses on Strategic Supply Chain Management (MTEC MSc course no. 363-0453-00L), on Purchasing and Supply Management (MTEC MSc course no. 363-0452-00L) and on Corporate Sustainability (MTEC MSc course no. 363-0387-00L) beforehand. Moreover, the course builds on and details lectures on Sustainable Supply Chain Management within the course LOS II: Manufacturing Strategies - From Supply Chain Design to Factory Planning II (MTEC MSc course no. 363-0448-00L).

Literature
Supplementary textbooks:

Literature

Suzanne Scotchmer, Innovation and Incentives, 2004


Bronwyn Hall / Nathan Rosenberg (eds.), Handbook of the Economics of Innovation, 2 volumes, Amderstam 2010

Bronwyn Hall / Dietmar Harhoff, Recent Research on the Economics of Patents, 2011


Einer Elhauge / Damien Geradin, Global Competition Law and Economics, 2007

Dennis Carlton / Jeffrey Perloff, Modern Industrial Organization, 4th edition, 2004


363-1028-00L Entrepreneurial Leadership of Innovation
Limited number of participants

Students apply with motivation letter, CV and a transcript of records no later than 25.8.2015. Earlier applications welcome. Send application to andreakuranth@ethz.ch. Once your application is confirmed, a registration in myStudies is possible.

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 910 of 1434
Abstract
This seminar provides the most ambitious and best performing master students at MTEC with the challenging opportunity of a real case on strategy, innovation and leadership in close collaboration with the top management of an outstanding company - in 2015: PwC Switzerland.

Objective
In your team, you will work on a specific assignment that flows from the current strategic agenda of the board. While gaining substantial insights into the structure, dynamics and challenges of the advisory and assurance industry, you immerse into the business model and strategic landscape of the corporate partner. You visit their headquarter, conduct interviews with members of the management team, experienced consultants as well as internal and external experts before you discuss your ideas with top executives. To secure impact, it is key that you formulate your recommendations from a deep understanding of the authentic leadership culture of the corporate partner.

Content
In this endeavour you are coached and supported by
- Guidela Grote, Chair of Work and Organizational Psychology
- Stefano Brusoni, Chair of Technology and Innovation Management
- Claude Siegenthaler, Hosei University / The St.Gallen MBA
- Georg von Krogh, Chair of Strategic Management and Innovation
- Pius Baschera, Chair of Entrepreneurship

Prerequisites / notice
Please apply for this course via the official website (www.mtec.ethz.ch) and send your application form together with a CV and transcript of records to andreakurath@ethz.ch.
Apply no later than August 25, yet early registrations are welcomed.
The number of participants is limited to 18.
ECTS: 4
Participants receive a certificate.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Prerequisites</th>
<th>Notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-1051-00L</td>
<td>Cases in Technology Marketing</td>
<td>Students have to apply for this course by sending a CV and an one-page motivation letter until 14.09.2015 to <a href="mailto:mgrohmann@ethz.ch">mgrohmann@ethz.ch</a>. Additionally please enroll via myStudies. Places will be assigned on the basis of your motivation letter.</td>
<td>F. von Wangenheim, C. Grieder</td>
</tr>
<tr>
<td>363-1055-00L</td>
<td>Marketing Practice</td>
<td>Please send your application documents (Cover Letter, CV, Transcript of Records, Reports) by 15.10.2015 to <a href="mailto:mgrohmann@ethz.ch">mgrohmann@ethz.ch</a>. Once your application has been confirmed, a registration in myStudies is possible.</td>
<td>F. von Wangenheim</td>
</tr>
<tr>
<td>363-1065-00L</td>
<td>Design Thinking: Human-Centred Solutions to Real World Challenges</td>
<td>Due to didactic reasons, the number of participants is limited to 30. All interested students are invited to apply for this course by sending a one-page motivation letter until 07.09.2015 to Florian Rittiner (<a href="mailto:rittiner@ethz.ch">rittiner@ethz.ch</a>). Additionally please enroll via mystudies. Places will be assigned after the first lecture on the basis of your motivation letter and commitment for the class.</td>
<td>A. Cabello Llamas, S. Brusoni, C. Hölscher, M. Meboldt, F. Rittiner</td>
</tr>
<tr>
<td>376-1177-00L</td>
<td>Human Factors I</td>
<td></td>
<td>M. Menozzi Jäckli, R. Boutellier, R. Huang, M. Siegrist</td>
</tr>
</tbody>
</table>
The simulation is conducted in collaboration with experts and students during a two days seminar at the University of Geneva. Lecturers

3 credits

Conference of Disarmament: Simulation of Negotiations

The Global Studies Institute (University of Geneva) is organizing a simulation seminar on nuclear disarmament in collaboration with the Chair of Negotiation and Conflict Management (ETH), experts from the United Nations Institute for Disarmament Research and the Geneva Center for Security Policy.

Objective

The simulation is conducted in collaboration with experts and students during a two days seminar at the University of Geneva.

Students will have the possibility to participate in simulated diplomatic negotiations and to analyse and assess the negotiation logic behind the situations. They should gain insight in the basic information on disarmament issues and on the functioning of the Conference on Disarmament as well as on negotiation techniques in general.

Content

- Physiological, physical, and cognitive factors in sensation and perception
- Body spaces and functional anthropometry
- Experimental techniques in assessing human performance and well-being
- Human factors and ergonomics in system designs, product development and innovation
- Human information processing and cybernetics
- Interaction among consumers, environments, behavior, and tasks

Literature


363-1050-00L

Conference of Disarmament: Simulation of Negotiations

W 3 credits 2S M. Ambühl

Abstract

The Global Studies Institute (University of Geneva) is organizing a simulation seminar on nuclear disarmament in collaboration with the Chair of Negotiation and Conflict Management (ETH), experts from the United Nations Institute for Disarmament Research and the Geneva Center for Security Policy.

Objective

The goal of the lecture is to empower students in better understanding the applied theories, principles, and methods in various applications. Students are expected to learn about how to enable an efficient and qualitatively high standing interaction between human and the environment, considering costs, benefits, health, and safety as well. Thus, an ergonomic design and evaluation process of products, tasks, and environments may be promoted in different disciplines. The goal is achieved in addressing a broad variety of topics and embedding the discussion in macroscopic factors such as the behavior of consumers and objectives of economy.

Content

- Physiological, physical, and cognitive factors in sensation and perception
- Body spaces and functional anthropometry
- Experimental techniques in assessing human performance and well-being
- Human factors and ergonomics in system designs, product development and innovation
- Human information processing and cybernetics
- Interaction among consumers, environments, behavior, and tasks

Literature


363-0879-00L

Industrial Internship

Practical Training

O 6 credits

Abstract

The practical experience gained by the student complements the studies at the Swiss Federal Institute of Technology and prepares her/him for future activities in industry.

Objective

The practical experience gained by the student complements the studies at the Swiss Federal Institute of Technology and prepares her/him for future activities in industry.

57D Professors

363-0600-00L

Master’s Thesis

O 30 credits

Note:

The participation in the simulations on 26. and 27. November in Geneva is necessary. The two hours lectures on the 22. September, 6. and 13. October have to be attended in Zürich via conference call (ETH HG D 16.2). The other lectures during the semester can be attended via Skype. To get the 3 ECTS, students have to participate at the 2 days simulation in Geneva, attend the 3 mandatory lecture parts via conference call an Zürich and write a report of 5 pages at the end of the course.

(technical note for registration: At this stage all registered students are on the waiting list)

Supplementary Courses

The students have to deepen their knowledge in the area(s) of engineering/natural sciences in consultation with the responsible professor (tutor). Core courses and electives of D-MTEC can not be used as supplementary courses.

Course Catalogue of ETH Zurich

Industrial Internship

Number Title Type ECTS Hours Lecturers

363-0879-00L Practical Training O 6 credits external organisers

Abstract

The practical experience gained by the student complements the studies at the Swiss Federal Institute of Technology and prepares her/him for future activities in industry.

Objective

The practical experience gained by the student complements the studies at the Swiss Federal Institute of Technology and prepares her/him for future activities in industry.

Master Thesis

Number Title Type ECTS Hours Lecturers

363-0600-00L Master’s Thesis O 30 credits 57D Professors

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 912 of 1434
Only students who fulfill the following criteria are allowed to begin with their master thesis:

a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to gain admission to the master programme;
c. internship fulfilled

Abstract

In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is supervised by the tutor and normally deals with a subject contained in the major fields. The research will be performed normally within a private company or at the ETH Zurich.

Objective

In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is supervised by the tutor and normally deals with a subject contained in the major fields. The research will be performed normally within a private company or at the ETH Zurich.

363-1063-00L Academic Writing Course

The course is highly recommended to all MTEC MSc students and compulsory for students who started in Spring 2015 or later.

Abstract

This course for MTEC master’s students will focus on developing and refining students’ English writing skills and their understanding of the requirements and conventions of academic writing.

Objective

The aim of this course is to improve the academic writing skills needed to complete an MSc thesis successfully. The course provides theoretical input, practical writing exercises, and detailed individual feedback organised into one group lecture and four workshops in smaller tutorial groups.

Initially, the lecture provides an overview of the range of demands on academic essay and MSc thesis writers and outlines the academic expectations that students must meet. Our goal is to provide a basis for informed decisions when selecting a thesis topic and supervisor. Guidance is then provided in the workshops on planning the writing process effectively, and individual feedback is provided to enhance writing ability.

The course develops a range of practical and transferrable writing skills. Students can use these skills to improve the overall quality of their MSc theses and to produce their thesis more rapidly and efficiently. The writing skills developed here can be used beyond the MSc, whether students go on to complete a PhD or to produce reports and other documents in industry.

Content

Group lecture:

- an introduction to writing an MSc thesis in D-MTEC
- selecting topic and supervisor
- academic expectations
- avoiding plagiarism

Workshop 1:

- the writing process
- reading, note taking and planning
- overview of the thesis structure
- building academic vocabulary

Workshop 2:

- writing methods sections
- embedding figures and tables
- structuring sentences and paragraphs
- noun phrases and articles

Workshop 3:

- introductions; results and discussion sections
- analysis v description
- writing critically
- relative clauses

Workshop 4:

- abstracts and conclusions
- editing your own text
- punctuation, spelling, and grammar

Lecture notes

Notes will be available after registration.
##主要内容

### Lecture
The lecture covers the structure and the properties of metallic materials. In the focus are the branches: microscopic structure; thermally activated processes, systems of ordinary differential equations; power series. The mathematical methods are applied in a large number of examples from mechanics, physics and other areas which are basic to engineering.

### Kinematics and Statics
Lecture notes: U. Stammbach: Analysis II/I
Prerequisites / notice: Die Übungsaufgaben (inkl. Multiple Choice) sind ein wichtiger Bestandteil der Lehrveranstaltung. Es wird erwartet, dass Sie mindestens 75% der wöchentlichen Serien bearbeiten und zur Korrektur einreichen.

### Linear Algebra I
Abstract: Linear algebra is an indispensable tool of engineering mathematics. The course offers an introduction into the theory with many applications. The new notions are practised in the accompanying exercise classes. The course will be continued as Linear algebra II.
Objective: Upon completion of this course, students will be able to recognize linear structures, and to solve corresponding problems in theory and in practice.
Content: Systems of linear equations, Gaussian elimination, solution space, matrices, LR decomposition, determinants, structure of linear spaces, normed vector spaces, inner products, method of least squares, QR decomposition, introduction to MATLAB, applications
Prerequisites / notice: Active participation in the exercises is part of this course. It is expected, that students submit 3/4 of all exercises for control.

### Kinematics and Statics
Abstract: Basics: Position of a material point, velocity, kinematics of rigid bodies, forces, reaction principle, mechanical power
Statics: Groups of forces, moments, equilibrium of rigid bodies, reactions at supports, parallel forces, center of gravity, statics of systems, principle of virtual power, trusses, frames, forces in beams and cables, friction
Objective: The understanding of the fundamentals of statics for engineers and their application in simple settings.
Content: Grundlagen; Lage eines materiellen Punktes; Geschwindigkeit; Kinematik starrer Körper, Translation, Rotation, Kreiselung, ebene Bewegung; Kräfte, Reaktionsprinzip, innere und äußere Kräfte, verteilte Flächen- und Raumkräfte; Leistung
Lecture notes: Übungsbücher
Literature: Sayir, M.B., Dual J., Kaufmann S., Ingenieurmechanik 1: Grundlagen und Statik, Teubner
Prerequisites / notice: Written session examination in "Kinematics and Statics" and "Mechanics of Materials" for D-MAVT Students, Students in Human Movement Sciences and Sport and all other Students, who take "Kinematics and Statics" and "Mechanics of Materials". It is expected, that students submit 3/4 of all exercises for control.

### Engineering Materials and Production I
Abstract: The lecture covers the structure and the properties of metallic materials. In the focus are the branches: microscopic structure; thermally activated processes; solidification, elastic, plastic deformation, creep. Generally the lecture also refers to manufacturing, to the processing, and application of the concerning materials.
Objective: Understanding the basics of metallic materials for engineers who are confronted with material decisions in design and production.
Content: The lecture covers the structure and the properties of metallic materials. In the focus are the branches: microscopic structure as ideal and real structure, alloying, thermally activated processes e.g. diffusion, recovery, recrystallisation, solidification, elastic and plastic deformation and creep. Generally the lecture also refers to manufacturing, to the processing, and application of the concerning materials.
Lecture notes: yes

### Machine Elements
Abstract: Introduction to machine elements and mechanical systems as basics of product development. Case studies of their application in products and systems.
Objective: The students get an overview of the main mechanical components (machine elements) which are used in mechanical engineering. Selected examples will demonstrate how these can be assembled into functional parts and complete systems such as machinery, tools or actuators. At the same time, also the problem of production (production-oriented design) is discussed. In concurrent lectures / exercises "technical drawing and CAD" the design implementation will be practiced.
Content

- Innovation Process: A Quick Overview
- Stages of the planning and design process
- Requirements for a design and technical implementation
- Choice of materials - Basic principles of a material-specific design
- Manufacturing process - fundamentals of a production-oriented design
- Connections, fuses, seals
- Machine-standard elements
- Storage & guides
- Transmission and its components
- Drives

The idea of machine elements is complemented by case studies and illustrated.

Lecture notes

The lecture slides will be published beforehand on the website of the pd|z.

Prerequisites / notice

For Bachelor studies in Mechanical and Process Engineering, the lecture "Maschinenelemente" (HS) is examined together with "Innovationsprozess" (FS) in the exam "Basisprüfung Maschinenelemente und Innovationsprozess".

529-0010-00L Chemistry O 3 credits 2V+1U A. de Mello, K. Elvira

Abstract

This is a general chemistry course aimed at first year undergraduate students in the Department of Mechanical and Process Engineering (D-MAVT).

Objective

The aims of the course are as follows:
1) To provide a thorough understanding of the basic principles of chemistry and its application.
2) To develop an understanding of the atomic and molecular nature of matter and of the chemical reactions that describe their transformations.
3) To emphasize areas considered most relevant in an engineering context.

Content

Electronic structure of atoms, chemical bonding, molecular shape and bonding theory, gases, thermodynamics, chemical thermodynamics, chemical kinetics, equilibria, solutions and intermolecular forces, redox and electrochemistry.

Literature

The course is based on "Chemistry the Central Science" by Brown, LeMay, Bursten, Murphy and Woodward. Pearson, 12th Edition (international edition).

Additional First Year Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0321-00L</td>
<td>Technical Drawing and CAD</td>
<td>O</td>
<td>4 credits</td>
<td>4G</td>
<td>K. Shea</td>
</tr>
</tbody>
</table>

Abstract


Objective

The lecture and exercises teach the fundamentals of technical drawing and CAD. After taking the course students will be able to create accurate technical drawings of parts and assemblies as well as read them. Students will also be able to create models of parts and assemblies in a 3D, feature-based CAD system. They will understand the links with simulation, product data management (PDM) and additive manufacturing.

Content

Introduction to Engineering Design
Sketching in Engineering Design
Technical Drawing:
- projections and views
- cuts
- notations
- primitives
- ISO norm elements
- dimensioning
- tolerances
- assemblies
- documentation

CAD:
- CAD basics
- CAD modeling methods
- sketch modeling
- modeling operations
- feature-based modeling
- assemblies
- creating 2D drawings from 3D parts
- links to simulation, e.g. kinematics
- links to model variants and Product Data Management (PDM)
- links to additive manufacturing (3D printing)

Lecture notes

Lecture slides and exercise handouts are available on the course Moodle website: https://moodle-app2.let.ethz.ch/course/index.php?categoryid=56

Literature

In addition to the lecture material the following books are recommended (only in German):

TZ Technisches Zeichnen: selbstständig lernen und effektiv üben
Susanna Labisch und Christian Weber
2008 Vieweg
eBook (accessible from the ETH domain): http://link.springer.com/book/10.1007/978-3-8348-9451-9/page/1

VSM Normen-Auszugs 2010
(kann in den Übungen bestellt und gekauft werden)

CAD
Marcel Schmid
CAD mit NX: NX 8
J.Schlembach Fachverlag
ISBN: 978-3-935340-72-4
This course is given as a lecture (1h/week) and an exercise (3h/week). Students are split into working groups for the exercises with a maximum of 20 students per group.

Semester Fee
A fee is charged for printed copies of the course handouts.

First Year Optional Colloquia

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>151-0501-02L</td>
<td>Kinematics and Statics (Colloquium)</td>
<td>Z</td>
<td>0</td>
<td>1K</td>
<td>E. Mazza</td>
</tr>
</tbody>
</table>

Abstract
Basics: Position of a material point, velocity, kinematics of rigid bodies, forces, reaction principle, mechanical power
Statics: Groups of forces, moments, equilibrium of rigid bodies, reactions at supports, parallel forces, center of gravity, statics of systems, principle of virtual power, trusses, frames, forces in beams and cables, friction

Objective
The understanding of the fundamentals of Statics for engineers and their application in simple settings.

Content
Statics: equivalence and reduction of groups of forces; rest and equilibrium; basic theorem of statics; kinematic and static boundary conditions, applications to supports and clamps of rods and beams; procedures for determination of forces at supports and clamps; parallel forces and centre of gravity; statics of systems, solution using basic theorem and using the principle of virtual power, statically indeterminate systems; statically determinate truss structures, ideal truss structures, nodal point equilibrium, methods for truss force determination; friction, static friction, sliding friction, friction at joints and supports, rolling resistance; forces in cables; beam loading, force and moment vector.

Lecture notes Übungsblätter

Literature
Sayir, M.B., Dual J., Kaufmann S., Ingenieurmechanik 1: Grundlagen und Statik, Teubner

3. Semester

Compulsory Courses

Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-0363-10L</td>
<td>Analysis III</td>
<td>O</td>
<td>3</td>
<td>2V+1U</td>
<td>A. Iozzi</td>
</tr>
</tbody>
</table>

Abstract
Introduction to partial differential equations. Differential equations which are important in applications are classified and solved. Elliptic, parabolic and hyperbolic differential equations are treated. The following mathematical tools are introduced: Laplace transforms, Fourier series, separation of variables, methods of characteristics.

Objective
Mathematical treatment of problems in science and engineering. To understand the properties of the different types of partial differential equations.

Content
Laplace Transforms:
- Laplace Transform, Inverse Laplace Transform, Linearity, s-Shifting
- Transforms of Derivatives and Integrals, ODEs
- Unit Step Function, t-Shifting
- Short Impulses, Dirac's Delta Function, Partial Fractions
- Convolution, Integral Equations
- Differentiation and Integration of Transforms

Fourier Series, Integrals and Transforms:
- Fourier Series
- Functions of Any Period p=2L
- Even and Odd Functions, Half-Range Expansions
- Forced Oscillations
- Approximation by Trigonometric Polynomials
- Fourier Integral
- Fourier Cosine and Sine Transform

Partial Differential Equations:
- Basic Concepts
- Modeling: Vibrating String, Wave Equation
- Solution by separation of variables; use of Fourier series
- D'Alembert Solution of Wave Equation, Characteristics
- Heat Equation: Solution by Fourier Series
- Heat Equation: Solutions by Fourier Integrals and Transforms
- Modeling Membrane: Two Dimensional Wave Equation
- Laplacian in Polar Coordinates; Circular Membrane, Fourier-Bessel Series
- Solution of PDEs by Laplace Transform

Literature

For reference/complement of the Analysis I/II courses:

Prerequisites / notice
Christian Blatter: Ingenieur-Analyse (Download PDF)
Up-to-date information about this course can be found at:
http://www.math.ethz.ch/education/bachelor/lectures/hs2013/other/analysis3_itet

Dynamics

<table>
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<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-0503-00L</td>
<td>Dynamics</td>
<td>O</td>
<td>6</td>
<td>4V+2U</td>
<td>G. Haller</td>
</tr>
</tbody>
</table>

Abstract
Kinematics, dynamics and oscillations: Motion of a single particle - Motion of systems of particles - 2D and 3D motion of rigid bodies
Vibrations
This course provides Bachelor students of mechanical engineering with fundamental knowledge of kinematics and dynamics of mechanical systems. By studying motion of a single particle, systems of particles and rigid bodies, we introduce essential concepts such as work and energy, equations of motion, and forces and torques. Further topics include stability of equilibria and vibrations. Examples presented in the lectures and weekly exercise lessons help students learn basic techniques that are necessary for advanced courses and work on engineering applications. Strength calculations are performed both for static and fatigue operating conditions.

Strength proof for different machine elements:
- Theoretical basics of engineering design
- Description of ductil and brittle material behavior
- Design of machine elements at static loading conditions
- Notch effects
- Axes and shafts
- Fatigue design
- Surface pressure
- Rotationally symmetric bodies, pressure vessels and cylindrical interference
- Dimensioning of permanent and separable joints

Additional documentation and handouts are available as PDFs on our website. Please log in to moodle (https://moodle-app2.let.ethz.ch/auth/shibboleth/login.php), search for "Dynamics", and join the course there. All exercises sheets, lecture materials etc. will be uploaded there.

**Lecture notes**
Hand-written slides will be downloadable after each lecture.

**Literature**
Typed course notes from the previous year

1. Motion of a single particle || Kinematics: trajectory, velocity, acceleration, inertial frame, moving frames - Forces and torques. Active- and reaction forces. - Linear momentum principle, angular momentum principle, work-energy principle - Equations of motion;
2. Motion of systems of particles || Internal and external forces - Linear momentum principle, angular momentum principle, work-energy principle - Rigid body systems of particles; conservative systems;
3. 3D motion of rigid bodies || Kinematics: angular velocity, velocity transport formula, instantaneous center of rotation - Linear momentum principle, angular momentum principle, work-energy principle - Parallel axis theorem. Angular momentum transport formula

**Objective**
Introduction to dimensioning (strength calculation) for static and dynamic loaded components and machine parts. Critical strength and fatigue criteria. Analytical methods for the calculation of stresses and strains. Consideration of stress concentrations by notch effects. Strength proof for different machine elements:

**Content**
- Theoretical basics of engineering design
- Description of ductil and brittle material behavior
- Design of machine elements at static loading conditions
- Notch effects
- Axes and shafts
- Fatigue design
- Surface pressure
- Rotationally symmetric bodies, pressure vessels and cylindrical interference
- Dimensioning of permanent and separable joints

**Literature**

**Objective**
Introduction to the fundamentals of technical thermodynamics.

**Content**
1. Konzepte und Definitionen
2. Der erste Hauptsatz der Energie- und Wärmelehre für geschlossene Systeme
3. Eigenschaften reiner kompressibler Substanzen, quasi-statische Zustandsänderungen
4. Elemente der kinetischen Gastheorie
5. Der erste Hauptsatz in offenen Systemen - Energieanalyse in einem Kontrollvolumen
6. Der zweite Hauptsatz - Der Begriff der Entropie
7. Nutzbarkeit der Energie - Exergie
8. Thermodynamische Beziehungen für einfache, kompressible Substanzen.

**Literature**

**Objective**
Introduction to linear control systems.

**Content**
Analysis and synthesis of linear systems with one input and one output signal (SISO); transition matrix; stability; controllability; observability; Laplace transform; transfer functions; transient and steady state responses. PID control; dynamic compensators; Nyquist theorem.

**Prerequisites**
Basic knowledge of (complex) analysis and linear algebra
Objective The lecture is intended to promote critical, scientific thinking. Key concepts of Physics will be acquired, with a focus on technically relevant applications. At the end of the two semesters, students will have a good overview over the topics of classical and modern Physics.

Content Electric and magnetic fields, current, magnetism, Maxwell's equations, concept of light, classical optics, waves.

Lecture notes Notes from lectures will be available (in German).

Literature Friedhelm Kuypers
Physik fuer Ingenieure und Naturwissenschaftler

Paul A. Tipler, Gene Mosca, Michael Basler und Renate Dohmen
Physik für Wissenschaftler und Ingenieure
Spektrum Akademischer Verlag, 2009, 1636 Seiten, ca. 80 Euro.

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Engineering Tools II

The participation at the Engineering Tools course is mandatory. If you miss any classes, no credit points will be awarded. For exemptions you have to contact the lecturer of the course.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0021-00L</td>
<td>Engineering Tool II: Introduction to MATLAB</td>
<td>O</td>
<td>0.4 credits</td>
<td>1K</td>
<td>B. Berisha, P. Hora</td>
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</tbody>
</table>

Abstract Introduction to MATLAB; vectors and matrices; graphics in MATLAB; calculus, differential equations; programming with MATLAB; data analysis and statistics; interpolation and polynomials. Exercises with solutions: using MATLAB commands, technical applications.

Objective Introduction to numerical calculations with MATLAB.

Content Introduction to MATLAB; vectors and matrices; graphics in MATLAB; calculus, differential equations; programming with MATLAB; data analysis and statistics; interpolation and polynomials. Exercises with solutions: using MATLAB commands, technical applications.

Lecture notes Web-based tutorial:
http://www.ivp.ethz.ch/studium/vorlesungen.html

Prerequisites / notice Der Kurs findet in einem Hörsaal statt und es stehen keine Rechner zur Verfügung. Es wird empfohlen, dass pro zwei Studierenden mindestens ein Laptop mit installiertem Matlab mitgebracht wird.

Installation Matlab:
- es funktionieren alle Versionen
- netzunabhängige Node-Lizenz (z.B. zum Download auf IDES)
- folgende Toolboxes/Features müssen installiert sein: Simulink (wird für RT1 benutzt), Curve Fitting Toolbox, Optimization Toolbox, Symbolic Toolbox, Global Optimization Toolbox

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5. Semester

Compulsory Courses Examination Block 3

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0261-00L</td>
<td>Thermodynamics III</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>R. S. Abhari, A. Steinfeld</td>
</tr>
</tbody>
</table>

Abstract Technical applications of engineering thermodynamics. Extension of thermodynamical fundamentals taught in Thermodynamics I and II.

Objective Understand and apply thermodynamic principles and processes for use in a range of cycles used commonly in practice.


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<tr>
<th>Number</th>
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<th>ECTS</th>
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<tbody>
<tr>
<td>151-0103-00L</td>
<td>Fluid Dynamics II</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>P. Jenny</td>
</tr>
</tbody>
</table>

Abstract Two-dimensional irrotational (potential) flows: stream function and potential, singularity method, unsteady flow, aerodynamic concepts.
Vorticity dynamics: vorticity and circulation, vorticity equation, vortex theorems of Helmholtz and Kelvin.
Compressible flows: isentropic flow along stream tube, normal and oblique shocks, Laval nozzle, Prandtl-Meyer expansion, viscous effects.

Objective Expand basic knowledge of fluid dynamics.
Concepts, phenomena and quantitative description of irrotational (potential), rotational, and one-dimensional compressible flows.

Content Two-dimensional irrotational (potential) flows: stream function and potential, complex notation, singularity method, unsteady flow, aerodynamic concepts.
Vorticity dynamics: vorticity and circulation, vorticity equation, vortex theorems of Helmholtz and Kelvin.
Compressible flows: isentropic flow along stream tube, normal and oblique shocks, Laval nozzle, Prandtl-Meyer expansion, viscous effects.

Lecture notes Lecture notes are available (in German).
(See also info on literature below.)

Literature Relevant chapters (corresponding to lecture notes) from the textbook

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Electives

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<tbody>
<tr>
<td>151-0917-00L</td>
<td>Mass Transfer</td>
<td>W</td>
<td>4 credits</td>
<td>2V+2U</td>
<td>R. Büchel, S. E. Pratsinis</td>
</tr>
</tbody>
</table>

Abstract This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

Objective This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.
At the end of the course the students should be able to:

- Introduction to generic system modeling approaches for control-oriented models based on first principles and on experimental data.
- The hands-on approach to problem solving in engineering and computer science.

### 401-0603-00L Stochastics (Probability and Statistics)
**W** 4 credits 2V+1U J. Teichmann

This class covers the following concepts: random variables, probability, discrete and continuous distributions, joint and conditional probabilities and distributions, the law of large numbers, the central limit theorem, descriptive statistics, statistical inference, inference for normally distributed data, point estimation, and two-sample tests.

**Objective**
- Knowledge of the basic principles of probability and statistics.

**Content**
- Introduction to probability theory, some basic principles from mathematical statistics and basic methods for applied statistics.

**Literature**

Three tests are offered for practicing the course material. Participation is voluntary.

### 151-0573-00L System Modeling
**W** 4 credits 2V+2U G. Ducard, C. Onder


**Objective**
- Introduction to system modeling for control. Analysis and optimization of linear and nonlinear systems.

**Content**
- Introduction to generic system modeling approaches for control-oriented models based on first principles and on experimental data.
- Examples: mechatronic, energy, and process engineering systems. Model scaling, linearization, order reduction, and balancing. Planning of experiments, estimation techniques for "gray-box" models (linear and nonlinear least-squares methods). The exercises are solved in teams. One larger case study is to be solved.

**Literature**
- The lecture notes are available in English.

### 151-0973-00L Fundamentals in Process Engineering
**W** 4 credits 2V+2U P. Rudolf von Rohr, C. Müller

Overview of process engineering, reactions, balances and residence time analysis; overview of the thermal separation processes; equilibria for multiphase systems; introduction into mechanical process engineering and particle technology.

**Objective**
- To expand fundamentals in process engineering.

**Content**
- Overview of process engineering, reactions, balances and residence time analysis; overview of the thermal separation processes; equilibria for multiphase systems; introduction into mechanical process engineering and particle technology.

**Literature**
- Lecture notes are available in English.

### 151-0575-01L Signals and Systems
**W** 4 credits 4G R. D'Andrea

Signals arise in most engineering applications. They contain information about the behavior of physical systems. Systems respond to signals and produce other signals. In this course, we explore how signals can be represented and manipulated, and their effects on systems. We further explore how we can discover basic system properties by exciting a system with various types of signals.

**Objective**
- Master the basics of signals and systems. Apply this knowledge to problems in the homework assignments and programming exercises.

**Content**

**Literature**
- Lecture notes available on course website.

### 363-0511-00L Managerial Economics
**W** 4 credits 3V S. Rausch, V. Hoffmann

Not for MSC students belonging to D-MTEC!

Managerial Economics applies economic theory and methods to business and economic decision-making. Economic ideas related to optimization, the theory of consumer demand, the theory of the firm, industrial organization, decision making under uncertainty are studied using methods of numerical analysis, statistical estimation, game theory, and constrained optimization.

**Objective**
- The objective of the course is to provide undergraduate and graduate students in MAVT with an understanding of the use of economic concepts for firm-level management decisions. The course covers a number of models and methods of analysis which are commonly employed in business decisions. The course covers the economic theory of choice, models of oligopoly and industrial organization, applications of game theory to contract design and agency theory, and the theory of decision making under uncertainty focusing specifically on long-term investment decisions. The course will include three lectures by Professor Volker Hoffmann focusing on related case-studies in management.

**Literature**
- Mikroökonomie (Pearson Studium - Economic VWL) Gebundene Ausgabe, August 2013, Robert S. Pindyck, Dr. Daniel L. Rubinfeld.

The course acquaints students who have previous not studied economics to economic concepts and quantitative methods which can be used to solve management decisions problems.

### 227-0076-00L Electrical Engineering II
**W** 4 credits 2V+2U J. Biela

Signals and systems in the frequency domain. Signals and systems in the time domain. Principle of operation and design of basic analog and digital circuits, analog-digital conversion. Basic power electronic circuits, design of magnetic components, electromechanical energy conversion, principle of operation and characteristics of transformers and selected rotating electrical machines.

**Objective**
- The objective of the course is to understand the numerical methods for the solution of ordinary and partial differential equations that play a central role in engineering applications. Both basic theoretical concepts and implementation techniques necessary to understand and master the methods will be addressed.

**Content**
- The course gives an introduction to the neural networks and fuzzy logic applications.

**Prerequisites / notice**
- The course is accessible to non-MSc students belonging to D-MTEC.

### 401-0435-00L Computational Methods for Engineering Applications
**W** 4 credits 2V+2U S. Mishra

The course gives an introduction to the numerical solution of ODEs and PDEs.

**Objective**
- The course gives an introduction to the numerical solution of ODEs and PDEs.

**Content**
- The course gives an introduction to the numerical solution of ODEs and PDEs.

**Literature**
- Lecture notes available on course website.
Content

Initial value problems for ODE: review of basic theory for ODEs, Forward and Backward Euler methods, Taylor series methods, Runge-Kutta methods, multi-step methods, predictor-corrector methods, basic stability and consistency analysis, numerical solution of stiff ODEs.

Two-point boundary value problems: Green's function representation of solutions, Maximum principle, finite difference schemes, stability analysis.

Elliptic equations: Laplace's equation in one and two space dimensions, finite element methods, implementation of finite elements, error analysis.


Hyperbolic equations: Linear advection equation, method of characteristics, upwind schemes and their stability. Burgers equation, scalar conservation laws, shocks and rarefactions, Riemann problems, Godunov type schemes, TVD property.

Lecture notes

Script will be provided.

Literature

Chapters of the following book provide supplementary reading and are not meant as course material:


Prerequisites / notice

(Suggested) Prerequisites:

Analysis I-III (for D-MAVT), Linear Algebra, CMEA I, basic familiarity with programming in C++.

151-3207-00L Lightweight W 4 credits 4G P. Ermanni

Abstract

The lecture embraces lightweight materials, construction techniques, design principles and calculation methods for the analysis of the load bearing and failure behavior of lightweight structures.

Objective

The course aims to impart basic principles for the understanding and for the design and dimensioning of modern lightweight constructions in mechanical, automotive and aerospace engineering.

Content

Light metals and fiber reinforced plastics, technologies and construction techniques, frames and truss structures, bending, shear and torsion of open and closed, thin-walled constructions, statically undetermined systems, stability of thin-walled systems.

Lecture notes

Handouts

Focus Project

Focus Projects in Mechatronics

Number Title Type ECTS Hours Lecturers

151-0073-30L Submersible Robot for Underwater Scanning W 0 credits 15A R. Siegwart

Abstract

This course is part of a one-year course. The 14 credit points will be issued at the end of FS2016 with new enrolling for the same Focus-Project in FS2016.

For MAVT BSc and ITET BSc only.

Prerequisites for the focus projects:

a. Basis examination successfully passed
b. Block 1 and 2 successfully passed

Objective

The various objectives of the Focus Project are:

- Synthesizing and deepening the theoretical knowledge from the basic courses of the 1. - 4. semester
- Team organization, work in teams, increase of interpersonal skills
- Independence, initiative, independent learning of new topic contents
- Problem structuring, solution identification in indistinct problem definitions, searches of information
- System description and simulation
- Presentation methods, writing of a document
- Ability to make decisions, implementation skills
- Workshop and industrial contacts
- Learning and recess of special knowledge
- Control of most modern engineering tools (Matlab, Simulink, CAD, CAE, PDM)
- Convert and experience technical solutions

Prerequisites / notice

This Focus-Project is supervised by the following lecturers:

Siegwart, R., ASL
Haas, R., ASL
Beardley P., Disney Research Zurich

151-0073-10L Remote Controlled Walking Excavator W 0 credits 15A R. Siegwart

Abstract

This course is part of a one-year course. The 14 credit points will be issued at the end of FS2016 with new enrolling for the same Focus-Project in FS2016.

For MAVT BSc and ITET BSc only.

Prerequisites for the focus projects:

a. Basis examination successfully passed
b. Block 1 and 2 successfully passed

Objective

Students develop and build a product from A-Z! They work in teams and independently, learn to structure problems, to identify solutions, system analysis and simulations, as well as presentation and documentation techniques. They build the product with access to a machine shop and state of the art engineering tools (Matlab, Simulink, etc).
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- Convert and experience technical solutions

**Prerequisites / notice**

This Focus-Project is supervised by the following lecturers:

- Siegwart, R., ASL
- Haas, R., ASL
- Fankhauser, P., ASL
- Alexis, K., ASL

### Focus Projects in Manufacturing

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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-0075-10L</td>
<td>Steer By Wire</td>
<td>W</td>
<td>0</td>
<td>15A</td>
<td>K. Wegener</td>
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<tbody>
<tr>
<td>151-0075-20L</td>
<td>Formula Student Electric - Chassis and Suspension</td>
<td>W</td>
<td>0</td>
<td>15A</td>
<td>P. Hora</td>
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**Abstract**

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<tbody>
<tr>
<td>151-0075-30L</td>
<td>Modularized Multi-Speed Compressor</td>
<td>W</td>
<td>0</td>
<td>15A</td>
<td>K. Wegener</td>
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**Prerequisites / notice**

This Focus-Project is supervised by the following lecturers:

- Hora, P.
- Heingärtner, J.
Students develop and build a product from A-Z! They work in teams and independently, learn to structure problems, to identify solutions, system analysis and simulations, as well as presentation and documentation techniques. They build the product with access to a machine shop and state of the art engineering tools (Matlab, Simulink, etc.).

### Objective

The various objectives of the Focus Project are:
- Synthesizing and deepening the theoretical knowledge from the basic courses of the 1. - 4. semester
- Team organization, work in teams, increase of interpersonal skills
- Independence, initiative, independent learning of new topic contents
- Problem structuring, solution identification in indistinct problem definitions, searches of information
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</thead>
<tbody>
<tr>
<td>151-0075-40L</td>
<td><strong>Formula Student Electric - Drivetrain</strong></td>
<td>W</td>
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<td>P. Hora</td>
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<td>Heingärtner, J.</td>
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</table>

### Focus Projects in Design, Mechanics and Materials

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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0079-20L</td>
<td><strong>Foldable Flettner Rotor for Small Sailing Boats</strong></td>
<td>W</td>
<td>0</td>
<td>15A</td>
<td>K. Shea</td>
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<td><strong>Abstract</strong></td>
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<td>system analysis and simulations, as well as</td>
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<td>presentation and documentation techniques.</td>
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<td>They build the product with access to a machine</td>
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<td>shop and state of the art engineering tools</td>
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<td>(Matlab, Simulink, etc.).</td>
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<td><strong>Objective</strong></td>
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<td>product during two semesters. On the basis of a</td>
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<td>processes of product development are beat down</td>
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<td>engineering, simulation, draft and production.</td>
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<td>gives them the possibility of a unique learning</td>
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<td>and realized by the teams.</td>
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<tr>
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<th>Hours</th>
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<tbody>
<tr>
<td>151-0079-30L</td>
<td><strong>Exoskelett für den Cybathlon</strong></td>
<td>W</td>
<td>0</td>
<td>15A</td>
<td>M. Meboldt</td>
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<td>This course is part of a one-year course. The 14</td>
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<td>credit points will be issued at the end of FS2016</td>
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Abstract
Students develop and build a product from A-Z! They work in teams and independently, learn to structure problems, to identify solutions, system analysis and simulations, as well as presentation and documentation techniques. They build the product with access to a machine shop and state of the art engineering tools (Matlab, Simulink, etc).

Objective
The various objectives of the Focus Project are:
- Synthesizing and deepening the theoretical knowledge from the basic courses of the 1. - 4. semester
- Team organization, work in teams, increase of interpersonal skills
- Independence, initiative, independent learning of new topic contents
- Problem structuring, solution identification in indistinct problem definitions, searches of information
- System description and simulation
- Presentation methods, writing of a document
- Ability to make decisions, implementation skills
- Workshop and industrial contacts
- Learning and recess of special knowledge
- Control of most modern engineering tools (Matlab, Simulink, CAD, CAE, PDM)
- Convert and experience technical solutions

151-0079-50L Zurich Heart MIAA (Minimal Invasive Aortic Anastomosis) W 0 credits 15A M. Meboldt

This course is part of a one-year course. The 14 credit points will be issued at the end of FS2016 with new enrolling for the same Focus-Project in FS2016.

For MAVT BSc and ITET BSc only.

Prerequisites for the focus projects:
- Basis examination successfully passed
- Block 1 and 2 successfully passed

Abstract
Students develop and build a product from A-Z! They work in teams and independently, learn to structure problems, to identify solutions, system analysis and simulations, as well as presentation and documentation techniques. They build the product with access to a machine shop and state of the art engineering tools (Matlab, Simulink, etc).

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►►► Focus Projects in Biomedical Engineering

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<tbody>
<tr>
<td>151-0077-10L</td>
<td>Stretchable electronics based bladder volume sensor</td>
<td>W</td>
<td>0</td>
<td>15A</td>
<td>J. Vörös, C. Hierold</td>
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</tbody>
</table>

For MAVT BSc and ITET BSc only.

Prerequisites for the focus projects:
- Basis examination successfully passed
- Block 1 and 2 successfully passed

Abstract
Students develop and build a product from A-Z! They work in teams and independently, learn to structure problems, to identify solutions, system analysis and simulations, as well as presentation and documentation techniques. They build the product with access to a machine shop and state of the art engineering tools (Matlab, Simulink, etc).

Objective
The various objectives of the Focus Project are:
- Synthesizing and deepening the theoretical knowledge from the basic courses of the 1. - 4. semester
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- Ability to make decisions, implementation skills
- Workshop and industrial contacts
- Learning and recess of special knowledge
- Control of most modern engineering tools (Matlab, Simulink, CAD, CAE, PDM)
- Convert and experience technical solutions

Content
Several teams of 4-8 students of the ETH as well as students from other universities realize a product during two semesters. On the basis of a vision and provocative problem definition, all processes of product development are beat down close-to-reality: conception, design, engineering, simulation, draft and production. The teams are coached by experienced staff who gives them the possibility of a unique learning experience. Innovative ideas of the research labs of the ETH, of industrial partners or students are selected and realized by the teams.

►►► Courses Eligible for Focus Projects

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<tr>
<td>151-0761-00L</td>
<td>Practice Course to Focus Projects on Product Development</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>M. Meboldt, C. R. Dietzsch, I. Goller, R. P. Haas, C. Schorno,</td>
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</table>
The course presents an overview of measurement tasks in engineering environments. Different concepts for the acquisition and processing of typical measurement quantities are introduced. Following an initial in-class introduction, laboratory exercises from different application areas (especially in thermofluidics and process engineering) are attended by students in small groups.

Abstract

Objective

Content

Communication

- Public Relations in a Nutshell
- How to acquire and manage suppliers and sponsors
- Technical reports

Creativity and Solution Finding

- Creativity methodology
- Design methodology and product validation
- Issues regarding patents

Lecture notes

- Lecture notes and documentation will be electronically available.

Prerequisites / notice

- only for students participating in a Focus Project in the same semester
- not more than 30 students

151-0763-00L  Practice Course to Focus Projects on CAD and CAE Based on Siemens NX

W  3 credits  3G  J.L. Emery, M. Schütz, K. Shea

Number of participants limited to 30.

Abstract

This course provides comprehensive input to ongoing focus project teams in the areas of project management, dealing with the media, suppliers and designers as well as creativity, design methodology, technical reports, and issues regarding patents.

Objective

Participants will receive tips, hints and background information from experienced tutors applicable to current projects.

Content

- Creating a solid project base
- Project planning and controlling
- Problem solving cycle and decision taking transparent for others

The Base Camp is an intense kick-off event for participants and coaches of the Focus Projects. During two days, the teams actively prepare their projects and share their ideas with experienced coaches and other project teams. Based on the individual development goals of the various Focus Projects, the teams work on several design tasks.

Abstract

- Getting aware of all project related aspects (problem understanding, user identification, generation of solution ideas)
- Learning about different approaches in Product Development (iteration, prototyping, testing, project management)
- Developing soft skills (presenting, giving and getting feedback, team composition and roles)
- Getting ready to start (motivation, vision, critical thinking, project plan)

Objective

- Teamwork, team composition, team roles, team performance
- Communication and leadership skills
- Creativity and Solution Finding

Content

- Getting ready to start (motivation, vision, critical thinking, project plan)
- Use of Siemens NX in the corresponding Focus Project

Prerequisites / notice

- only for students participating in a Focus Project in the same semester
- not more than 30 students

151-0759-00L  Base Camp for Focus Projects

Das Base Camp ist eine intensive Kick Off Veranstaltung für Teilnehmer und Coaches der Fokusprojekte.

Number of participants limited to 30.

Abstract

The Base Camp is an intense kick-off event for participants and coaches of the Focus Projects. During two days, the teams actively prepare their projects and share their ideas with experienced coaches and other project teams. Based on the individual development goals of the various Focus Projects, the teams work on several design tasks.

Objective

- Getting aware of all project related aspects (problem understanding, user identification, generation of solution ideas)
- Learning about different approaches in Product Development (iteration, prototyping, testing, project management)
- Developing soft skills (presenting, giving and getting feedback, team composition and roles)
- Getting ready to start (motivation, vision, critical thinking, project plan)

Content

- Teamwork, team composition, team roles, team performance
- Communication and leadership skills
- Creativity and Solution Finding

Prerequisites / notice

- only for students participating in a Focus Project in the same semester
- not more than 30 students

Teilnehmer müssen in einem Fokusprojekt eingeschrieben oder Coach eines Fokusprojektes sein.
The students should become familiar with the fundamentals and with application examples of chemically reactive processes in energy conversion (combustion engines in particular) as well as the synthesis of new materials. The lecture is part of the focus “Energy, Flows & Processes” on the Bachelor level and is recommended as a basis for a future Master in the area of energy. It is also a facultative lecture on Master level in Energy Science and Technology and Process Engineering.


Lecture notes

HANDOUTS are EXCLUSIVELY IN GERMAN ONLY, however recommendations for English text books will be provided.

**TEACHING LANGUAGE IN CLASS is German OR English (ON DEMAND).**

**Literature**


**Content**


**Lecture notes**

script in German available

**Literature**


**Prerequisites / notice**

Basic understanding in the following areas:

- fluid mechanics, thermodynamics, heat and mass transfer
- electrical engineering / electronics
- numerical data analysis and processing (e.g. using MATLAB)

151-0973-00L Fundamentals in Process Engineering

**Abstract**

Overview of process engineering, reactions, balances and residence time analysis; overview of the thermal separation processes; equilibria for multiphase systems; introduction into mechanical process engineering and particle technology.

**Objective**

To expound fundamentals in process engineering

**Content**

Overview of process engineering, reactions, balances and residence time analysis; overview of the thermal separation processes; equilibria for multiphase systems; introduction into mechanical process engineering and particle technology.

**Lecture notes**

script in German available

151-0917-00L Mass Transfer

**Abstract**

This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

**Objective**

This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

**Content**

Fick's laws; application and significance of mass transfer; comparison of Fick's laws with Newton's and Fourier's laws; derivation of Fick's 2nd law; diffusion in dilute and concentrated solutions; rotating disk; dispersion; diffusion coefficients, viscosity and heat conduction (Pr and Sc numbers); Brownian motion; Stokes-Einstein equation; mass transfer coefficients (Nu and Sh numbers); mass transfer across interfaces; Reynolds- and Chilton-Colburn analogies for mass-, heat-, and momentum transfer in turbulent flows; film-, penetration-, and surface renewal theories; simultaneous mass, heat and momentum transfer (boundary layers); homogenous and heterogenous reversible and irreversible reactions; diffusion-controlled reactions; mass transfer and first order heterogenous reaction. Applications.

**Literature**


**Prerequisites / notice**

Three tests are offered for practicing the course material. Participation is voluntary.

151-0109-00L Turbulent Flows

**Abstract**

Contents

- Laminar and turbulent flows, instability and origin of turbulence - Statistical description: averaging, turbulent energy, dissipation, closure problem - Scelings, Homogeneous isotropic turbulence, correlations, Fourier representation, energy spectrum - Free turbulence: wake, jet, mixing layer - Wall turbulence: Channel and boundary layer - Computation and modelling of turbulent flows.

**Objective**

Basic physical phenomena of turbulent flows, quantitative and statistical description, basic and averaged equations, principles of turbulent flow computation and elements of turbulence modelling

**Content**

- Properties of laminar, transitional and turbulent flows.
- Origin and control of turbulence. Instability and transition.
- Statistical description, averaging, equations for mean and fluctuating quantities, closure problem.
- Scelings, homogeneous isotropic turbulence, energy spectrum.
- Turbulent free shear flows. Jet, wake, mixing layer.
- Wall-bounded turbulent flows.
- Turbulent flow computation and modeling.

**Lecture notes**

Lecture notes are available

**Literature**


151-0135-00L Focused Study: Selected Topics in Research and Application in Energy, Flows and Processes

**Abstract**

Independent studies on a defined field in energy, flows, and processes.

**Objective**

Independent studies on a defined field in energy, flows, and processes.

**Prerequisites / notice**

The following professors can be chosen and please contact the professor directly:


**Number**

151-0640-00L Studies on Mechatronics

**Data:** 06.02.2019 13:00  
**Autumn Semester 2015**  
**Page 925 of 1434**
The students work independently on a study of selected topics in the field of Mechatronics or Microsystems. They start with a selection of 10 pertinent refereed articles or works in the literature in consultation with supervisor or instructor. After 4 weeks, submission of a 2-page proposal outlining the value, state-of-the-art and study plan based on these articles. After feedback on the substance and technical writing by the instructor, project commences.

Objective
The students are familiar with the challenges of the fascinating and interdisciplinary field of Mechatronics and Microsystems. They are introduced in the basics of independent non-experimental scientific research and are able to summarize and to present the results efficiently.

Content
The students work independently on a study of selected topics in the field of Mechatronics or Microsystems. They start with a selection of scientific papers to continue literature research. The results (e.g. state-of-the-art, methods) are evaluated with respect to predefined criteria. Then the results are presented in an oral presentation and summarized in a report, which takes the discussion of the presentation into account.

Literature
will be available

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<tr>
<td>151-0575-01L</td>
<td>Signals and Systems</td>
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<tr>
<td>376-1504-00L</td>
<td>Physical Human Robot Interaction (pHRI)</td>
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**Abstract**
Overview of Mechatronics topics and study subjects. Identification of minimum 10 pertinent refereed articles or works in the literature in consultation with supervisor or instructor. After 4 weeks, submission of a 2-page proposal outlining the value, state-of-the-art and study plan based on these articles. After feedback on the substance and technical writing by the instructor, project commences.

**Objective**
The students are familiar with the challenges of the fascinating and interdisciplinary field of Mechatronics and Microsystems. They are introduced in the basics of independent non-experimental scientific research and are able to summarize and to present the results efficiently.

**Content**
The students work independently on a study of selected topics in the field of Mechatronics or Microsystems. They start with a selection of scientific papers to continue literature research. The results (e.g. state-of-the-art, methods) are evaluated with respect to predefined criteria. Then the results are presented in an oral presentation and summarized in a report, which takes the discussion of the presentation into account.

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Signals arise in most engineering applications. They contain information about the behavior of physical systems. Systems respond to signals and produce other signals. In this course, we explore how signals can be represented and manipulated, and their effects on systems. We further explore how we can discover basic system properties by exciting a system with various types of signals.

**Objective**
Master the basics of signals and systems. Apply this knowledge to problems in the homework assignments and programming exercises.

**Content**

**Lecture notes**
Lecture notes available on course website.

**Abstract**

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</table>

**Objective**
The objective of this course is to give an introduction to the fundamentals of physical human robot interaction, through lectures on the underlying theoretical/mechatronics aspects and application fields, in combination with a hands-on lab tutorial. The course will guide students through the design and evaluation process of such systems.

**Content**
By the end of this course, you should understand the critical elements in human-robot interactions - both in terms of engineering and human factors - and use these to evaluate and design safe and efficient assistive and rehabilitative robotic systems. Specifically, you should be able to:

1) identify critical human factors in physical human-robot interaction and use these to derive design requirements;
2) compare and select mechatronic components that optimally fulfill the defined design requirements;
3) derive a model of the device dynamics to guide and optimize the selection and integration of selected components into a functional system;
4) design control hardware and software and implement and test human-interactive control strategies on the physical setup;
5) characterize and optimize such systems using both engineering and psychophysical evaluation metrics;
6) investigate and optimize one aspect of the physical setup and convey the gained insights in a technical presentation.

**Lecture notes**
Will be distributed through the document repository before the lectures.

http://www.relab.ethz.ch/education/courses/phri.html


The students are expected to have basic control knowledge from previous classes. http://www.relab.ethz.ch/education/phri

Students are introduced to the basics of micromachining and silicon process technology and will understand the fabrication of microsystem devices and -systems by a sequence of defined processing steps (process flow).

Students are introduced to the basics of micromachining and silicon process technology and will understand the fabrication of microsystem devices by the combination of unit process steps (process flow).

- Introduction to Microsystems technology (MST) and micro electro mechanical systems (MEMS).
- Basic silicon technologies: Thermal oxidation, photolithography, etching, diffusion and ion implantation, thin film deposition.
- Specific microsystems technologies: Bulk and surface micromachining, dry and wet etching, isotropic and anisotropic etching, beam and membrane formation, wafer bonding, thin film mechanical and thermal properties, piezoelectric and piezoresitive materials.
- Selected microsystems: Mechanical sensors and actuators, microsensors, thermal sensors and actuators, system integration and encapsulation.

Lecture notes

- S.M. Sze: Semiconductor Devices, Physics and Technology
- W. Menz, J. Mohr, O.Paul: Microsystem Technology
- G. Kovacs: Micromachined Transducer Sourcebook

Prerequisites / notice

The registration is limited to 26 students.
There are 4 credit points for this lecture.
The lecture will be held in English.

There are 4 credit points for this lecture.

Prerequisites: Physics I and II.

Abstract

Fields of application of power electronic systems. Principle of operation of basic pulse-width modulated and line-commutated power electronic converters, analysis of the operating behavior and of the control oriented behavior, converter design. Reduction of effects of line-commutated rectifiers on the mains, electromagnetic compatibility.

Abstract

Fields of application of power electronic systems. Principle of operation of basic pulse-width modulated and line-commutated power electronic converters, analysis of the operating behavior and of the control oriented behavior, converter design. Reduction of effects of line-commutated rectifiers on the mains, electromagnetic compatibility.

Abstract


Lecture notes

Lecture notes and associated exercises including correct answers, simulation program for interactive self-learning including visualization/animation features.

Prerequisites / notice

Prerequisites: Basic knowledge of electric circuit analysis and signal theory.
Microrobotics

B. Nelson

Hours

Independent studies on a defined field in mechatronics.

Microscale Acoustofluidics

5 credits

2V+3P

1 credit

The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

In this lecture the basics as well as practical aspects (from modelling to design and fabrication) are described from a solid and fluid continuum mechanics. Notice: The exercise part is a mixture of presentation, lab session and hand in homework.

°Focused Study: Selected Topics in Research and Application in Mechatronics

Exclusive for D-MAVT Bachelor-students of Focus Specialization "Mechatronics". Please discuss with your focus coordinator.

Independent studies on a defined field in mechatronics.

Solid and fluid continuum mechanics. Notice: The exercise part is a mixture of presentation, lab session and hand in homework.

Microsystems and Nanoscale Engineering

Introduction to Nanoscale Engineering

W

4 credits

3G

B. Nelson

Number of participants limited to 20.

The class gives an overview of fundamental concepts in nanoscale engineering. Mobility of small objects, interacting forces, surface tensions and wetting phenomena are some of the physical phenomena investigated. These will be applied to the description of formation and growth of nanoparticles and thin films as well as nanofabrication technologies.

The goal of the lecture is to familiarize the students with the basic phenomena occurring on the nanometer scale, thereby illustrating the links to physics, chemistry, materials science, and biology. A further objective is to demonstrate the development of technologies and processes based on or including nanoscale phenomena.

- Nanoparticle building blocks for device fabrication
- Particle size distributions and size selection
- Nanoparticle formation
- Forces between small objects
- Control of nanoparticle properties in the gas-phase
- The electric double layer
- Characterization of nanomaterials
- Microscopes and tools for nanoscale objects
- Thin film formation
- Nanofabrication
- Small "hands-on" research project including project presentations and reporting

Studies on Micro and Nano Systems

Please contact one of the following professors directly: J. Dual, C. Hierold, B. Nelson, D. Poulikakos, S.E. Pratsinis, A. Stemmer, D. Norris and C. Daraio

The students get familiarized with the challenges of the fascinating and interdisciplinary field of Micro- and Nanosystems. They are introduced to the basics of independent non-experimental scientific research and are able to summarize and to present the results efficiently.
The students get familiarized with the challenges of the fascinating and interdisciplinary field of Micro- and Nanosystems. They are introduced to the basics of independent non-experimental scientific research and are able to summarize and to present the results efficiently.

Students work independently on a study of selected topics in the field of Micro- and Nanosystems. They start with a selection of scientific papers, and continue with an independent literature research. The results (e.g. state-of-the-art, methods) are evaluated with respect to predefined criteria. Then the results are presented in an oral presentation and summarized in a report, which takes the discussion of the presentation into account.

Literature

 Literature will be provided

### 151-0604-00L

**Microrobotics**

**W**  
4 credits  
3G  
B. Nelson

**Abstract**

Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.

**Objective**

The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.

**Content**

Main topics of the course include:

- Scaling laws at micro/nano scales
- Electrostatics
- Electromagnetism
- Low Reynolds number flows
- Observation tools
- Materials and fabrication methods
- Applications of biomedical microrobots

**Lecture notes**

The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

**Prerequisites / notice**

The lecture will be taught in English.

### 151-0621-00L

**Microsystems Technology**

**W+**  
6 credits  
4G  
C. Hierold, M. Haluska

**Abstract**

Students are introduced to the basics of micromachining and silicon process technology and will learn about the fabrication of microsystems and -devices by a sequence of defined processing steps (process flow).

**Objective**

Students are introduced to the basics of micromachining and silicon process technology and will understand the fabrication of microsystem devices by the combination of unit process steps (process flow).

**Content**

- Introduction to microsystems technology (MST) and micro electro mechanical systems (MEMS)
- Basic silicon technologies: Thermal oxidation, photolithography and etching, diffusion and ion implantation, thin film deposition.
- Specific microsystems technologies: Bulk and surface micromachining, dry and wet etching, isotropic and anisotropic etching, beam and membrane formation, wafer bonding, thin film mechanical and thermal properties, piezoelectric and piezoresistive materials.
- Selected microsystems: Mechanical sensors and actuators, microresonators, thermal sensors and actuators, system integration and encapsulation.

**Lecture notes**

Handouts (available online)

**Literature**

- S.M. Sze: Semiconductor Devices, Physics and Technology
- W. Menz, J. Mohr, O.Paul: Microsystem Technology
- G. Kovacs: Micromachined Transducer Sourcebook

**Prerequisites / notice**

Prerequisites: Physics I and II

### 151-0140-00L

**Focused Study: Selected Topics in Research and Application in Micro- and Nanosystems**

**W**  
1 credit  
2A  
C. Hierold

**Exclusive for D-MAVT Bachelor-students of Focus Specialization "Microsystems and Nanoscale Engineering". Please discuss with your focus coordinator.**

**Abstract**

Independent studies on a defined field in micro- and nanosystems.

**Objective**

Independent studies on a defined field in micro- and nanosystems.

**Prerequisites / notice**

Prerequisites: Physics I and II

### 151-0911-00L

**Introduction to Plasmonics**

**W**  
4 credits  
2+1U  
D. J. Norris

**Abstract**

This course provides fundamental knowledge of surface plasmon polaritons and discusses their applications in plasmonics. Electromagnetic oscillations known as surface plasmon polaritons have many unique properties that are useful across a broad set of applications in biology, chemistry, physics, and optics. The field of plasmonics has arisen to understand the behavior of surface plasmon polaritons and to develop applications in areas such as catalysis, imaging, photovoltaics, and sensing. In particular, metallic nanoparticles and patterned metallic interfaces have been developed to utilize plasmonic resonances. The aim of this course is to provide the basic knowledge to understand and apply the principles of plasmonics. The course will strive to be approachable to students from a diverse set of science and engineering backgrounds.

**Objective**

Fundamentals of Plasmonics

- Basic electromagnetic theory
- Optical properties of metals
- Surface plasmon polaritons on surfaces
- Surface plasmon polariton propagation
- Localized surface plasmons

Applications of Plasmonics

- Waveguides
- Extraordinary optical transmission
- Enhanced spectroscopy
- Sensing
- Metamaterials

**Lecture notes**

Class notes and handouts

**Literature**


**Prerequisites / notice**

Physics I, Physics II

### Manufacturing Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

**Data: 06.02.2019 13:00**  
**Autumn Semester 2015**  
**Page 929 of 1434**
Acquaintance with forming processes. Determination of forming processes. Interpretation of forming technology. 4 credits
Operational Simulation of Production Lines  yes 4 credits
Manufacturing I  O  4 credits  2V+2U  K. Wegener, M. Boccadoro, F. Kuster
The lecture teaches on the basic knowledge of major processes in sheet metal, tube and bulk metal forming technologies. In particular it focuses on fundamental computation methods, which allow a fast assessment of process behaviour and a rough layout. Process-specific states of stress and deformation are analysed and process limits are identified.
Objective
Content
The study of metal working processes: sheet metal forming, folding die cutting, cold bulk metal forming, ro extrusion, plunging, open die forging, drop forging, milling, active principle; elementary methods to estimate stress and strain; fundamentals of process design; manufacturing limits and machining accuracy; tools and operation; machinery and machine usage.
Lecture notes
yes
Prerequisites / notice
Prerequisites: Recommendation: Lecture 151-0700-00L Manufacturing elective course in the 4th semester.
Language: Help for English speaking students on request as well as English translations of slides shown.

Forming Technology III - Forming Processes  O  4 credits  2V+2U  P. Hora
The lecture teaches on the basic knowledge of major processes in sheet metal, tube and bulk metal forming technologies. In particular it focuses on fundamental computation methods, which allow a fast assessment of process behaviour and a rough layout. Process-specific states of stress and deformation are analysed and process limits are identified.
Abstract
The fundamentals of forming technology are presented to Mechanical, Production and Material Engineers. The content of the lecture is: Overview of forming processes, deformation specific description of material properties and their experimental measurement, material laws, residual stresses, heat balance, tribological aspects of forming processes, workpiece and tool failure.
Abstract
Forming technology represents with its 70% global share in manufactured metal volume with respect to yield and cost, the most important manufacturing process in metal-working industries. Typical applications of forming technology range from the manufacturing of sheet metal components in auto bodies to applications in food and pharma packaging, fabrication of implants in medical technologies and to the fabrication of leads in microelectronic components. This course introduces the fundamentals which are essential to evaluate metal-forming processes and its industrial applications. This includes, together with the requirements of the most important forming processes, the characterization of plastic material behavior and manufacturing limits.
Abstract
Knowledge of fundamental computation methods, which allow a fast assessment of process behaviour and a rough layout. Process-specific states of stress and deformation are analysed and process limits are identified.
Objective
Forming processes, influence of tribology, Work piece failure through cracking and folding, tool failure through rupture and mechanical wear, metal-forming tools, sheet forming and massive forming processes, handling systems, metal-forming machinery.
Content
Understanding of the complexity of the assembly process as well as its meaning as success and cost factor. The assembly with the different aspects of adding, moving, adjusting, controlling parts etc. Adding techniques; solvable and unsolvable connections. Assembly plants. Coating techniques and their tasks, in particular corrosion protection.
Abstract
To understand assembly in its full complexity and its paramount importance regarding cost and financial success. An introduction into a choice of selected joining and forming techniques and coating technologies.
Objective
Assembly as combination of several classes of action like, e.g., joining, handling, fine adjustments, etc. Techniques for joining objects temporarily or permanently. Assembly systems.
Content
Assembly systems and their specific applications, with particular emphasis on corrosion protection.
Lecture notes
ja
Prerequisites / notice
Recommended to the focus production engineering. Majority of lecturers from the industry.

Forming Technology I - Basic Knowledge  W  4 credits  2V+2U  P. Hora
The fundamentals of forming technology are presented to Mechanical, Production and Material Engineers. The content of the lecture is: Overview of manufacturing with forming techniques, deformation specific description of material properties and their experimental measurement, material laws, residual stresses, heat balance, tribological aspects of forming processes, workpiece and tool failure.
Abstract
Forming technology represents with its 70% global share in manufactured metal volume with respect to yield and cost, the most important manufacturing process in metal-working industries. Typical applications of forming technology range from the manufacturing of sheet metal components in auto bodies to applications in food and pharma packaging, fabrication of implants in medical technologies and to the fabrication of leads in microelectronic components. This course introduces the fundamentals which are essential to evaluate metal-forming processes and its industrial applications. This includes, together with the requirements of the most important forming processes, the characterization of plastic material behavior and manufacturing limits.
Abstract
Knowledge of fundamental computation methods, which allow a fast assessment of process behaviour and a rough layout. Process-specific states of stress and deformation are analysed and process limits are identified.
Objective
Forming processes, influence of tribology, Work piece failure through cracking and folding, tool failure through rupture and mechanical wear, metal-forming tools, sheet forming and massive forming processes, handling systems, metal-forming machinery.
Content
Understanding of the complexity of the assembly process as well as its meaning as success and cost factor. The assembly with the different aspects of adding, moving, adjusting, controlling parts etc. Adding techniques; solvable and unsolvable connections. Assembly plants. Coating techniques and their tasks, in particular corrosion protection.
Abstract
To understand assembly in its full complexity and its paramount importance regarding cost and financial success. An introduction into a choice of selected joining and forming techniques and coating technologies.
Objective
Assembly as combination of several classes of action like, e.g., joining, handling, fine adjustments, etc. Techniques for joining objects temporarily or permanently. Assembly systems.
Content
Assembly systems and their specific applications, with particular emphasis on corrosion protection.
Lecture notes
ja
Prerequisites / notice
Recommended to the focus production engineering. Majority of lecturers from the industry.

Quality of Machine Tools - Dynamics and Metrology at Micro and Submicro Level  W  4 credits  2V+1U  W. Knapp, F. Kuster
The course “Machine tool metrology” deals with the principal design of machine tools, their spindles and linear axes, with possible geometric, kinematic, thermal and dynamic errors of machine tools and testing these errors, with the influence of errors on the workpiece (error budgeting), with testing of drives and numerical control, as well as with checking the machine tool capability.
Abstract
Knowledge of principal design of machine tools, errors of linear and rotational axes and of machine tools, influence of errors on the workpiece (error budgeting), dynamical, kinematical, thermal, dynamic testing of machine tools, test uncertainty, machine tool capability.
Objective
Metrology for production, machine tool metrology - basics, like principal machine tool design and machine tool coordinate system - principal design and errors of linear and rotational axes - error budgeting, influence of errors on the workpiece - geometric and kinematic testing of machine tools - reversal, measurement techniques, multi-dimensional machine tool metrology - thermal influences on machine tools and testing these influences - test uncertainty, simulation - dynamics of mechanical systems, dynamic error sources - machine tool dynamics and the engineering tools modal analysis and finite element method (FEM) - testing of drives and numerical control - machine tool capability.
Content
Documents are provided during the course. English handouts available on request.
Lecture notes
Exercises in the laboratories and with the machine tools of the institute for machine tools and manufacturing (IWF) provide the practical background for this course.
Prerequisites / notice

Operational Simulation of Production Lines  W  4 credits  2V+1U  P. Acély
The student learns the application of the event-driven and computer-based simulation for layout and operational improvement of production facilities by means of practical examples.
Abstract
The course "Machine tool metrology" deals with the principal design of machine tools, their spindles and linear axes, with possible geometric, kinematic, thermal and dynamic errors of machine tools and testing these errors, with the influence of errors on the workpiece (error budgeting), with testing of drives and numerical control, as well as with checking the machine tool capability.
Objective
Knowledge of principal design of machine tools, errors of linear and rotational axes and of machine tools, influence of errors on the workpiece (error budgeting), dynamical, kinematical, thermal, dynamic testing of machine tools, test uncertainty, machine tool capability.
Content
Metrology for production, machine tool metrology - basics, like principal machine tool design and machine tool coordinate system - principal design and errors of linear and rotational axes - error budgeting, influence of errors on the workpiece - geometric and kinematic testing of machine tools - reversal, measurement techniques, multi-dimensional machine tool metrology - thermal influences on machine tools and testing these influences - test uncertainty, simulation - dynamics of mechanical systems, dynamic error sources - machine tool dynamics and the engineering tools modal analysis and finite element method (FEM) - testing of drives and numerical control - machine tool capability.
Lecture notes
Documents are provided during the course. English handouts available on request.
Prerequisites / notice
Exercises in the laboratories and with the machine tools of the institute for machine tools and manufacturing (IWF) provide the practical background for this course.

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 930 of 1434
The student learns the right use of (Who? When? How?) of the event-driven and computer-based simulation in the illustration of the operating procedures and the production facilities.

Operating simulation in the productions, logistic and scheduling will be shown by means of practical examples. The student should make his first experiences in the use of computer-based simulation.

- Application and application areas of the event-driven simulation
- Exemplary application of a software tool (Technometrix-Simulation-Software)
- Internal organisation and functionality of simulation tools
- Procedure for application: optimizing, experimental design planning, analysis, data preparation
- Controlling philosophies, emergency concepts, production in sequence, line production, rescheduling
- Application on the facilities projecting

The knowledge is enhanced by practice-oriented exercises and an excursion. A guest speaker will present a practical example.

Lecture notes will be distributed simultaneously during lecture (+ PDF)

Prerequisites / notice
Recommended for all Bachelor-Students in the 5th semester and Master-Students in the 7th semester.

**Lecture notes**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Type</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0833-00L</td>
<td>Principles of Nonlinear Finite-Element-Methods</td>
<td>W</td>
<td>5 credits 2V+2U N. Manopulo, B. Berisha</td>
</tr>
</tbody>
</table>

**Abstract**

Most problems in engineering are of nonlinear nature. The nonlinearities are caused basically due to the nonlinear material behavior, contact conditions and instability of structure. The principles of the nonlinear Finite-Element-Method (FEM) will be introduced in the scope of this lecture for treating such problems.

**Objective**

The goal of the lecture is to provide the students with the fundamentals of the non linear Finite Element Method (FEM). The lecture focuses on the principles of the nonlinear Finite-Element-Method based on explicit and implicit formulations. Typical applications of the nonlinear Finite-Element-Methods are simulations of:

- Crash
- Collapse of structures
- Materials in Biomechanics (soft materials)
- General forming processes

Special attention will be paid to the modeling of the nonlinear material behavior, thermo-mechanical processes and processes with large plastic deformations. The ability to independently create a virtual model which the complete nonlinear system will be acquired through accompanying exercises. This will include the Matlab programming of important model components such as constitutive equations.

**Content**

- Fundamentals of continuum mechanics to characterize large plastic deformations
- Elasto-plastic material models
- Updated-Lagrange (UL), Euler and combined Euler-Lagrange (ALE) approaches
- FEM implementation of constitutive equations
- Element formulations
- Implicit and explicit FEM methods
- FEM formulations of coupled thermo-mechanical problems
- Modeling of tool contact and the influence of friction
- Solvers and convergence
- Modeling of crack propagation
- Introduction of advanced FE-Methods

**Lecture notes**

Specialization "Manufacturing Science". Please discuss this lecture for treating such problems.

**Prerequisites / notice**

If we will have a large number of students, two dates for the exercises will be offered.

**Lecture notes**

<table>
<thead>
<tr>
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<th>Prerequisites / notice</th>
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</thead>
<tbody>
<tr>
<td>227-0113-00L</td>
<td>Power Electronics</td>
<td>W</td>
<td>6 credits 4G J. W. Kolar</td>
</tr>
</tbody>
</table>

**Abstract**

Fields of application of power electronic systems. Principle of operation of basic pulse-width modulated and line-commutated power electronic converters, analysis of the operating behavior and of the control oriented behavior, converter design. Reduction of effects of line-commutated rectifiers on the mains, electromagnetic compatibility.

**Objective**

Fields of application of power electronic systems. Principle of operation of basic pulse-width modulated and line-commutated power electronic converters, analysis of the operating behavior and of the control oriented behavior, converter design. Reduction of effects of line-commutated rectifiers on the mains, electromagnetic compatibility.

**Content**


**Lecture notes**

Lecture notes and associated exercises including correct answers, simulation program for interactive self-learning including visualization/animation features.

**Prerequisites / notice**

Prerequisites: Basic knowledge of electric circuit analysis and signal theory.

**Lecture notes**

<table>
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</thead>
<tbody>
<tr>
<td>151-0573-00L</td>
<td>System Modeling</td>
<td>W</td>
<td>4 credits 2V+2U G. Ducard, C. Onder</td>
</tr>
</tbody>
</table>

**Abstract**


**Objective**

Introduction to system modeling for control. Analysis and optimization of linear and nonlinear systems. Parameter identification. Case studies.

**Content**

Introduction to generic system modeling approaches for control-oriented models based on first principles and on experimental data. Examples: mechatronic, energy, and process engineering systems. Model scaling, linearization, order reduction, and balancing. Planning of experiments, estimation techniques for "gray-box" models (linear and nonlinear least-squares methods). The exercises are solved in teams. One larger case study is to be solved.

**Lecture notes**

The handouts in English will be sold in the first lecture.

A list of references is included in the handouts.

**Lecture notes**

<table>
<thead>
<tr>
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<th>Title</th>
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</thead>
<tbody>
<tr>
<td>151-0141-00L</td>
<td>Focused Study: Selected Topics in Research and Application in Manufacturing Science A</td>
<td>W</td>
<td>1 credit 2A K. Wegener</td>
</tr>
</tbody>
</table>

**Abstract**

Recommended for all Bachelor-Students in the 5th semester and Master-Students in the 7th semester.
### Biomedical Engineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0723-00L</td>
<td>Manufacturing of Electronic Devices</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>A. Kunz, A. Guber, R.D. Morison, F. Reichert</td>
</tr>
<tr>
<td>Objective</td>
<td>Independent studies on a defined field in manufacturing and reporting.</td>
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</tr>
<tr>
<td>Content</td>
<td>The lecture follows the value added process sequence of electric and electronic components. It contains: Development of electric and electronic circuits, design of electronic circuits on printed circuit boards as well as in hybrid technology, integrated test technology, planning of production lines, production of highly integrated electronic on a wafer as well as recycling.</td>
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<tr>
<td>Lecture notes</td>
<td>Help for English speaking students on request.</td>
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#### Dynamic Behavior of Materials and Structures

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<tr>
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<th>Dynamic Behavior of Materials and Structures</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0735-00L</td>
<td>Dynamic Behavior of Materials and Structures</td>
<td>W</td>
<td>4</td>
<td>2V+2U</td>
<td>D. Mohr</td>
</tr>
<tr>
<td>Abstract</td>
<td>Lectures and computer labs concerned with the modeling of the deformation response and failure of engineering materials (metals, polymers and composites) subject to extreme loads during manufacturing, crash, impact and blast events.</td>
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<tr>
<td>Objective</td>
<td>Students will learn to apply, understand and develop computational models of a large spectrum of engineering materials to predict their dynamic deformation response and failure in finite element simulations. Students will become familiar with important dynamic testing techniques to identify material model parameters from experiments. The ultimate goal is to provide the students with the knowledge and skills required to engineer modern multi-material solutions for high performance structures in automotive, aerospace and naval engineering. Topics include viscoelasticity, temperature and rate dependent plasticity, dynamic brittle and ductile fracture; impulse transfer, impact and wave propagation in solids; computational aspects of material model implementation into hydrocodes; simulation of dynamic failure of structures;</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Various books will be recommended covering the topics discussed in class</td>
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</table>

#### Manufacturing of Electronic Devices

<table>
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<tr>
<td>151-0723-00L</td>
<td>Manufacturing of Electronic Devices</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>A. Kunz, A. Guber, R.D. Morison, F. Reichert</td>
</tr>
<tr>
<td>Objective</td>
<td>Independent studies on a defined field in manufacturing and reporting.</td>
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<tr>
<td>Content</td>
<td>The lecture follows the value added process sequence of electric and electronic components. It contains: Development of electric and electronic circuits, design of electronic circuits on printed circuit boards as well as in hybrid technology, integrated test technology, planning of production lines, production of highly integrated electronic on a wafer as well as recycling.</td>
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<tr>
<td>Lecture notes</td>
<td>Help for English speaking students on request.</td>
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#### Biomedical Engineering

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</tr>
</thead>
<tbody>
<tr>
<td>151-0619-00L</td>
<td>Introduction to Nanoscale Engineering</td>
<td>W</td>
<td>5</td>
<td>2V+3P</td>
<td>S. E. Pratsinis, D. J. Norris, A. Teleki Sotiriou, K. Wegner</td>
</tr>
<tr>
<td>Abstract</td>
<td>The class gives an overview of fundamental concepts in nanoscale engineering. Mobility of small objects, interacting forces, surface tensions and wetting phenomena are some of the physical phenomena investigated. These will be applied to the description of formation and growth of nanoparticles and thin films as well as nanofabrication technologies.</td>
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<tr>
<td>Objective</td>
<td>The goal of the lecture is to familiarize the students with the basic phenomena occurring on the nanometer scale, thereby illustrating the links to physics, chemistry, materials science, and biology. A further objective is to demonstrate the development of technologies and processes based on or including nanoscale phenomena.</td>
<td></td>
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</tr>
</tbody>
</table>
| Content   | - Nanoparticle building blocks for device fabrication  
- Particle size distributions and size selection  
- Nanoparticle formation  
- Forces between small objects  
- Control of nanoparticle properties in the gas-phase  
- The electric double layer  
- Characterization of nanomaterials  
- Microscopes and tools for nanoscale objects  
- Thin film formation  
- Nanofabrication  
- Small "hands-on" research project including project presentations and reporting |

#### Energy Conversion and Transport in Biosystems

<table>
<thead>
<tr>
<th>Number</th>
<th>Energy Conversion and Transport in Biosystems</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0255-00L</td>
<td>Energy Conversion and Transport in Biosystems</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>D. Poulikakos, A. Ferrari</td>
</tr>
<tr>
<td>Abstract</td>
<td>Theory and application of thermodynamics and energy conversion in biological systems and biomedicine at the macro scale and the cellular level.</td>
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</tbody>
</table>
Objective
Theory and application of energy conversion at the macro scale and the cellular level. Understanding of the basic features governing fluid transport in the principal systems of the human cell. Connection of characteristics and patterns from other fields of engineering to biofluidics. Heat and mass transport processes within the human body and relation to biomedical technologies.

Content
Mass transfer models for the transport of chemical species in the human cell. Organization and function of the cell membrane and of the cell cytoskeleton. The role of molecular motors in cellular force generation and their function in cell migration. Description of the functionality of these systems and of analytical experimental and computational methodologies for understanding of their operation. Introduction to bioengineering approaches for the treatment of common pathogenic conditions of these systems. Introduction to cell metabolism, cellular energy transport and cellular thermodynamics.

Lecture notes
Script as well as additional material in the form of hand-outs will be distributed.

Literature
Lecture notes and references therein.

151-0604-00L Microrobotics W 4 credits 3G B. Nelson
Abstract
Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.

Objective
The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.

Content
Main topics of the course include:
- Scaling laws at micro/nano scales
- Electrostatics
- Electromagnetism
- Low Reynolds number flows
- Observation tools
- Materials and fabrication methods
- Applications of biomedical microrobots

Lecture notes
The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

Prerequisites / notice
The lecture will be taught in English.

151-0621-00L Microsystems Technology W 6 credits 4G C. Hierold, M. Haluska
Abstract
Students are introduced to the basics of micromachining and silicon process technology and will learn about the fabrication of microsystems and devices by a sequence of defined processing steps (process flow).

Objective
Students are introduced to the basics of micromachining and silicon process technology and will understand the fabrication of microsystem devices by the combination of unit process steps (= process flow).

Content
- Introduction to microsystems technology (MST) and micro electro mechanical systems (MEMS)
- Basic silicon technologies: Thermal oxidation, photolithography and etching, diffusion and ion implantation, thin film deposition.
- Specific microsystems technologies: Bulk and surface micromachining, dry and wet etching, isotropic and anisotropic etching, beam and membrane formation, wafer bonding, thin film mechanical and thermal properties, piezoelectric and piezoresistive materials.
- Selected microsystems: Mechanical sensors and actuators, microresonators, thermal sensors and actuators, system integration and encapsulation.

Lecture notes
Handouts (available online)

Literature
- S.M. Sze: Semiconductor Devices, Physics and Technology
- W. Menz, J. Mohr, O.Paul: Microsystem Technology
- G. Kovacs: Micromachined Transducer Sourcebook

Prerequisites / notice
Prerequisites: Physics I and II

376-1504-00L Physical Human Robot Interaction (pHRI) W 4 credits 2V+2U R. Gassert, O. Lambercy, R. Riener
Number of participants limited to 26.

Abstract
This course focuses on the emerging, interdisciplinary field of physical human-robot interaction, bringing together themes from robotics, real-time control, human factors, haptics, virtual environments, interaction design and other fields to enable the development of human-oriented robotic systems.

Objective
The objective of this course is to give an introduction to the fundamentals of physical human robot interaction, through lectures on the underlying theoretical/mechatronics aspects and application fields, in combination with a hands-on lab tutorial. The course will guide students through the design and evaluation process of such systems.

By the end of this course, you should understand the critical elements in human-robot interactions - both in terms of engineering and human factors - and use these to evaluate and design safe and efficient assistive and rehabilitative robotic systems. Specifically, you should be able to:

1) identify critical human factors in physical human-robot interaction and use these to derive design requirements;
2) compare and select mechatronic components that optimally fulfill the defined design requirements;
3) derive a model of the device dynamics to guide and optimize the selection and integration of selected components into a functional system;
4) design control hardware and software and implement and test human-interactive control strategies on the physical setup;
5) characterize and optimize such systems using both engineering and psychophysical evaluation metrics;
6) investigate and optimize one aspect of the physical setup and convey and defend the gained insights in a technical presentation.

Content
This course provides an introduction to fundamental aspects of physical human-robot interaction. After an overview of human haptic, visual and auditory sensing, neurophysiology and psychophysics, principles of human-robot interaction systems (kinematics, mechanical transmissions, robot sensors and actuators used in these systems) will be introduced. Throughout the course, students will gain knowledge of interaction control strategies including impedance/admittance and force control, haptic rendering basics and issues in device design for humans such as transparency and stability analysis, safety hardware and procedures. The course is organized into lectures that aim to bring students up to speed with the basics of these systems, readings on classical and current topics in physical human-robot interaction, laboratory sessions and lab visits.

Students will attend periodic laboratory sessions where they will implement the theoretical aspects learned during the lectures. Here the salient features of haptic device design will be identified and theoretical implemented in a haptic system based on the haptic paddle (http://edu.haptics.org/index.php/HapticDevices/HapticPaddles), by creating simple dynamic haptic virtual environments and understanding the performance limitations and causes of instabilities (direct/virtual coupling, friction, damping, time delays, sampling rate, sensor quantization, etc..) during rendering of different mechanical properties.

Lecture notes
Will be distributed through the document repository before the lectures.

http://www.relab.ethz.ch/education/courses/pphi.html

Date: 06.02.2019 13:00  Autumn Semester 2015  Page 933 of 1434
E. Mazza

Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques.

K. P. Prüssmann, M. Rudin

Wong

Literature


Prerequisites / notice

Notice:
The registration is limited to 26 students
There are 4 credit points for this lecture.
The lecture will be held in English.
The students are expected to have basic control knowledge from previous classes.
http://www.relab.ethz.ch/education/pHRI

151-0524-00L

Continuum Mechanics 1

W
4 credits
2V+1U

E. Mazza

Abstract

The lecture deals with constitutive models that are relevant for design and calculation of structures. These include anisotropic linear elasticity, linear viscoelasticity, plasticity, viscoplasticity. Homogenization theories and laminate theory are presented. Theoretical models are complemented by examples of engineering applications and experiments.

Objective

Basic theories for solving continuum mechanics problems of engineering applications, with particular attention to material models.

Content


Lecture notes

yes

376-1714-00L

Biocompatible Materials

W
4 credits
3G

K. Maniura, J. Möller, M. Zenobi-Wong

Abstract

Introduction to molecules used for biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

Objective

The class consists of three parts:
1. Introduction into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of biocompatibility.
3. Introduction into methodology used in biomaterials research and application.

Content

Introduction into native and polymeric biomaterials used for medical applications. The concepts of biocompatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize biomaterials are discussed in vitro as well as in vivo analysis of implanted and explanted materials are discussed.

In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

Lecture notes

Handouts can be accessed online.

Literatur


(available online via ETH library)

227-0385-10L

Biomedical Imaging

New course. Not to be confused with 227-0385-00L of fall 2014.

W
6 credits
5G

S. Kazerke, U. Moser, K. P. Prüssmann, M. Rudin

Abstract

Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using simple photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.
Management, Technology, and Economics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>363-0203-00L</td>
<td>Movement and Sport Biomechanics</td>
<td>W+</td>
<td>4</td>
<td>3G</td>
<td>B. Taylor, R. List, S. Lorenzetti</td>
</tr>
<tr>
<td>151-0509-00L</td>
<td>Microscale Acoustofluidics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>J. Dual</td>
</tr>
<tr>
<td>363-0541-00L</td>
<td>Systems Dynamics and Complexity</td>
<td>W+</td>
<td>3</td>
<td>3G</td>
<td>F. Schweitzer, P. Mavrodiev</td>
</tr>
</tbody>
</table>

Implementing solutions: project management, critical path method, quality control feedback loop.

A successful participant of the course is able to:
- understand why most real problems are not simple, but require solution methods that go beyond algorithmic and mathematical approaches
- apply the problem solving cycle as a systematic approach to identify problems and their solutions
- calculate project schedules according to the critical path method
- setup and run systems dynamics models by means of the Vensim software
- identify feedback cycles and reasons for unintended systems behavior
- analyse the stability of nonlinear dynamical systems and apply this to macroeconomic dynamics

Why are problems not simple? Why do some systems behave in an unintended way? How can we model and control their dynamics? The course provides answers to these questions by using a broad range of methods encompassing systems oriented management, classical systems dynamics, nonlinear dynamics and macroeconomic modeling.

The course is structured along three main tasks:
1. Finding solutions
2. Implementing solutions
3. Controlling solutions

PART 1 introduces complexity as a system immanent property that cannot be simplified. It introduces the problem solving cycle, used in systems oriented management, as an approach to structure problems and to find solutions.

PART 2 discusses selected problems of project management when implementing solutions. Methods for identifying the critical path of subtasks in a project and for calculating the allocation of resources are provided. The role of quality control as an additional feedback loop and the consequences of small changes are discussed.

PART 3, by far the largest part of the course, provides more insight into the dynamics of existing systems. Examples come from biology (population dynamics), management (inventory modeling, technology adoption, production systems) and economics (supply and demand, investment and consumption). For systems dynamics models, the software program VENSIM is used to evaluate the dynamics. For economic models analytical approaches, also used in nonlinear dynamics and control theory, are applied. These together provide a systematic understanding of the role of feedback loops and instabilities in the dynamics of systems. Emphasis is on oscillating phenomena, such as business cycles and other life cycles.

Weekly self-study tasks are used to apply the concepts introduced in the lectures and to come to grips with the software program VENSIM.

The lecture slides are provided as handouts - including notes and literature sources - to registered students only. All material is to be found on the Moodle platform. More details during the first lecture.

Self-study tasks (discussion exercises, Vensim exercises) are provided as home work. Weekly exercise sessions (45 min) are used to discuss selected solutions. Regular participation in the exercises is an efficient way to understand the concepts relevant for the final exam.
Abstract

Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.

Objective

An effective and efficient flow of goods, data, and control in and between companies contributes significantly to the value added for the customer; Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.

Content

Strategic and tactical concepts in logistics, operations, and supply chain management: Conflicts of objectives and strategies and in the entrepreneurial context; business process analysis and fundamental logistics concepts; the lean / just-in-time and repetitive manufacturing; concepts for product families and one-of-a-kind production; concepts for the process industry.

Lecture notes


This book also serves as textbook for LOS II (spring term) as well as ERP and SCM software systems (autumn term). In addition powerpoint-handouts and documents for case studies.

Literature

Sales at 17.9.15, from 12:45, before and during breaks of the first lecture.

Prerequisites / notice

As for the lecture of the 3rd week (BEMAD, a much-liked Business Engineering and Management Ability Development game), this lecture (of Oct. 1) will follow a specific schedule in specific rooms. The schedule will be presented at Sept. 17 during the 1st lecture.

Due to the big number of students, about half of the students will play this game, instead of Oct. 1, at Friday afternoon, Oct. 2. Please be available. Thank you for your help in this matter.

363-0503-00L

Principles of Microeconomics

W 3 credits 2G

M. Filippini

Abstract

The course introduces basic principles, problems and approaches of microeconomics.

Objective

The course includes the following main topics:

- Basic principles of demand and supply, market and state in a modern economy, externalities, cost analysis, consumer behaviour,
- economies of scale and economies of scope, perfect competition, monopoly, oligopoly, monopolistic competition, mathematical treatment of some basic concepts.

Lecture notes

Lecture notes, exercises and reference material can be downloaded from Moodle.

Literature


The book can also be used for the course 'Principles of Macroeconomics' (Sturm)

For students taking only the course 'Principles of Microeconomics' there is a shorter version of the same book:


Complementary:


363-0565-00L

Principles of Macroeconomics

W 3 credits 2V

J.E. Sturm

Abstract

This course examines the behaviour of macroeconomic variables, such as gross domestic product, unemployment and inflation rates. It tries to answer questions like: How can we explain fluctuations of national economic activity? What can economic policy do against unemployment and inflation. What significance do international economic relations have for Switzerland?

Objective

This lecture will introduce the fundamentals of macroeconomic theory and explain their relevance to every-day economic problems.

Content

This course helps you understand the world in which you live. There are many questions about the macroeconomy that might spark your curiosity. Why are living standards so meagre in many African countries? Why do some countries have high rates of inflation while others have stable prices? Why have some European countries adopted a common currency? These are just a few of the questions that this course will help you answer. Furthermore, this course will give you a better understanding of the potential and limits of economic policy. As a voter, you help choose the policies that guide the allocation of society's resources. When deciding which policies to support, you may find yourself asking various questions about economics. What are the burdens associated with alternative forms of taxation? What are the effects of free trade with other countries? What is the best way to protect the environment? How does the government budget deficit affect the economy? These and similar questions are always on the minds of policy makers.

Lecture notes

The course webpage (to be found at http://www.kof.ethz.ch/en/events/teaching/) contains announcements, course information and lecture slides.

Literature


We advise you to also buy access to Aplia. This internet platform will support you in learning for this course. To save money, you should buy the book together with Aplia. This is sold as a bundle (ISBN: 9781473715998).

Besides this textbook, the slides and lecture notes will cover the content of the lecture and the exam questions.

351-0778-00L

Discovering Management

W 3 credits 3G


Abstract

Discovering Management offers an introduction to the field of business management and entrepreneurship for engineers and natural scientists. The module provides an overview of the principles of management, teaches knowledge about management that is highly complementary to the students' technical knowledge, and provides a basis for advancing the knowledge of the various subjects offered at D-MTEC.
Discovering Management offers an integrated learning system, which combines in an innovative format a set of lectures, an advanced business game simulation and a set of group exercises involving industry speakers (ranging from leading venture capitalists to executives at established corporations). Unlike more traditional courses, the learning model for Discovering Management involves ‘learning by doing’. While the 13 different lectures, in-class discussions and assigned readings provide the theoretical and conceptual foundations, the experiential learning outcomes result from the interrelated group activities: 1) the interactive case studies and exercises, 2) the business game simulation.

By discovering the key aspects of entrepreneurial management, the purpose of the course is to advance students’ understanding of factors driving company success, where success is understood as a broad construct including financial return, employee, customer and supplier satisfaction as well as social and ecological responsibility.

Discovering Management is designed to suit the needs and expectations of Bachelor students at all levels as well as Master and PhD students not belonging to D-MTEC. By providing an overview of Entrepreneurial Management, this course is an ideal enrichment of the standard curriculum at ETH Zurich. No prior knowledge of business or economics is required to successfully complete this course.

### Content

The lectures for Discovering Management are designed to broaden the participant’s understanding of the principles of entrepreneurial management, emphasizing the interdependence of various specialties in the development and management of a firm. For this reason, the lectures are structured on the basis of a coherent business model and will be presented by the respective area specialists at D-MTEC.

The lectures broaden the view and the understanding of technology by interlinking it with society. Corporate sustainability, for example, introduces economic, ecological and social issues that are relevant to all engineering disciplines. Practical examples stimulate the students to assess these issues and be aware of their responsibilities as engineers. Technology and innovation management, to mention a second example, focuses on the interplay of technical and organizational change, and how these often neglected interactions explain why many new technologies are never used. It fosters the students’ ability to see the business and social consequences of their ‘technical’ decisions.

Critical skills will be trained by the case study exercise, a participant-centered learning activity, which provides students with the opportunity to place themselves in the role of the decision maker, as they learn more about the specific case and identify the challenge they are faced with. Students will be presented real case scenarios by industry guests from established corporations and will have to critically analyze specific issues. The case study exercise will provide an insight into the context of a managerial problem-solving and enhance the participant’s appreciation for the complex tools companies deal with.

Discovering Management attempts to overcome the limitations of traditional teaching curricula of management in technical universities, which often merely focus on transferring specific skills to students, e.g. planning or forecasting. In response to the new challenges for entrepreneurial decision-making, students will be offered the opportunity to actively engage in an advanced business game simulation; a business game that establishes a link between business management theory and business management in practice. The simulation presents a realistic model of a company and provides participants with the opportunity to quickly gain the lasting effects of practical experience in a risk-free environment. All this provides a valuable learning platform to integrate the increasingly important development of the skills and competences required to identify entrepreneurial opportunities, analyze the future business environment and successfully respond to it by taking systematic decisions, e.g. critical assessment of technological possibilities.

In the example focuses on the interplay of technical and organizational change, and how these often neglected interactions explain why many new technologies are never used. It fosters the students’ ability to see the business and social consequences of their ‘technical’ decisions. Critical skills will be trained by the case study exercise, a participant-centered learning activity, which provides students with the opportunity to place themselves in the role of the decision maker, as they learn more about the specific case and identify the challenge they are faced with. Students will be presented real case scenarios by industry guests from established corporations and will have to critically analyze specific issues. The case study exercise will provide an insight into the context of a managerial problem-solving and enhance the participant’s appreciation for the complex tools companies deal with.

### Prerequisites / notice

No prior knowledge of business or economics is required to successfully complete this course.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-0445-02L</td>
<td>Logistics, Operations, and Supply Chain Management (I (Additional Cases))</td>
<td>The lecture 363-0389-00L Technology and Innovation Management needs to be taken in order to participate in this module</td>
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<tr>
<td>363-0389-02L</td>
<td>Technology and Innovation Management (Additional Cases)</td>
<td>Only for Mechanical Engineering BSc.</td>
</tr>
<tr>
<td>363-0541-02L</td>
<td>Systems Dynamics and Complexity (Additional Cases)</td>
<td>Only for Mechanical Engineering BSc.</td>
</tr>
</tbody>
</table>

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 937 of 1434
1. Modelling path dependence and formation of standards
   - Why do clocks go clockwise? Why do people in most nations drive on the right? Why do nearly all computer keyboards have the QWERTY layout, even though it is more inefficient compared to DVORAK? It turns out that many real-world processes are path dependent, i.e. small random events early in their history determine the ultimate end state, even when all end states are equally likely at the beginning. Students will learn how to model such processes, to understand the feedback mechanisms that lead to path dependence. As a case in point, we will study the 'war' between the Betamax and the VHS standards.

2. Optimal migration as promoter of cooperation
   - Mechanisms to promote cooperative behaviour is a vibrant research topic in various fields - economics, evolutionary biology and management science to name but a few. Students will be introduced to one such mechanism - migration. They will develop and analyse a macroscopic model to study how the rate of migration affects the long-term cooperation rate in a population.

3. Information transfer
   - Information flow in a social system (e.g. about the location of resources or appearance of a competitor) is an important component of group living. For example, it is well known that ants can achieve remarkable feats in finding an optimal route to a food patch through pheromone trails. The goal of this study case is to model information transfer in such systems by investigating the dynamics of trail formation in ants. The students will learn that the complexity in navigating to a food source may nevertheless be explained as a simple dynamical system with one control parameter only.

4. Decisions in social societies
   - In many situations individuals have to decide between two or more options. Such decisions often have a profound impact on the system as a whole, especially regarding group cohesion. Group cohesion is preferred, as individuals can benefit from living in groups, yet it may not be the underlying reason behind individual choices. In this case, students will develop and extend a macroscopic model of an animal social system faced with a decision to choose a new home, and identify the conditions which promote group cohesion versus group splitting.

5. Antigenic variation of HIV
   - One of the characteristic traits of HIV is that a host can be a carrier and a transmitter of the virus without experiencing symptoms for up to 10 years. This case is concerned with finding the mechanism of HIV disease progression. The students will develop a general population-based model for the interaction of an infectious agent with the host immune system. The model is applicable to a variety of infectious agents, ranging from acute lethal infections to chronic illness. Through analysing and simulating the model, the students will understand how the HIV virus interacts with the host and how the mutation rate of the virus is ultimately responsible for this long asymptomatic period.

6. Compartmental models in epidemiology
   - Many diffusive processes in social systems, such as epidemics, can be understood as a result of the interaction between a few groups (compartments) of individuals. The most common example is to divide a population into those who are susceptible (S) to a disease, those who are infected (I), and those who have recovered (R) and are immune, and to model their interactions. These so called SIR models find wide application in studying non-biological diffusive processes, e.g. spread of technological innovations, fads, internet memes etc. In this study case, students will become familiar with the basic components of an SIR model and the conditions under which a disease can cause the outbreak of an epidemic. Students will extend the basic model to investigate more realistic scenarios relevant to e.g. different vaccination strategies.

363-0387-00L Corporate Sustainability W 3 credits 2G V. Hoffmann
Abstract
We introduce the concept of corporate sustainability; discuss its implications focusing on strategy, technology, and financial markets; and offer e-modules to train relevant critical thinking skills. With this input, students explore the practical challenges of corporate sustainability in a group project, focusing on one of the four sustainability challenges of water, energy, mobility, and food.

Objective
Understand the limits and the potential of corporate sustainability for sustainable development

Content
Develop critical thinking skills that are useful for corporate sustainability (argumentation, communication, evaluative judgment)

Overview of the grand sustainability challenges of Water, Energy, Mobility, and Food

Business implications of sustainable development, in particular for corporate strategy, marketing & leadership, technology & innovation, and financial markets.

Critical thinking skills for corporate sustainability

In-depth case study of concrete corporate sustainability challenge in the group project phase, such as: How to deal with environmental pressure groups? How to use the strengths of business to solve pressing sustainability problems? How to catalyze radical innovations for sustainability? How to invest money in a sustainable way?

Lecture notes Will be provided

Literature
Presentation slides will be distributed prior to lectures.

363-0389-00L Technology and Innovation Management W 3 credits 2G S. Brusoni
Abstract
This course focuses on the analysis of innovation as a pervasive process that cuts across organizational and functional boundaries. It looks at the sources of innovation, at the tools and techniques that organizations deploy to routinely innovate, and the strategic implications of technical change.

Objective
This course intends to enable all students to:
- understand the core concepts necessary to analyze how innovation happens
- master the most common methods and tools organizations deploy to innovate
- develop the ability to critically evaluate the innovation process, and act upon the main obstacles to innovation

Content
This course looks at technology and innovation management as a process. Continuously, organizations are faced with a fundamental decision: they have to allocate resources between well-known tasks that reliably generate positive results; or explore new ways of doing things, new technologies, products and services. The latter is a high risk choice. Its rewards can be high, but the chances of success is small.

How do firms organize to take these decisions? What kind of management skills are necessary to take them? What kind of tools and methods are deployed to sustain managerial decision-making in highly volatile environments? These are the central questions on which this course focuses, relying on a combination of lectures, case-based discussion, guest speakers, simulations and group work.

Lecture notes Slides will be available on the TIMGROUP website.

Literature Readings will be available on the TIMGROUP website.

Prerequisites / notice No specific background in economics or management is required.
The lecture teaches on the basic knowledge of major processes in sheet metal, tube and bulk metal forming technologies. In particular it focuses on fundamental computation methods, which allow a fast assessment of process behaviour and a rough layout. Process-specific states of stress and deformation are analysed and process limits are identified.

Acquaintance with forming processes. Determination of forming processes. Interpretation of forming manufacturing. The study of metal working processes: sheet metal forming, folding die cutting, cold bulk metal forming, ro extrusion, plunging, open die forging, drop forging, milling; active principle; elementary methods to estimate stress and strain; fundamentals of process design; manufacturing limits and machining accuracy; tools and operation; machinery and machine usage.

- Concept development
- design of the component including FEM simulation and stability checks
- manufacturing and structural testing of a prototype
- manufacturing and structural testing of an improved component
- Report

The project work is supported by selected teaching units.

The fundamentals of forming technology are represented to Mechanical, Production and Material Engineers. The content of the lecture is: Overview of manufacturing with forming techniques, deformation specific description of material properties and their experimental measurement, material laws, residual stresses, heat balance, tribological aspects of forming processes, workpiece and tool failure.

Forming technology represents with its 70% global share in manufactured metal volume with respect to yield and cost, the most important manufacturing process in metal-working industries. Typical applications of forming technology range from the manufacturing of sheet metal components in auto bodies to applications in food and pharma packaging, fabrication of implants in medical technologies and to the fabrication of leads in microelectronic components. This course introduces the fundamentals which are essential to evaluate metal-forming processes and its industrial applications. This includes, together with the acquirements of the most important forming processes, the characterization of plastic material behavior and manufacturing limits.

Overview of the most important processes of metal-forming technology and its field of applications, characterization of the plastic metal-forming behavior, basic principles of plastic-mechanical calculations, metal-forming residual stresses, thermo-mechanical-coupling of metal-forming processes, influence of tribology. Work piece failure through cracking and folding, tool failure through rupture and mechanical wear, metal-forming tools, sheet forming and massive forming processes, handling systems, metal-forming machinery.

The project is structured as described below:
- Concept development
- design of the component including FEM simulation and stability checks
- manufacturing and structural testing of a prototype
- manufacturing and structural testing of an improved component
- Report

The project work is supported by selected teaching units.

The aim of the course is to introduce students to the engineering design research and practice in a multitude of Mechanical Engineering disciplines and convey knowledge from both academia and industry about state of the art methods, tools and processes.

The course is structured in three main blocks, each of them addressing a specific grand challenge in engineering design. Each block is composed of an introductory lecture and two to three invited talks, considering a good mix between speakers coming from academia and industry. Each talk is introduced and moderated by the students.

Teams of 2 to 4 students have to design, size, and manufacture a lightweight structure complying with given specifications. A prototype as well as an improved component will be tested and assessed regarding to design and to structural mechanical criteria.

Well as an improved component will be tested and assessed regarding to design and structural mechanical criteria.

The aim of the course is to introduce students to the engineering design research and practice in a multitude of Mechanical Engineering disciplines and convey knowledge from both academia and industry about state of the art methods, tools and processes.

The course is structured in three main blocks, each of them addressing a specific grand challenge in engineering design. Each block is composed of an introductory lecture and two to three invited talks, considering a good mix between speakers coming from academia and industry. Each talk is introduced and moderated by the students.
Content

The students are exposed to a variety of topics in the field of Engineering Design. Topics are bundled in three main grand challenges and include an introductory lecture held by one of the responsible Professors and 2-3 invited talks of 45 min. each, addressing specific issues. The success of the course is largely dependent on active involvement of the students. Accordingly, a small group of students (1-3) is asked to introduce and moderate each external talk. The group will therefore gather adequate information about the speaker and topic, read and synthesize relevant documents and scientific papers, prepare questions to motivate the interaction with the audience and summarize, at the end of the lecture, the discussed points and outcome.

Prerequisites / notice

Offered in English and German

151-3201-00L Studies on Engineering Design  W  3 credits  6A  K. Shea, P. Ermanni, M. Meboldt

Abstract

This course introduces students to the exciting world of Engineering Design research, which crosses disciplines and requires a variety of skills. Each student identifies a topic in Engineering Design for further investigation, either based on those proposed or a new, agreed topic.

Objective

Students gain their first knowledge of Engineering Design research and carry out their first, independent scientific study. Students learn how to read scientific literature and critically analyze and discuss them, gain hands-on experience in the area and learn how to document their work concisely through a report and short presentation.

Content

Students identify 5-10 journal articles, or scientifically equivalent, in consultation with the supervisor and can define a small, related project in the area to gain hands-on experience. In the beginning of the semester, students develop with the supervisor a 2-page proposal outlining the objective of the study, tasks to be carried out and a brief time plan for the work. Once agreed, the project starts resulting in a report combining the state-of-art literature review and project results, if carried out.

The students work independently on a study of selected topics in the field of Engineering Design. They start with a selection of the topic, identify scientific papers for the literature research and can define a small, related project. The results (e.g. state-of-the-art literature review and small project results where defined) are evaluated with respect to predefined criteria.

Prerequisites / notice

Students take this course in parallel to the Lecture "Grand Challenges in Engineering Design". A general meeting will be held in the beginning of the semester to propose topics for the studies. Studies are carried out individually and can be the pre-study for a Bachelor thesis.

151-0511-00L Mechanics of Nano- and Micro-Materials  W  4 credits  2V+1U  C. Daraio

Abstract

Does not take place this semester.

Objective

The course provides an introduction to the mechanics of nano- and micro-materials and devices, in the quasistatic and dynamic domains. It reviews scale effects in materials, surveys available characterization techniques and describes the effects of surfaces and microscale contacts. Recent applications of nano- and micro-materials in engineering systems will be discussed.

Content

Follows soon

Lecture notes

Slides and notes from the course will be provided.

Literature

Relevant articles and reading materials will be provided. Various books will be recommended pertaining to the topics covered.

Prerequisites / notice

Mechanics I, II, III

151-3209-00L Engineering Design Optimization  W+  4 credits  4G  K. Shea, T. Stankovic

Abstract

Number of participants limited to 25.

Objective

The course covers fundamentals of computational optimization methods in the context of engineering design. It develops skills to formally state and model engineering design tasks as optimization problems and select appropriate methods to solve them.

Content


Lecture notes

Available on Moodle

151-3207-00L Lightweight  W  4 credits  4G  P. Ermanni

Abstract

The lecture embraces lightweight materials, construction techniques, design principles and calculation methods for the analysis of the load bearing and failure behavior of lightweight structures.

Objective

The course aims to impart basic principles for the understanding and for the design and dimensioning of modern lightweight constructions in mechanical, automotive and aerospace engineering.

Content

Light metals and fiber reinforced plastics, technologies and construction techniques, frames and truss structures, bending, shear and torsion of open and closed, thin-walled constructions, statically undetermined systems, stability of thin-walled systems.

Lecture notes

Handouts

151-0735-00L Dynamic Behavior of Materials and Structures  W  4 credits  2V+2U  D. Mohr

Abstract

Lectures and computer labs concerned with the modeling of the deformation response and failure of engineering materials (metals, polymers and composites) subject to extreme loadings during manufacturing, crash, impact and blast events.

Objective

Students will learn to apply, understand and develop computational models of a large spectrum of engineering materials to predict their dynamic deformation response and failure in finite element simulations. Students will become familiar with important dynamic testing techniques to identify material model parameters from experiments. The ultimate goal is to provide the students with the knowledge and skills required to engineer modern multi-material solutions for high performance structures in automotive, aerospace and naval engineering.

Content

Topics include viscoelasticity, temperature and rate dependent plasticity, dynamic brittle and ductile fracture; impulse transfer, impact and wave propagation in solids; computational aspects of material model implementation into hydrocodes; simulation of dynamic failure of structures;

Lecture notes

Various books will be recommended covering the topics discussed in class.

Literature

Slides of the lectures, relevant journal papers and users manuals will be provided.

Prerequisites / notice

Course in continuum mechanics (mandatory), finite element method (recommended)

151-0509-00L Microscale Acoustofluidics  W  4 credits  3G  J. Dual

Abstract

In this lecture the basics as well as practical aspects (from modelling to design and fabrication ) are described from a solid and fluid mechanics perspective with applications to microsystems and lab on a chip devices.

Objective

Understanding acoustophoresis, the design of devices and potential applications

Content

Linear and nonlinear acoustics, foundations of fluid and solid mechanics and piezoelectricity, Gorkov potential, numerical modelling, acoustic streaming, applications from ultrasonic microrobotics to surface acoustic wave devices
Engineering Tools IV

The participation at the Engineering Tools course is mandatory. If you miss any classes, no credit points will be awarded. For exemptions you have to contact the lecturer of the course.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0015-10L</td>
<td>Engineering Tool IV/V: Experimental Modal Analysis</td>
<td>W</td>
<td>0.4 credits</td>
<td>1K</td>
<td>F. Kuster, K. Wegener</td>
</tr>
</tbody>
</table>

Number of participants limited to 16.

Abstract

Measuring- and analysis-methods for the determination of transfer functions of mechanical structures. Evaluation and preparation of the measured data for visualisation and interpretation of the dynamic behaviour.

Objective

Introduction into the practical application of measuring- and analysis-methods for determination of transfer functions of mechanical structures. Evaluation and preparation of the measured data for visualisation and interpretation of the dynamic behaviour.

Content

Acquaintance with the acceleration- and force-sensors, measurement of transfer functions of mechanical structures, determination and description of modes of vibration by means of practical examples, introduction into the vibration theory and its fundamental terms, discrete oscillator.

Lecture notes

Yes, distribution in the course (CHF 20.-)

Literature

David Ewins, Modal Testing: Theory and Practice

Prerequisites / notice

In the practical part of the course the participants self will make measurements on structures and then analyse them for eigenfrequencies and modes of vibrations.

151-0017-10L | Engineering Tool IV/V: Introduction to Structural Testing | W    | 0.4 credits | 1K     | P. Ermanni, T. Heinrich |

Number of participants limited to 18.

Abstract

Structural testing is a very broad and interdisciplinary field. Taking into account the limited time, the scope of this tool-course is to provide a general introduction to structural testing, with particular attention to theoretical and practical aspects of strain gage measurements. Furthermore a real engineering case is presented and discussed in small groups.

Objective

Introduction to structural testing. Focus lies in measurements with strain gages. Selected case-studies help the participant to better understanding critical issues and possible solutions.

Content

Working with strain gages preparation of the structure, positioning and application of the strain gages, data-gathering, verification.

Introduction to Structural Testing (Theory)

Lecture notes

Script is available (follow the link)

Literature

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Prerequisites / notice

In the practical part of the course the participants self will make measurements on structures and then analyse them for eigenfrequencies and modes of vibrations.
Abstract
Introduction of integrated CAD applications CAM (Computer Aided Manufacturing), Motion Simulation (Kinematics)

Objective
The participants learn the possibilities of integrated CAD applications. The goal is to understand the procedures and the most important functions of these applications.

Content
CAM: Introduction to CAM, practical examples for a 3-axle milling machine
Motion simulation (kinematic): Introduction to the possibilities of the movement simulator. Practical examples.

Prerequisites / notice
Voraussetzungen:
- CAD-Grundkenntnisse in NX (CAD 1. Sem.)
- Eigenes Laptop mit installierter, lauffähiger Software NX für die Durchführung der Übungen (Siemens NX kann über Stud-IDES kostenlos bestellt werden).

151-0027-10L Engineering Tool IV/V: Programming with LabView
W 0.4 credits 1K L. Prochazka, T. Rösgen

All Engineering Tool courses are for MAVT-Bachelor students only.

Number of participants limited to 16.

Abstract
An introduction is given to the LabView programming environment. The basic concepts of "virtual instruments" and data flow programming are presented. Computer-based exercises are solved during class. A simple electronic data acquisition module is used to demonstrate basic concepts of interface management and data acquisition.

Objective
Introduction to the LabView programming environment.
Understanding of fundamental concepts: virtual instruments, data flow programming, control structures, data types etc.
Development of basic programming skills using in-class exercises on computers.

Prerequisites:
Matlab skills; your laptop with Matlab/Simulink may be useful.

Number of participants limited to 30.

151-0030-10L Engineering Tool IV/V: Modelling and Servo Axis Control of Machine Tool Manipulators

W 0.4 credits 1K O. Zirn, K. Wegener

All Engineering Tool courses are for MAVT-Bachelor students only.

Number of participants limited to 36.

Abstract
This course covers model building and the applied stimulation of (power-assisted axles on production machinery using MATLAB/Simulink and provides a practical example of how drive parameters may be set up, how through simulation an optimal axis design can be developed and which characteristics of a production machine can be reliably estimated in advance.

Objective
The students are able to model servo axes considering all relevant components and process influences to simulate the achievable productivity.

Content
1. Introduction, complexity levels in model building for production machines.
2. Complexity level 1: Power-assisted axles, transmission systems, general structural model.
3. Complexity level 2: Robotic models, kinematics and dynamics
4. Complexity level 3: Multi-body models and finite element models
5. Regulation of power-assisted axles, cascade regulator and state regulator extensions.
7. Master slave and gantry operations with dispersed servo drive.
8. Simulation examples in MATLAB/Simulink ((Swivel axle, 5-axis milling machine, parallel kinematic milling machine, industrial robots).

Lecture notes
Wird abgegeben

Prerequisites:
Prerequisite is knowledge of Matlab.

151-0032-10L Engineering Tool IV: Introduction to the Methods of Six Sigma Quality Control and Lean Production

W 0.4 credits 1K B. G. Rüttimann, K. Wegener

All Engineering Tool courses are for MAVT-Bachelor students only.

Number of participants limited to 36.

Abstract
The course introduces to Six Sigma quality management and quality improvement, which aims to reduce process variation and to sustain process capability. It introduces also to the Lean production principles, aiming to reduce waste within the processes as well as aiming to a customer taked pull-production.

Objective
The participant gets an overview to the Operational Excellence philosophy and the working methods of these two approaches. He learns the most important tools and the interaction of these two approaches.
1. Understanding the changing environment
   - Globalization, customer requirements, production systems
   - Six Sigma quality philosophy
   - Lean Manufacturing and TPS (Toyota Production System)

2. Quality management with Six Sigma
   - What is Six Sigma
   - DMAIC problem solving cycle
   - Use of different control charts
   - Evaluate process capability, DPMO, Cp, Cpk, Taguchi
   - Cause-effect diagram
   - Control plan and sustainability, PDCA

3. Introduction to the Lean approach
   - Lean goals and principles
   - A3 project management
   - The 8 types of waste
   - Value add and non value add activities
   - The 8 Lean-Tools, whereof 4
   - 5S workplace organization
   - Value stream mapping (exercise), Little's law
   - Continuous flow vs batch
   - Pull Principles, Kanban, DBR
   - Cell design
   - Linear Programming

4. Lean and Six Sigma in practice
   - How fits Lean and Six Sigma together
   - Continuous Improvement/Kaizen organization
   - Change-Management, risks
   - Inspire deployment approach

Lecture notes

Notes will be distributed.

151-0044-10L Engineering Tool IV/V: Computational Fluid Dynamics (CFD) with OpenFoam
All Engineering Tool courses are for MAVT-Bachelor students only.

Number of participants limited to 40.

Abstract
Participants will learn to use the open source simulation software OpenFOAM on a user level (i.e. to conduct classical CFD studies). We will also introduce the students into programming with OpenFOAM so they will be able to implement additional equations into existing solvers.

Objective
Participants will learn to use the open source simulation software OpenFOAM on a user level (i.e. to conduct classical CFD studies). We will also introduce the students into programming with OpenFOAM so they will be able to implement additional equations into existing solvers.

Content
OpenFOAM is a very professional open-source simulation package which is freely (CHF 0.-) available under the GNU General Public License (GPL). It consists of a vast C++ library, many different applications and additional tools. Although most of the existing applications are flow solvers, OpenFOAM can be used in many different areas, as varied as solid dynamics, electromagnetics or pricing of financial options.

Most users make only use of the included applications. One particular strength of OpenFOAM, however, is that new applications and even extensions of the library can be developed in a rather compact and elegant way.


Prerequisites / notice
Knowing C++ or at least having some experience in another programming language will be of an advantage but is not strictly required to follow this course.

151-0057-10L Engineering Tool IV/V: Systems Engineering for Project Work
All Engineering Tool courses are for MAVT-Bachelor students only.

Number of participants limited to 60.

Abstract
The course is about a methodical basis of systematic project work, with a focus on demanding interdisciplinary problems. The participants will be shown how to use it appropriately and correctly in their projects. This short course is based on the "Systems Engineering" (SE) method, which was developed at the ETH.

Objective
The goals of this compact course are:
- Goal-oriented identification and perception of relevant problem areas and project goal setting.
- Deduction and development of procedures for a promising project, including systematic planning of the project content.
- Development of work packages including efficient methodology
- Simple embedding of the projects in the organization, including relationships with buyers, users and securing project participation.
By looking at specific examples during class you will obtain an overview on composing scientific papers (e.g. bachelor theses, semester theses, master theses) using LaTeX and acquire the most important commands to typeset complex formulas, tables and graphics.

**Objective**

The participants will deepen their existing CAD knowledge and learn new PDM knowledge, so that these may be directly applied and used for reports and publications in the scientific domain.

**Abstract**

The participants will learn about the procedures and tools that are necessary to develop technical products. The focus is on computer-based design and development and the management in an integrated software environment.

**Content**

1. **Nachmittag:**
   - Einstieg ins Systems Engineering; Entstehung, Inhalt und Werdegang; Voraussetzungen (anspruchsvolle Fragestellungen, institutionelle Einbettung, Systemdenken und heuristische Prinzipien);
   - Grundstruktur und Inhalt Lebensphasenmodell; Grundstruktur in Inhalt Problemlösungszyklus;
   - Zusammenwirken von Lebensphasenmodell & Problemlösungszyklus in Projekten

2. **Nachmittag:**
   - Situationsanalyse: Systemanalyse (Systemabgrenzung (gestaltbarer Bereich, relevante Bereiche des Umkreises)), Methoden der Analyse und Modellierung, Umgang mit Vernetzung, Dynamik und Unsicherheit; wichtigste Methoden der IST-Zustands- und Zukunftsanalyse,
   - Zielformulierung (wichtigste Methoden der Zielformulierung),
   - Konzeptsynthese und Konzeptanalyse (u. a. Kreativität; wichtigste Methoden der Synthese und Analyse),

3. **Nachmittag:**
   - Beurteilung (u. a. Methoden für mehrdimensionale Kriterienvergleich, z. B. Kosten-Wirksamkeits-Analyse); Diskussion von Planungsbeispielen
   - Diskussion von Planungsbeispielen: Analyse des Methodeneinsatzes, Entwickeln alternativer Vorgehensschritte und Auswahl des zweckmäßigsten Vorgehens

**Prerequisites / notice**


**151-0059-10L Engineering Tool IV: CAD-Methodology and PDM-Technology in the Focus Project**

All Engineering Tool courses are for MAVT-Bachelor students only.

Number of participants limited to 25.

Only one course can be chosen per semester.

**Abstract**

The participants learn about the procedures and tools that are necessary to develop technical products. The focus is on computer-based design and development and the management in an integrated software environment.

**Objective**

The participants will learn and experiment with procedures by working on concrete examples so that they will subsequently be able to begin with independent product construction.

The following topics will be dealt with in depth in the lectures supporting the focus project (Praxiskurs): CAD-Methodology, FE calculations, motion simulation and construction methodology.

**Content**

1. **Nachmittag:**
   - CAD refresh (Modelling, Assembling, Drafting, etc.) and CAD mythology for construction (Top-Down modelling)
   - Introduction to the Team Center (Siemens PDM System)
   - TeamCenter data flow, in particular the process of creating and managing new Items and Parts, the approval procedure and creating different versions of Parts

2. **Nachmittag:**
   - To refresh already existing knowledge of CAD functionality.
   - Sketch and features as well as manipulation and optimizing models.
   - Assembling
   - Drafting
   - Organisation, working methods, conventions.

   - Top down modelling CAD
   - i. Introduction to top down modelling and concept modelling
   - ii. Case study of top down modelling

3. **Nachmittag:**
   - Introduction to TC (Team Center)
   - Introduction: Short introduction to PLM (What is the idea of PLM? PLM is more than the pure management of drawings!)
   - Lesson 1 - Team Center Rich Client Interface
   - Lesson 2 - TC data types
   - Lesson 3 - Construction from data in TC
   - Lesson 4 - Searching for and examining data.

   - TC application
   - Lesson 5 - Unit lists (PSE)
   - Lesson 6 - Cross-referencing
   - Lesson 7 - Data release
   - Lesson 8 - Product data examination

   - Organisation. working methods, conventions.

   - at least two students of a Focus-Team should sign in for this course, if teh use of Siemens TeamCenter PLM is given for the Team.
   - only for students participating in a Focus Project in the same semester
   - not more than 25 students

**151-0061-10L Engineering Tool IV/V: Scientific Writing with LaTeX and Vector Graphics**

All Engineering Tool courses are for MAVT-Bachelor students only.

Number of participants limited to 40.

Only one course can be chosen per semester.

**Abstract**

This course provides insights into the structure and compilation of scientific papers and publications using LaTeX as well as open source software for image editing and the creation of vector graphics. LaTeX is a typesetting tool that separates text format and layout. It is widely used for reports and publications in the scientific domain.

**Objective**

By looking at specific examples during class you will obtain an overview on composing scientific papers (e.g. bachelor theses, semester theses, master theses) using LaTeX and acquire the most important commands to typeset complex formulas, tables and graphics.
**Content**

-- layout of scientific reports
-- writing with LaTeX (structure, formatting, formulas, tables, graphics, references, table of contents, hyperlinks, packages) based on a template for bachelor/semester/master theses.
-- graphic design and illustration using open source software and Matlab
-- including PDF files in the report (project description, data sheets)
-- managing bibliography databases

**Literature**

http://www.relab.ethz.ch/education/courses/engineering-tools-latex.html

**Prerequisites / notice**

Particular: The exercises will be done on your personal laptop (at least one laptop per two students). The entire LaTeX package, Inkscape and Gimp should be installed in advance.

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**151-0067-10L Engineering Tool IV: Sketching and Visualization of Technical Concepts**

All Engineering Tool courses are for MAVT-Bachelor students only.

Number of participants limited to 20.

**Abstract**

This course is offered by the Design and Technology Lab Zurich. Effective visualizations of ideas are essential to communicate technical concepts. This course focuses on the basics of a coherent draft design through forms of sketches using various simple techniques.

**Objective**

Mastering various simple techniques for the visualization of technical ideas.

**Content**

Basics in: Perspective, line drawing, proportions, implementation of the plan views of perspective will be distributed.

**Literature**

It requires no further books

**Prerequisites / notice**

Max 20 participants

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**151-0069-10L Engineering Tool IV: Design Optimization and CAD**

Does not take place this semester.

All Engineering Tool courses are for MAVT-Bachelor students only.

Number of participants limited to 20.

**Abstract**

Participants will learn about the Computer-Aided Engineering fundamentals and methods that are necessary for successful design of modern technical products. The focus will be placed on the simulation-driven design in the context of product development process as well as on the fundamentals of the design optimization.

**Objective**

Basic Computer-Aided Engineering (CAE) knowledge and skills will be acquired to enable students to recognize both the advantages and the limitations of current CAE tools. Examples of how to build feature-based and parametric models for simulation-driven design automation will be given along with common pitfalls. The CAE environment will be the Siemens NX 8.5 which couples the simulation modeling (e.g. structural, thermal, flow, motion, and multiphysics) with design optimization and Feature-Based Design (FBD). After taking the course students should be able to independently create effective feature-based and parametric models to suit the requirements of simulation-driven design.

**Content**

1. Computer-Aided Engineering (CAE) methods and tools in context of design process (2 afternoons):
   - CAE in the context of the design process
   - Introduction to design optimization
   - Features, parameterization and synchronous modeling technology
   - Basic design optimization examples
   - Introduction to Finite-Element Method (FEM) with basic examples

2. Simulation-Driven Design with application to structural design (1 afternoon):
   - Coupling simulation with structural design optimization and feature-based design
   - Simulation driven design examples (single parts and assemblies)

**Lecture notes**

Handouts in the lecture

1. CAD NX:
2. CAE NX:

**Prerequisites / notice**

Max. 25 participants

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**151-0091-10L Engineering Tool IV: Scientific Writing**

All Engineering Tool courses are for MAVT-Bachelor students only.

Number of participants limited to 50.

**Abstract**

Participants acquire scientific writing basics as a core competency to communicate with different audiences. They apply important methods and tools to refine a scientific question, research and evaluate the necessary information, quote and paraphrase, and to plan the structure of their own text.

**Objective**

Students are able to
- derive and structure ideas for a text starting from a scientific question using simple techniques
- find literature sources, check their relevance and completeness, organize them with a suitable tool and cite correctly
- apply a reading technique for summarizing a text
- distinguish plagiarism, quotation and paraphrase in texts using the presented criteria and correctly cite or paraphrase external content
- use and cite information from the Internet correctly
- plan and structure specialized texts that refer to different target groups
KURSPROGRAMM

1. Halbtag: Recherchieren und Lesen
   (1) Auf Vorhandenem aufbauen
   (2) Ideen generieren
   (3) Recherchieren
   (4) Quellen beurteilen

2. Halbtag: Paraphrasieren nicht Plagiarisieren (1 Nachmittag, 3 Stunden, 15 min Pause)
   (1) Verantwortlich sein: der Wert des eigenständigen Denkens
   (2) Regeln und Anweisungen: was ist ein Plagiat, wie wird es an der ETHZ gehandhabt, Eigenständigkeitserklärung, Prüfwerkzeuge
   (3) Zitieren und Paraphrasieren - so geht’s
   (4) Paraphrasieren oder Zitieren?
   (5) Lesen und verstehen
   (6) Vom Umgang mit Quellen und Material aus dem Internet

3. Halbtag: Einen Text strukturieren und generieren
   (1) Verwendung einer Standard-Textstruktur als Vorlage für ein Outline
   (2) Ein Grundgerüst mit Abschnitten erstellen
   (3) Eine Textabschnitt schreiben

LEHRFORMEN
- Inputs: Kurzvorträge
- Übungen: während des Nachmittags selbständig in Moodle anhand von Fallstudien
- Feedback und Diskussion: Lösungen der Studierenden via Moodle an Dozentenbeamer und Besprechen durch die Dozierenden

Zu allen Inhaltsteilen gibt es Übungsteile in Moodle, für die ein Laptop mit funktionierendem Internetanschluss benötigt wird.


Literatur

Prerequisites / notice
Computer für Online-Übungen während der Veranstaltung.

<table>
<thead>
<tr>
<th>151-0062-10L</th>
<th>Engineering Tool V: Computer-Aided Design Methods W</th>
<th>0.4 credits</th>
<th>1K</th>
<th>T. Stankovic, K. Shea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of participants limited to 25. All Engineering Tool courses are for MAVT-Bachelor students only.</td>
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</tbody>
</table>

Abstract
Participants will learn about the Computer-Aided Design fundamentals and methods that are necessary to model complex technical products. The focus will be placed on feature-based and parametric modelling that is common to all modern CAD tools used in mechanical engineering design.

Objective
CAD knowledge and skills will be further developed to enable students to recognize both the advantages and the limitations of current Computer-Aided Design tools. Examples of how to build feature-based and parametric models including design automation will be given along with common pitfalls. After taking the course students should be able to independently create effective feature-based and parametric models of mechanical parts.

Content
1. CAD Methods and Feature-Based Design (2 afternoons):
   * CAD in the context of the design process
   * Feature types and their relation to mechanical design
   * Strategies for building feature-based assemblies
   * Integration of digital part libraries
   * Common issues and difficulties with feature interaction
2. CAD and Parametric Modeling (1 afternoon):
   * Designing and building parametric models
   * Design automation to create design variants
   * Common issues and difficulties with parametric modelling

Workshop Training

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0003-00L</td>
<td>Workshop Training</td>
<td>O</td>
<td>5 credits</td>
<td>external organisers</td>
<td></td>
</tr>
</tbody>
</table>

Abstract
Students are required to conduct a workshop training outside ETH Zurich for a minimum duration of five weeks. The students learn how to operate workshop equipment, and acquire first experience in the realization of an engineering project. They summarize the workshop practice in a work and project description.

Objective
The students learn how to operate workshop equipment, and acquire first experience in the realization of an engineering project.

Prerequisites / notice
The minimum duration of the workshop practice is five weeks. The practice may be done prior to the start of the study.

Laboratory Practice

Students attend at least 10 Laboratory Practices during the 4th and 5th semester. 4 of these must be Physics laboratories. All laboratory work is graded "pass" or "fail". After completion of 10 laboratory training units, 2 credit points will be issued.

Please register online at https://www.mavt.ethz.ch/praktika/index.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0029-10L</td>
<td>Laboratory Practice</td>
<td>O</td>
<td>2 credits</td>
<td>4P</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Abstract
Selected laboratory experiments in physics, mechanical and process engineering. With the Laboratory Training held during the fourth and fifth semester, the students learn how to handle and apply measurement methods and devices. Students are offered a diversified choice of laboratory experiments at least ten of which must be completed. Four of the chosen experiments must be in physics.

Objective
With the Laboratory Training held during the fourth and fifth semester, the students learn how to handle and apply measurement methods and devices.

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-MAVT.

see GESS Compulsory Electives: Type A. Enhancement of Reflection Capability
### Bachelor Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0001-10L</td>
<td>Bachelor's Thesis</td>
<td>W</td>
<td>14 credits</td>
<td>32D</td>
<td>Professors</td>
</tr>
<tr>
<td></td>
<td><em>Potential supervisors for the Bachelor's Thesis:</em></td>
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<tr>
<td></td>
<td>- All D-MAVT professors (<a href="https://www.mavt.ethz.ch/the-department/people/professors.html">https://www.mavt.ethz.ch/the-department/people/professors.html</a>)</td>
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<tr>
<td></td>
<td>- Professors in other departments who are accredited at D-MAVT (<a href="https://www.mavt.ethz.ch/the-department/people/accredited-professors.html">https://www.mavt.ethz.ch/the-department/people/accredited-professors.html</a>)</td>
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<tr>
<td></td>
<td>- D-MAVT titular professors (<a href="https://www.mavt.ethz.ch/the-department/people/titular-professors.html">https://www.mavt.ethz.ch/the-department/people/titular-professors.html</a>). For enrollment, please contact the D-MAVT Student Administration.</td>
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</tr>
<tr>
<td>Abstract</td>
<td>The bachelor's thesis is the culmination of the program. The students develop, enhance, and demonstrate their methodological abilities to independently tackle and solve a given research problem. The thesis furnishes the students with their first major research experience and is a further development of the work done in the basis courses, and usually, the focused study.</td>
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</tr>
<tr>
<td>Objective</td>
<td>The students develop, enhance and demonstrate their methodological abilities to independently tackle and solve a given research problem.</td>
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</tr>
<tr>
<td>Content</td>
<td>The topics for the bachelor's thesis are published by the professorship or they can be set in consultation between the professors and the students. Thesis projects in cooperation with the industry are also possible.</td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Supervisors should normally be part of the D-MAVT professorship or may be professors accredited by D-MAVT. The bachelor's thesis must be completed within 14 weeks, which is an equivalent half-time workload during a semester.</td>
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<table>
<thead>
<tr>
<th>Number</th>
<th>Bachelor's Thesis (Focus Spezialization Management, Technology and Economics)</th>
<th>W</th>
<th>14 credits</th>
<th>32D</th>
<th>Professors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prerequisites for the Bachelor's Thesis MTEC is the Focus Spezialization Management, Technology and Economics.</td>
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<tr>
<td>Abstract</td>
<td>The bachelor's thesis is the culmination of the program. The students develop, enhance and demonstrate their methodological abilities to independently tackle and solve a given research problem. The thesis furnishes the students with their first major research experience and is a further development of the knowledge acquired in the engineering fundamentals and the focused study.</td>
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<tr>
<td>Objective</td>
<td>The students develop, enhance and demonstrate their methodological abilities to independently tackle and solve a given research problem.</td>
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<tr>
<td>Content</td>
<td>The topics for the bachelor's thesis are defined by the professorship or can be set in consultation between the professors and the students.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Exclusively D-MAVT students who have enrolled for the focus specialization Management, Technology and Economy are eligible for this type of bachelor's thesis. Supervisors are normally part of the D-MTEC professorship. Further prerequisites have to be discussed with the responsible professor. The bachelor's thesis must be completed within 14 weeks which is an equivalent half-time workload during a semester.</td>
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### Mechanical Engineering Bachelor - Key for Type

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<thead>
<tr>
<th>Key for Type</th>
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<tr>
<td>Compulsory</td>
<td>E-</td>
<td>Z</td>
<td>Dr</td>
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<tr>
<td>Eligible for credits and recommended</td>
<td>Recommended, not eligible for credits</td>
<td>Courses outside the curriculum</td>
<td>Suitable for doctorate</td>
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<tr>
<td>Eligible for credits</td>
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### Key for Hours

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<tr>
<th>Key for Hours</th>
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<tr>
<td>Lecture</td>
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<td>R</td>
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<tr>
<td>Lecture with exercise</td>
<td>practical/laboratory course</td>
<td>independent project</td>
<td>diploma thesis</td>
<td>revision course / private study</td>
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<tr>
<td>Exercise</td>
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**ECTS**

European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
Mechanical Engineering Master

Core Courses

Energy, Flows and Processes

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0203-00L</td>
<td>Turbomachinery Design</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>R. S. Abhari, N. Chokani, B. Ribi</td>
</tr>
</tbody>
</table>

Abstract
Introduction to the understanding of a broad range of turbomachinery devices. Learn the steps of turbomachinery design.

Objective
Understand the principles, and learn the design procedures and the behaviour of turbomachines.

Content
Homo-geneous gas-phase mixtures, laminar diffusion and premixed flames. Catalytic combustion and its coupling with homogeneous combustion are dealt in detail, and turbulent combustion modeling approaches are presented. Available numerical codes will be used for modeling.

Lecture notes
Lecture notes

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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-0851-00L</td>
<td>Robot Dynamics</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>R. Siegwart, M. Hutter, K. Rudin, T. Stasny</td>
</tr>
</tbody>
</table>

Abstract
We will provide an overview on how to kinematically and dynamically model typical robotic systems such as robot arms, legged robots, rotary wing systems, or fixed wing.

Objective
The primary objective of this course is that the student deepens an applied understanding of how to model the most common robotic systems. The student receives a solid background in kinematics, dynamics, and rotations of multi-body systems. On the basis of state of the art applications, he/she will learn all new tools necessary to work in the field of design or control of robotic systems.

Content
The course consists of three parts: First, we will refresh and deepen the student’s knowledge in kinematics, dynamics, and rotations of multi-body systems. In this context, the learning material will build upon the courses for mechanics and dynamics available at ETH, with the particular focus on their application to robotic systems. The goal is to foster the conceptual understanding of similarities and differences among various types of robots. In the second part, we will apply the learned material to classical robotic arms as well as legged systems and discuss kinematic constraints and interaction forces. In the third part, focus is put on modeling fixed wing aircraft, along with related aeroelasticity and control concepts. In this context, we also touch aerodynamics and flight mechanics to an extent typically required in robotics. The last part finally covers different helicopter types, with a focus on quadrotors and the coaxial configuration which we see today in many UAV applications. Case studies on all main topics provide the link to real applications and to the state of the art in robotics.

Prerequisites / notice
The contents of the following ETH Bachelor lectures or equivalent are assumed to be known: Mechanics and Dynamics, Control, Basics in Fluid Dynamics.

Lecture notes
Lecture notes

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<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-0251-00L</td>
<td>IC-Engines and Propulsion Systems I</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>K. Boulouchos, G. Georges, P. Kyrato</td>
</tr>
</tbody>
</table>

Abstract
Introduction to basic concepts, operating maps and work processes of internal combustion engines. Thermodynamic analysis and design, scavenging methods, heat transfer mechanisms, turbulent flow field in combustion chambers, turbocharging. Energy systemic role of IC engines: conventional and electrified vehicle propulsion systems and decentralized power generation.

Objective
The students learn the basic concepts of an internal combustion engine by means of the topics mentioned in the abstract. This knowledge is applied in several calculation exercises and two lab exercises at the engine test bench. The students get an insight into practical power train systems.

Lecture notes
in English

Literature

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-0207-00L</td>
<td>Theory and Modeling of Reactive Flows</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>C. E. Frouzakis, I. Mantzaras</td>
</tr>
</tbody>
</table>

Abstract
The course first reviews the governing equations and combustion chemistry, setting the ground for the analysis of homogeneous gas-phase mixtures, laminar diffusion and premixed flames. Catalytic combustion and its coupling with homogeneous combustion are dealt in detail, and turbulent combustion modeling approaches are presented. Available numerical codes will be used for modeling.

Objective
Theory of combustion with numerical applications

Content
The analysis of realistic reactive flow systems necessitates the use of detailed computer models that can be constructed starting from first principles i.e. thermodynamics, fluid mechanics, chemical kinetics, and heat and mass transport. In this course, the focus will be on combustion theory and modeling. The reacting flow governing equations and the combustion chemistry are firstly reviewed, setting the ground for the analysis of homogeneous gas-phase mixtures, laminar diffusion and premixed flames. Heterogeneous (catalytic) combustion, an area of increased importance in the last years, will be dealt in detail along with its coupling with homogeneous combustion. Finally, approaches for the modeling of turbulent combustion will be presented. Available numerical codes will be used to compute the above described phenomena. Familiarity with numerical methods for the solution of partial differential equations is expected.

Lecture notes
Handouts

Prerequisites / notice
NEW course

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-0185-00L</td>
<td>Radiation Heat Transfer</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>A. Steinfeld, A. Z'Graggen</td>
</tr>
</tbody>
</table>

Abstract
Advanced course in radiation heat transfer

Objective
Fundamentals of radiative heat transfer for high-temperature applications. Examples are combustion and solar thermal/thermochemical processes, and other applications in the field of energy conversion and material processing.

Content


Lecture notes
Copy of the slides presented.

Literature

<table>
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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0105-00L</td>
<td>Quantitative Flow Visualization</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>T. Rösgen</td>
</tr>
</tbody>
</table>

Abstract
Learn the steps of turbomachinery design.

Objective
Understand the principles, and learn the design procedures and the behaviour of turbomachines.

Content
Homo-geneous gas-phase mixtures, laminar diffusion and premixed flames. Catalytic combustion and its coupling with homogeneous combustion are dealt in detail, and turbulent combustion modeling approaches are presented. Available numerical codes will be used for modeling.

Lecture notes
Lecture notes

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 948 of 1434
The course provides an introduction to digital image analysis in modern flow diagnostics. Different techniques which are discussed include image velocimetry, laser induced fluorescence, liquid crystal thermography and interferometry. The physical foundations and measurement configurations are explained. Image analysis algorithms are presented in detail and programmed during the exercises.

Objective
Introduction to modern imaging techniques and post processing algorithms with special emphasis on flow analysis and visualization. Understanding of hardware and software requirements and solutions. Development of basic programming skills for (generic) imaging applications.

Content
Fundamentals of optics, flow visualization and electronic image acquisition. Frequently used image processing techniques (filtering, correlation processing, FFTs, color space transforms). Image Velocimetry (tracking, pattern matching, Doppler imaging). Surface pressure and temperature measurements (fluorescent paints, liquid crystal imaging, infrared thermography). Laser induced fluorescence. (Digital) Schlieren techniques, phase contrast imaging, interferometry, phase unwrapping. Wall shear and heat transfer measurements. Pattern recognition and feature extraction, proper orthogonal decomposition.

Lecture notes
Available

Prerequisites / notice
Prerequisites: Fluidodynamics I, Numerical Mathematics, programming skills.
Language: German on request.

151-0113-00L
Applied Fluid Dynamics

Abstract
Applied Fluid Dynamics
The methods of fluid dynamics play an important role in the description of a chain of events, involving the release, spreading and dilution of dangerous fluids in the environment. Tunnel ventilation systems and strategies are studied, which must meet severe requirements during normal operation and in emergency situations (tunnel fires etc.).

Objective
Generally applicable methods in fluid dynamics and gas dynamics are illustrated and practiced using selected current examples.

Content
Often experts fall back on the methodology of fluid dynamics when involved in the construction of environmentally friendly processing and incineration facilities, as well as when choosing safe transport and storage options for dangerous materials. As a result of accidents, but also in normal operations, dangerous gases and liquids may escape and be transported further by wind or flowing water. There are many possible forms that the resulting damage may take, including fire and explosion when flammable substances are mixed. The topics covered include: Emissions of liquids and gases from containers and pipelines, evaporation from pools and vaporization of gases kept under pressure, the spread and dilution of waste gas plumes in the wind, deflagration and detonation of inflammable gases, fireballs in gases held under pressure, pollution and exhaust gases in tunnels (tunnel fires etc.).

Lecture notes
Available

Prerequisites / notice
Requirements: successful attendance at lectures "Fluidodynamik I und II", "Thermodynamik I und II"

151-1116-00L
Introduction to Aircraft and Car Aerodynamics

Abstract

Objective
An introduction to the basic principles and interrelationships of aircraft and automotive aerodynamics. To understand the basic relations of the origin of aerodynamic forces (ie lift, drag). To quantify the aerodynamic forces for basic configurations of aircraft and car components. Illustration of the intrinsic problems and results using examples.

Content

Lecture notes
1.) Grundlagen der Flugtechnik (Basics of flight science, script in german language)
2.) Einführung in die Fahrzeugaerodynamik (Introduction in car aerodynamics, script in german language)

Literature
English literature covering the content of the course:

151-0235-00L
Thermodynamics of Novel Energy Conversion Technologies

Abstract
Does not take place this semester.

Objective
In the framework of this course we will look at a broad spectrum of novel energy conversion processes which are not based on the heat-power-conversion. Especially the production of electrical energy without using mechanical work will be covered.

Content
This course deals with novel energy conversion and storage systems such as fuel cells and micro-fuel cells, batteries, hydrogen production and storage, plasmonics and photovoltaics. The focus of the course is on the physics and basic understanding of those systems as well as their real-world applications.

Part 1: Fundamentals:
- Thermodynamic overview and exergy analysis;
- Thermodynamics of multi-component-systems (mixtures) and phase equilibrium;
- Electrochemistry;

Part 2: Novel energy conversion and storage systems:
- batteries and accumulators;
- fuel cells and micro fuel cells (fundamentals, fabrication, modelling, and applications);
- hydrogen production and storage, Fuel reforming;
- Plasmonics and photovoltaics.

Lecture notes
Available (ca. 200 pages in English)

The course will be given in English:

1. Weekly exercises, each includes 1 or 2 questions which should be solved and returned at the specified due dates. Exercises count as 15% of the final grade.
2. One programming mini-project which should be finished at the specified due date. It counts as 5% of the final grade.
3. Final exam: Written exam during the regular examination session. It counts as 80% of the final grade.

151-0109-00L
Turbulent Flows

Abstract
The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern biology design project, during which the students are required to give presentations on advanced topics in synthetic biology.

Objective

- Students get an overview on energy conversion in nuclear power plants, on construction and operation of the most important types of nuclear power plants with pressurized and boiling water reactors, role and function of the most important safety systems, special features of the energy conversion.

Content

- Nuclear physics of fission and chain reaction, Thermodynamics of nuclear reactors. Design of the reactor core. Introduction into the dynamic behaviour of nuclear reactors. Overview on types of nuclear reactors, difference between thermal reactors and fast breeders. Construction and operation of nuclear power plants with pressurized and boiling water reactors, role and function of the most important safety systems.

Literature

- Dieter Smidt: Reaktortechnik, Band 1 und Band 2, G. Braun Karlsruhe, 1971

- Script is available, english slides will be distributed

151-0987-00L

Separations in Biotechnology and Bioprocess

Objective

- Students should be able to select for a given biotechnological product a suitable set of purification operations and judge on process economy.

Content

- Separations by integral part of any biotechnological process. This course aims at enabling students specifically with a chemistry/biology background to select & roughly design suitable separation processes for typical biotechnological products such as monoclonal antibodies, antibiotics, and fine chemicals and at providing a basic set of purification operations & judge on process economy.

Literature


151-0988-00L

Rate-Controlled Separations in Fine Chemistry

Objective

- The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

Content

- Identification of separation techniques that are central in the purification and downstream processing of chemicals and biopharmaceuticals. Examples from both areas illustrate the utility of the methods: 1) Liquid-liquid extraction; 2) Adsorption and chromatography; 3) Membrane processes; 4) Crystallization and precipitation.

Prerequisites / notice

- Requirements: Thermal separation Processes I (151-0926-00) and Modelling and mathematical methods in process and chemical engineering (151-0940-00)

151-0990-00L

Seminar on Advanced Separation Processes

Objective

- The students are supposed to acquire a deep understanding of the process of biological design including model representation of a biological system, its thorough analysis, and the subsequent experimental implementation of the system and the related problems.

Content

- Presentations on advanced synthetic biology topics (eg genetic circuit design, adaptation of systems dynamics, analytical concepts, large scale de novo DNA synthesis), project selection, modeling of selected biological system, design space exploration, sensitivity analysis, conversion into DNA sequence, (DNA synthesis external,) implementation and analysis of design, summary of results in form of scientific presentation and poster, presentation of results at the iGEM international student competition (www.igem.org).

Prerequisites / notice

- The final presentation of the project is typically at the MIT (Cambridge, US). Other competing schools include regularly Imperial College, Cambridge University, Harvard University, UC Berkeley, Princeton University, CalTech, etc.

Please note that the number of ECTS credits and the actual work load are disconnected.
Objective

Research seminar for master's students and doctoral students

529-0193-00L Renewable Energy Technologies I 4 credits 3G A. Wokaun, A. Steinfeld

Abstract

The lectures Renewable Energy Technologies I (529-0193-00L) and Renewable Energy Technologies II (529-0191-01L) can be taken independently from one another.

Objective

Scenarios for world energy demand and CO2 emissions, implications for climate. Methods for the assessment of energy chains. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaic electricity, solar chemistry), wind and ocean energy, heat pumps, geothermal energy, energy from waste, CO2 sequestration.

Content


Lecture notes

Lecture notes will be distributed during the course.

Literature


Prerequisites / notice

Fundamentals of chemistry and physics are a prerequisite for this course.

227-0950-00L Acoustics Z 0 credits 0.5K K. Heutschi

Abstract

Current topics in Acoustics presented mostly by external speakers from academia and industry.

Objective

Research seminar for master's students and doctoral students

151-0243-00L New Enterprises for Engineers W 4 credits 3G R. S. Abhari, A. Gawlikowska

Abstract

Transforming Needs to opportunities for new technology enterprises. - Links between entrepreneurship and product development/engineering. - Sales, marketing, financing, and growth. Detailed Plans and execution. - Survival through cash flow management.

Objective

Transforming Needs to Business Enterprises

Goals of the course:
- Propose the role of Needs-Driven Opportunities for new technology enterprises
- Explore links between entrepreneurship and engineering; such as problem solving, planning, system analysis, can-do attitude!
- Making it happen- through sales, marketing, planning, staffing, implementation, financing, and growth. Detailed Plans and execution
- Survival (and success) through cash flow management
- Explore the human issues in any new enterprise
- Alignment of interests. - Transition of enterprises along growth path
- http://www.NEFE.ethz.ch

Content

Approach:
Weekly lectures including discussions of international case studies
Exercises to develop and present modules of new plans
Extensive class interactions capped with presentation by each (group) student of new enterprise plan

Please see http://www.NEFE.ethz.ch

Lecture notes

Course material will be communicated to the students prior to the start of each class for download.

Prerequisites / notice

This course is primarily for engineering and natural science students at all levels who are interested in participating in the initiation or growth of a new enterprise. The new enterprise could be stand-alone start up or a new business unit for an existing enterprise.

The class is practical in nature but emphasizes the basic understanding of the parameters that significantly contribute to the success of a new enterprise. It will be highly interactive with special selected guests from Selected guests from; companies founder, venture capital and business angel, and large corporation executive. Class attendance and active participation is required.

151-0917-00L Mass Transfer W 4 credits 2V+2U R. Büchel, S. E. Pratsinis

Abstract

This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

Objective

This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

Content

Fick's laws; application and significance of mass transfer; comparison of Fick's laws with Newton's and Fourier's laws; derivation of Fick's law (2nd law); diffusion in dilute and concentrated solutions; rotating disk; dispersion; diffusion coefficients, viscosity and heat conduction (Pr and Sc numbers); Brownian motion; Stokes-Einstein equation; mass transfer coefficients (Nu and Sh numbers); mass transfer across interfaces; Reynolds- and Chilton-Colburn analogies for mass-, heat-, and momentum transfer in turbulent flows; film-, penetration-, and surface renewal theories; simultaneous mass, heat and momentum transfer (boundary layers); homogenous and heterogenous reversible and irreversible reactions; diffusion-controlled reactions; mass transfer and first order heterogenous reactions. Applications.

Literature


Prerequisites / notice

Three tests are offered for practicing the course material. Participation is voluntary.

151-0709-00L Stochastic Methods for Engineers and Natural Scientists, fundamentals of stochastic processes

Abstract

The course provides an introduction into stochastic methods that are applicable for example for the description and modeling of turbulent and subsurface flows. Moreover, mathematical techniques are presented that are used to quantify uncertainty in various engineering applications.

Prerequisites / notice

Fundamentals of chemistry and physics are a prerequisite for this course.

Topics are available to carry out a Project Work (Semesterarbeit) on the contents of this course.
### Objective
By the end of the course you should be able to mathematically describe random quantities and their effect on physical systems. Moreover, you should be able to develop basic stochastic models of such systems.

### Content
- Probability theory, single and multiple random variables, mappings of random variables
- Stochastic differential equations, Ito calculus, PDF evolution equations
- Polynomial chaos and other expansion methods

All topics are illustrated with application examples from engineering.

### Lecture notes
Detailed lecture notes will be provided.

### Literature
Some textbooks related to the material covered in the course:

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### 151-0911-00L Introduction to Plasmonics
**W 4 credits 2V+1U**  
D. J. Norris

#### Abstract
This course provides fundamental knowledge of surface plasmon polaritons and discusses their applications in plasmonics.

#### Objective
Electromagnetic oscillations known as surface plasmon polaritons have many unique properties that are useful across a broad set of applications in biology, chemistry, physics, and optics. The field of plasmonics has arisen to understand the behavior of surface plasmon polaritons and to develop applications in areas such as catalysis, imaging, photovoltaics, and sensing. In particular, metallic nanoparticles and patterned metallic interfaces have been developed to utilize plasmonic resonances. The aim of this course is to provide the basic knowledge to understand and apply the principles of plasmonics. The course will strive to be approachable to students from a diverse set of science and engineering backgrounds.

#### Content
- Fundamentals of Plasmonics
- Optical properties of metals
- Surface plasmon polaritons on surfaces
- Surface plasmon polariton propagation
- Localized surface plasmons

Applications of Plasmonics
- Waveguides
- Enhanced spectroscopy
- Sensing
- Metamaterials

### Literature
- Physics I, Physics II

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### 151-0213-00L Fluid Dynamics with the Lattice Boltzmann Method
**W 4 credits 3G**  
I. Karlin

#### Abstract
The course provides an introduction to theoretical foundations and practical usage of the Lattice Boltzmann Method for fluid dynamics simulations.

#### Objective
Methods like molecular dynamics, DSMC, lattice Boltzmann etc are being increasingly used by engineers all over and these methods require knowledge of kinetic theory and statistical mechanics which are traditionally not taught at engineering departments. The goal of this course is to give an introduction to ideas of kinetic theory and non-equilibrium thermodynamics with a focus on developing simulation algorithms and their realizations.

During the course, students will be able to develop a lattice Boltzmann code on their own. Practical issues about implementation and performance on parallel machines will be demonstrated hands on.

Central element of the course is the completion of a lattice Boltzmann code (using the framework specifically designed for this course).

The course will also include a review of topics of current interest in various fields of fluid dynamics, such as multiphase flows, reactive flows, microflows among others.

Optionally, we offer an opportunity to complete a project of student's choice as an alternative to the oral exam. Samples of projects completed by previous students will be made available.
The course builds upon three parts:
I Elementary kinetic theory and lattice Boltzmann simulations introduced on simple examples.
II Theoretical basis of statistical mechanics and kinetic equations.
III Lattice Boltzmann method for real-world applications.

The content of the course includes:
1. Background: Elements of statistical mechanics and kinetic theory:
   Particle’s distribution function, Liouville equation, entropy, ensembles; Kinetic theory: Boltzmann equation for rarefied gas, H-theorem, hydrodynamic limit and derivation of Navier-Stokes equations, Chapman-Enskog method, Grad method, boundary conditions; mean-field interactions, Vlasov equation;
   Kinetic models: BGK model, generalized BGK model for mixtures, chemical reactions and other fluids.

2. Basics of the Lattice Boltzmann Method and Simulations:
   Minimal kinetic models: lattice Boltzmann method for single-component fluid, discretization of velocity space, time-space discretization, boundary conditions, forcing, thermal models, mixtures.

3. Hands on:
   Development of the basic lattice Boltzmann code and its validation on standard benchmarks (Taylor-Green vortex, lid-driven cavity flow etc).

4. Practical issues of LBM for fluid dynamics simulations:
   Lattice Boltzmann simulations of turbulent flows; numerical stability and accuracy.

5. Microflow:
   Rarefaction effects in moderately dilute gases; Boundary conditions, exact solutions to Couette and Poiseuille flows; micro-channel simulations.

6. Advanced lattice Boltzmann methods:
   Entropic lattice Boltzmann scheme, subgrid simulations at high Reynolds numbers; Boundary conditions for complex geometries.

7. Introduction to LB models beyond hydrodynamics:
   Relativistic fluid dynamics; flows with phase transitions.

Lecture notes
Lecture notes on the theoretical parts of the course will be made available.
Selected original and review papers are provided for some of the lectures on advanced topics.
Handouts and basic code framework for implementation of the lattice Boltzmann models will be provided.

Prerequisite / notice
The course addresses mainly graduate students (MSc/Ph D) but BSc students can also attend.

151-0107-20L High Performance Computing for Science and Engineering (HPCSE) I

Abstract
This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.

Objective
Introduction to HPC for scientists and engineers
Fundamental of:
1. Parallel Computing Architectures
2. MultiCores
3. ManyCores

Content
Programming models and languages:
1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)

Computers and methods:
1. Hardware and architectures
2. Libraries
3. Particles: N-body solvers
4. Fields: PDEs
5. Stochastics: Monte Carlo

Lecture notes
http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1
Class notes, handouts

151-0182-00L Fundamentals of CFD Methods

Abstract
This course is focused on providing students with the knowledge and understanding required to develop simple computational fluid dynamics (CFD) codes to solve the incompressible Navier-Stokes equations and to critically assess the results produced by CFD codes. As part of the course, students will write their own codes and verify and validate them systematically.

Objective
1. Students know and understand basic numerical methods used in CFD in terms of accuracy and stability.
2. Students have a basic understanding of a typical simple CFD code.
3. Students understand how to assess the numerical and physical accuracy of CFD results.

Content
1. Governing and model equations. Brief review of equations and properties
2. Overview of basic concepts: Overview of discretization process and its consequences
3. Overview of numerical methods: Finite-difference and finite-volume methods
4. Analysis of spatially discrete equations: Consistency, accuracy, stability, convergence of semi-discrete methods
5. Time-integration methods: LMS and RK methods, consistency, accuracy, stability, convergence
6. Analysis of fully discrete equations: Consistency, accuracy, stability, convergence of fully discrete methods
7. Solution of one-dimensional advection equation: Motivation for and consequences of upwinding, Godunov's theorem, TVD methods, DRP methods
8. Solution of two-dimensional advection equation: Dimension-by-dimension methods, dimensional splitting, multidimensional methods
9. Solution of one- and two-dimensional diffusion equations: Implicit methods, ADI methods
10. Solution of one-dimensional advection-diffusion equation: Numerical vs physical viscosity, boundary layers, non-uniform grids
11. Solution of incompressible Navier-Stokes equations: Incompressibility constraint and consequences, fractional-step and pressure-correction methods
12. Solution of incompressible Navier-Stokes equations on unstructured grids

Lecture notes
The course is based mostly on notes developed by the instructor.
The goal of this course is to provide the students with a thorough understanding of the key concepts behind structural reliability and risk. This mechanical engineering course focuses on the technical aspects of wind turbines; non-technical issues are not within the scope of this technically oriented course. On completion of this course, the student shall be able to conduct the preliminary aerodynamic and structural design of the wind turbine blades. The student shall also be more aware of the broad context of drivetrains, dynamics and control, electrical systems, and meteorology, relevant to all types of wind turbines.

**Literature**

**Prerequisites / notice**
Prior knowledge of fluid dynamics, applied mathematics, basic numerical methods, and programming in Fortran and/or C++ (knowledge of MATLAB is "not" sufficient).

<table>
<thead>
<tr>
<th>Code: 151-0216-00L</th>
<th>Wind Energy</th>
<th>W</th>
<th>4 credits</th>
<th>2V+1U</th>
<th>N. Chokani</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>The objective of this course is to introduce the students to the fundamentals, technologies, modern day application, and economics of wind energy. These subjects are introduced through a discussion of the basic principles of wind energy generation and conversion, and a detailed description of the broad range of relevant technical, economic and environmental topics.</td>
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<tr>
<td><strong>Objective</strong></td>
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<td><strong>Content</strong></td>
<td>This mechanical engineering course focuses on the technical aspects of wind turbines; non-technical issues are not within the scope of this technically oriented course. On completion of this course, the student shall be able to conduct the preliminary aerodynamic and structural design of the wind turbine blades. The student shall also be more aware of the broad context of drivetrains, dynamics and control, electrical systems, and meteorology, relevant to all types of wind turbines.</td>
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</table>

<table>
<thead>
<tr>
<th>Code: 151-0368-00L</th>
<th>Aeroelasticity</th>
<th>W</th>
<th>4 credits</th>
<th>2V+1U</th>
<th>F. Campanile</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>Introduction to the basics and methods of Aeroelasticity. An overview of the main static and dynamic phenomena arising from the interaction between structural and aerodynamic loads.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>The course will give you a physical basic overview of current-structure phenomena. Furtermore you will get to know the most important phenomena in the statistical and dynamical aerelastic as well as an introduction to the methods for mathematical descriptions and for the wording of quantitative forecasts.</td>
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</table>

**Literature**
www.structures.ethz.ch/education/master/ Intro/ compulsory/aeroelasticity

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 954 of 1434
Content

Engineers are confronted every day to decision making under limited amount of information and uncertain conditions. When designing new structures and systems, the design codes such as SIA or Euro-codes usually provide a framework that guarantees safety and reliability. However, the level of safety is not quantified explicitly, which does not allow the analyst to properly choose between design variants and evaluate a total cost in case of failure. In contrast, the framework of risk analysis allows one to incorporate the uncertainty in decision making.

The first part of the course is a reminder on probability theory that is used as a main tool for reliability and risk analysis. Classical concepts such as random variables and vectors, dependence and correlation are recalled. Basic statistical inference methods used for building a probabilistic model from the available data, e.g. the maximum likelihood method, are presented.

The second part is related to structural reliability analysis, i.e. methods that allow one to compute probabilities of failure of a given system with respect to prescribed criteria. The framework of reliability analysis is first set up. Reliability indices are introduced together with the first order-second moment method (FOSM) and the first order reliability method (FORM). Methods based on Monte Carlo simulation are then reviewed and illustrated through various examples. By-products of reliability analysis such as sensitivity measures and partial safety coefficients are derived and their links to structural design codes is shown. The reliability of structural systems is also introduced as well as the methods used to reassess existing structures based on new information.

The third part of the course addresses risk assessment methods. Techniques for the identification of hazard scenarios and their representation by fault trees and event trees are described. Risk is defined with respect to the concept of expected utility in the framework of decision making. Elements of Bayesian decision making, i.e. pre-, post and pre-post risk assessment methods are presented. Bayesian networks are introduced as a generic numerical tool for solving such problems. The course also includes a tutorial using a software dedicated to real world structural reliability analysis.

Literature


Prerequisites / notice

Basic course on probability theory and statistics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0317-00L</td>
<td>Visualization, Simulation and Interaction - Virtual Reality II</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>A. Kunz</td>
</tr>
<tr>
<td>151-0349-00L</td>
<td>Fatigue Strength of Materials, Components and Structures</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>M. Guillaume, R. E. Koller</td>
</tr>
</tbody>
</table>

Abstract

This lecture provides deeper knowledge on the possible applications of virtual reality, its basic technology, and future research fields. The goal is to provide a strong knowledge on Virtual Reality for a possible future use in business processes.

Virtual Reality can not only be used for the visualization of 3D objects, but also offers a wide application field for small and medium enterprises (SME). This could be for instance an enabling technology for net-based collaboration, the transmission of images and other data, the interaction of the human user with the digital environment, or the use of augmented reality systems.

The goal of the lecture is to provide a deeper knowledge of today's VR environments that are used in business processes. The technical background, the algorithms, and the applied methods are explained more in detail. Finally, future tasks of VR will be discussed and an outlook on ongoing international research is given.

Introduction into Virtual Reality; basics of augmented reality; interaction with digital data, tangible user interfaces (TUI); basics of simulation; compression procedures of image-, audio-, and video signals; new materials for force feedback devices; introduction into data security; cryptography; definition of free-form surfaces; digital factory; new research fields of virtual reality

Prerequisites:

"Visualization, Simulation and Interaction - Virtual Reality I" is recommended.

Didactical concept:
The course consists of lectures and exercises.
Content

1. INTRODUCTION, OVERVIEW, MOTIVATION
1.1 Preface (General introduction and history survey) (Schijve; Chapter 1)
1.2 Standards and Guidelines
1.3 Examples of damage events Comet-Accident (Pressure cycles, stress concentration)
Accident of an aerial passenger tramway (Fretting corrosion on axle)
Aloha-Incident at Hawaii (Multiple site damage)
ICE-Accident (Wheel failure)
1.4 Presentations
DVD "MTW Materialermüdung (1995, 21')",
DVD "F/A-18 Full Scale Fatigue Test (2004, 12')",
DVD "Sicherheit von Seilbahnen (1996, 7')" with discussion

2. LOADING
2.1 Fatigue strength overview
2.2 Significance of operational loading
2.3 Types of load histories (Schijve; Chapter 9)
2.4 Terms and definitions (Schijve; Chapter 9)
2.5 Measurement of operational loadings (Schijve; Chapter 9)
2.6 Counting algorithms (Schijve; Chapter 9)
2.7 Frequency distributions or spectra (Schijve; Chapter 9)
2.8 Impact of spectrum shape
2.9 Design Spectra (Schijve; Chapter 13)

3. MATERIAL
3.1 Fatigue strength overview
3.2 Evaluation of material properties for cyclic loading (Schijve; Chapter 13)
3.3 Fatigue properties (Schijve; Chapter 6)
3.4 Wöhler-Diagram (Schijve; Chapter 6, 7)
3.5 Scatter of fatigue properties (Schijve; Chapter 12)
3.6 Mean stress effect (Schijve; Chapter 6)
3.7 Damage mechanisms & material selection (Schijve; Chapter 2)
3.8 Environmental effects (Schijve; Chapter 16, 17)
3.9 Specific fatigue properties (Schijve; Chapter 6)

4. STRUCTURAL COMPONENT
4.1 Fatigue strength overview
4.2 Notches (Schijve; Chapter 3, 7)
4.3 Residual stresses (Schijve; Chapter 4)
4.4 Size effect
4.5 Surface condition and surface layers (Schijve; Chapter 7, 14)
4.6 Fretting corrosion (Schijve; Chapter 15)
4.7 Summary of fatigue strength improving methods (Schijve; Chapter 14)

5. SAFETY FACTORS (Schijve; Chapter 19)

6. FATIGUE STRENGTH ASSESSMENT
6.1 Fatigue strength overview
6.2 Assessment concepts for fatigue lifetime prediction
6.3 Assessment of the endurance strength
6.4 Finite life fatigue strength assessment using the nominal stress concept (Schijve; Chapter 10)
6.5 Local stress-strain concept (Schijve; Chapter 10)
6.6 Fracture mechanics concept (Schijve; Chapter 5, 8, 11)
6.7 Accuracy of concepts for fatigue lifetime assessment

7. STRUCTURAL INTEGRITY CONCEPTS
7.1 Safe life design (Mirage III, Pressure Vessel)
7.2 Fail safe design (modern aircraft construction)
7.3 Damage tolerance (approach according to US Air Force)
7.4 F/A-18 design philosophy
7.5 Summary

8. EXPERIMENTAL FATIGUE STRENGTH
8.1 In case of interesting current tests laboratory visitation at Empa

Lecture notes
All lecture chapters are on Powerpoint presentations. The chapters will be available as presentation handouts at the first day for a fee of CHF 20.-

Literature
Recommended books as supplement to the lecture:

Schijve, Jaap
Fatigue of Structures and Materials

Broek, David
The Practical Use of Fracture Mechanics

Prerequisites / notice
Depending on actual fatigue tests a Laboratory visitation at Empa in Dübendorf may be organized.

151-0353-00L Mechanics of Composite Materials W 4 credits 2V+1U G. Kress
Abstract
The course Mechanics of Composite Materials is dedicated to modeling problems following from the complex mechanical behavior of these anisotropic material structures. and modeling of continuous fibre reinforced composites. Participants will be able to design parts for the mechanical, automotive and aerospace industry.

Objective
Understanding of the mechanical properties of fiber reinforced composites with regard to analysis and design of lightweight structures for mechanical, transportation and aerospace applications.
Students learn the basic principles governing the propagation of waves in discrete and continuum solid media. These methods can be used to study the propagation of waves in materials, including the analysis of wave behavior in structures and the potential for wave propagation in different media.

Cable cars and cable cranes: Construction methods and areas of application. The use of mechanical principles in system engineering, Swiss building and business regulations, planning and equipment with special consideration for business and the environment: steel cables (construction, evaluation, damage, inspection), drive mechanisms, brakes, vehicles, construction over an extended area. Calculation of the supporting cable with weight strain and with fixed mountings on both sides. Excursions.

The lectures with related exercises offer an excellent opportunity to apply the learned theoretical basic principles of mechanics and engineering in plant construction. Not only the function and resistance of individual components will be studied, but also complex interactions, which are imperative for the safe and smooth running of the equipment. It also includes the teaching of the basics of project planning and design, as well as the evaluation of systems in a distinctly interdisciplinary manner. For the manufacturer of a cable car, installation the integration of sub-assemblies making use of very different technologies always poses a particular challenge. For this reason, the methodology for the handling of these typical engineering assignments is important and makes up a significant part of the lecture content.

The course will cover the basic principles of wave propagation in periodic media. It will discuss the fundamental principles used to describe linear and nonlinear wave propagation in continuum and discrete media. Selected recent scientific advancements in the dynamics of periodic media will also be discussed.

Rehab. Engineering is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.

The lecture material is covered by the script and further literature is referenced in there.
Content

Introduction, problem definition, overview
Rehabilitation of visual function
- Anatomy and physiology of the visual sense
- Technical aids (glasses, sensor substitution)
- Retina and cortex implants
Rehabilitation of hearing function
- Anatomy and physiology of the auditory sense
- Hearing aids
- Cochlea Implants
Rehabilitation and use of kinesthetic and tactile function
- Anatomy and physiology of the kinesthetic and tactile sense
- Tactile/haptic displays for motion therapy (incl. electrical stimulation)
- Role of displays in motor learning
Rehabilitation of vestibular function
- Anatomy and physiology of the vestibular sense
- Rehabilitation strategies and devices (e.g. BrainPort)
Rehabilitation of vegetative Functions
- Cardiac Pacemaker
- Phrenic stimulation, artificial breathing aids
- Bladder stimulation, artificial sphinter
Brain stimulation and recording
- Deep brain stimulation for patients with Parkinson, epilepsy, depression
- Brain-Computer Interfaces

Literature
Introductory Books:

Prerequisites / notice
Target Group:
- Students of higher semesters and PhD students of
  - D-MAVT, D-ITET, D-INFK, D-HEST
- Biomedical Engineering, Robotics, Systems and Control
- Medical Faculty, University of Zurich
Students of other departments, faculties, courses are also welcome

151-0535-00L Optical Methods in Experimental Mechanics  W  4 credits  3G  E. Hack, R. Brönnimann
Abstract
The lecture introduces a variety of optical methods to assess the mechanical behaviour of a structure, to determine material parameters, or to validate results from FE analysis. Focus is on camera-based techniques for deformation, strain and stress analysis. Applications and limitations will be thoroughly discussed. The lecture includes two afternoons of hands-on experience at Empa (Dübendorf).

Objective
The students are able to describe simple optical set-ups and image formation by using a camera system. They understand the working principle of various camera-based techniques for shape, deformation and strain measurement. Most notably they can explain how the measurement is transformed into an interference signal, a change of polarization or temperature, or a different signal modulation. They know the main application fields of the individual techniques. They are able to choose the most appropriate technique for solving a measurement task and to estimate its expected resolution. Through the hands-on experience the students gain a deeper and sustained understanding of the theoretical content by applying the theoretical foundations to dedicated measurement tasks.

Content
After an introduction into optics and image acquisition the lecture explains how to transform mechanical quantities such as strain, stress or deformation into an image content. Imaging optical measurement techniques for deformation and strain analysis make use of a variety of optical principles:
- Triangulation (Digital Image Correlation, Fringe Projection),
- Interference (Speckle Pattern Interferometry, Shearography),
- Diffraction (Moiré-Interferometry, Fiber Bragg Gratings),
- Birefringence (Photelasticity)
- Infrared radiation (Thermal Stress Analysis)

In addition, dynamic measurements and vibration analysis are explained in the context of modal analysis or transient events. The calibration of imaging optical methods and their application to the validation of numerical simulations are described.

The content is structured as follows:
1. Imaging methods: an introduction
2. Digital Image Correlation
3. White light moire methods
4. Interferometry
5. Deformation analysis: Speckle pattern interferometry
6. Strain analysis: Shearography
7. Modal analysis
8. Measurement of transient deformations
9. Stress analysis: Photoelasticity
10. Stress analysis: Thermoelasticity
11. Validation of FEA results and calibration of optical full-field methods
12. Fibre based methods

The lecture includes two afternoons of laboratory experience at Empa, where the student will take the first steps with optical methods.

Hands-on experience includes e.g. Digital Image Correlation, Speckle pattern interferometry, Thermal Stress Analysis, Fibre optic sensors, Fringe projection, depending on availability of the equipment and the interest of the students.

Lecture notes
Copies of the slides will be made available on-line through ILIAS. A private blog will stimulate the discussion on lecture and exercises.

Literature
A good overview on the optical methods is presented in the following text books:

- (available on-line through NEBIS)

Prerequisites / notice
Basic knowledge of optics and interferometry as taught in basic physics courses are advantageous but not compulsory.

Every week exercises will be made available. Solving is warmly recommended but voluntary.

The two afternoons with hands-on experience, however, are central elements of the lecture.

151-0573-00L System Modeling W 4 credits 2V+2U G. Ducard, C. Onder

Abstract

Objective
Introduction to system modeling for control. Analysis and optimization of linear and nonlinear systems. Parameter identification. Case studies.

Content
Introduction to generic system modeling approaches for control-oriented models based on first principles and on experimental data. Examples: mechatronic, energy, and process engineering systems. Model scaling, linearization, order reduction, and balancing. Planning of experiments, estimation techniques for "gray-box" models (linear and nonlinear least-squares methods). The exercises are solved in teams. One larger case study is to be solved.

Lecture notes
The handouts in English will be sold in the first lecture.

Literature
A list of references is included in the handouts.

151-0703-00L Operational Simulation of Production Lines W 4 credits 2V+1U P. Acél

Abstract
The student learns the application of the event-driven and computer-based simulation for layout and operational improvement of production facilities by means of practical examples.

Objective
The student learns the right use of (Who? When? How?) of the event-driven and computer-based simulation in the illustration of the operating procedures and the production facilities. Operating simulation in the productions, logistic and scheduling will be shown by means of practical examples. The student should make his first experiences in the use of computer-based simulation.

Content
- Application and application areas of the event-driven simulation
- Exemplary application of a software tool (Technomatix-Simulation-Software)
- Internal organisation and functionality of simulation tools
- Procedure for application: optimizing, experimental design planning, analysis, data preparation
- Controlling philosophies, emergency concepts, production in sequence, line production, rescheduling
- Application on the facilities projecting

Lecture notes
The knowledge is enhanced by practice-oriented exercises and an excursion. A guest speaker will present a practical example.
151-0705-00L Manufacturing I

**Prerequisites / notice**
Recommmended for all Bachelor-Students in the 5th semester and Master-Students in the 7th semester.

**W** 4 credits 2V+2U

**K. Wegener, M. Boccadore, F. Kuster**

**Abstract**

**Objective**
Deepened discussion on the machining processes and their optimisation. Outlook for additional areas such as NC-Technique, dynamics of processes and machines, chatter as well as process monitoring.

**Content**
Deepened insight in the machining processes and their optimization, chip removal by undefined cutting edge, such as grinding, honing and lapping, machining processes without cutting edges, such as EDM, ECM, outlook in additional areas as NC-technique, machine- and process dynamics including cutting and process monitoring.

**Lecture notes**
yes

**Prerequisites / notice**
Prerequisites: Recommendation: Lecture 151-0700-00L Manufacturing elective course in the 4th semester.

**Language**
Help for English speaking students on request as well as english translations of slides shown.

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151-0771-00L Forming Technology I - Basic Knowledge

**Prerequisites / notice**

**W** 4 credits 2V+1U

**F. Kuster, V. H. Derflinger, F. Durand, P. Jousset**

**Abstract**
Understanding the complexity of the assembly process as well as its meaning as success and cost factor. The assembly with the different aspects of adding, moving, adjusting, controlling parts etc. Adding techniques; solvable and unsolvable connections. Assembly plants. Coating techniques and their tasks, in particular corrosion protection.

**Objective**
To understand assembly in its full complexity and its paramount importance regarding cost and financial success. An introduction into a choice of selected joining and coating techniques.

**Content**
Assembly as combination of several classes of action like, e.g., joining, handling, fine adjustments, etc. Techniques for joining objects temporarily or permanently. Assembly systems. Coating processes and their specific applications, with particular emphasis on corrosion protection.

**Lecture notes**
yes

**Prerequisites / notice**
Recommended to the focus production engineering.

**Majority of lecturers from the industry.**

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151-0719-00L Quality of Machine Tools - Dynamics and Metrology at Micro and Submicro Level

**Prerequisites / notice**
Documents are provided during the course. English handouts available on request.

**W** 4 credits 2V+1U

**W. Knapp, F. Kuster**

**Abstract**
The course "Machine tool metrology" deals with the principal design of machine tools, their spindles and linear axes, with possible geometric, kinematic, thermal and dynamic errors of machine tools and testing these errors, with the influence of errors on the workpiece (error budgeting), with testing of drives and numerical control, as well as with checking the machine tool capability.

**Objective**
Knowledge of
- principal design of machine tools
- errors of linear and rotational axes and of machine tools,
- influence of errors on the workpiece (error budgeting)
- dynamics of mechanical systems
- geometric, kinematic, thermal, dynamic testing of machine tools
- uncertainty
- machine tool capability

**Content**
Metrology for production, machine tool metrology
- basics, like principal machine tool design and machine tool coordinate system
- principal design and errors of linear and rotational axes
- error budgeting, influence of machine errors on the workpiece
- geometric and kinematic testing of machine tools
- reversal, measurement techniques, multi-dimensional machine tool metrology
- thermal influences on machine tools and testing these influences
- test uncertainty, simulation
- dynamics of mechanical systems, dynamic error sources
- machine tool dynamics and the engineering tools modal analysis and finite element method (FEM)
- testing of drives and numerical control
- machine tool capability

**Lecture notes**
Exercises in the laboratories and with the machine tools of the institute for machine tools and manufacturing (IWF) provide the practical background for this course.

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151-0721-00L Production Machines II

**Prerequisites / notice**

**W** 4 credits 2V+1U

**K. Wegener, F. Kuster, S. Weikert**

**Abstract**
Control, closed loop control, processing of geometrical data, main drives, noise, flexibility, rationalization and automation, modern machine concepts, thermal and dynamic behavior.

**Objective**
Deeper competence for evaluation and development of production machines, sensitization for unconventional kinematics with their advantages and drawbacks.

**Content**
Control (PLC, NC), closed loop control, processing of geometrical data, main drives, noise emission, flexibility, rationalization and automation, modern machine concepts like high speed machines, alternative kinematics, ultraprecision machines, thermal and dynamic behavior of machine tools, flexibility, rationalization and automation, practical case studies

**Lecture notes**
yes

**Prerequisites / notice**
Help for English speaking students on request.

**Parts of the lecture are held in english.**

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151-0731-00L Forming Technology I - Basic Knowledge

**Prerequisites / notice**

**W** 4 credits 2V+2U

**P. Hora**

**Abstract**
The fundamentals of forming technology are presented to Mechanical, Production and Material Engineers. The content of the lecture is:
Overview of manufacturing with forming technologies, deformation specific description of material properties and their experimental measurement, material laws, residual stresses, heat balance, tribological aspects of forming processes, workpiece and tool failure.

**Objective**
Forming technology represents with its 70% global share in manufactured metal volume with respect to yield and cost, the most important manufacturing process in metal-working industries. Typical applications of forming technology range from the manufacturing of sheet metal components in auto bodies to applications in food and pharma packaging, fabrication of implants in medical technologies and to the fabrication of leads in microelectronic components. This course introduces the fundamentals which are essential to evaluate metal-forming processes and its industrial applications. This includes, together with the acquisitions of the most important forming processes, the characterization of plastic behavior and manufacturing.

**Content**
Overview of the most important processes of metal-forming technology and its field of applications, characterization of the plastic metal-forming behavior, basic principles of plasto-mechanical calculations, metal-forming residual stresses, thermo-mechanical coupling of metal-forming processes, influence of tribology. Work piece failure through cracking and folding, tool failure through rupture and mechanical wear, metal-forming tools, sheet forming and massive forming processes, handling systems, metal-forming machinery.
<table>
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<th>Lecture notes</th>
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<tbody>
<tr>
<td><strong>151-0733-00L</strong></td>
<td><strong>Forming Technology III - Forming Processes</strong></td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>The lecture teaches on the basic knowledge of major processes in sheet metal, tube and bulk metal forming technologies. In particular it focuses on fundamental computation methods, which allow a fast assessment of process behaviour and a rough layout. Process-specific states of stress and deformation are analysed and process limits are identified.</td>
</tr>
<tr>
<td><strong>Objective</strong></td>
<td>Acquaintance with forming processes. Determination of forming processes. Interpretation of forming manufacturing conditions and instability of structures. The principles of the nonlinear Finite-Element-Method (FEM) will be introduced in the scope of this lecture for treating such problems.</td>
</tr>
<tr>
<td><strong>Content</strong></td>
<td>- General forming processes - Elasto-plastic material models - Updated-Lagrange (UL), Euler and combined Euler-Lagrange (ALE) approaches - FEM implementation of constitutive equations - Element formulations - Implicit and explicit FEM methods - FEM formulations of coupled thermo-mechanical problems - Modeling of tool contact and the influence of friction - Solvers and convergence - Modeling of crack propagation - Introduction of advanced FE-Methods</td>
</tr>
<tr>
<td><strong>Lecture notes</strong></td>
<td>yes</td>
</tr>
<tr>
<td><strong>Literature</strong></td>
<td>Bathe, K. J., Finite-Element-Procedures, Prentice-Hall, 1996</td>
</tr>
<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>If we will have a large number of students, two dates for the exercises will be offered.</td>
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<tr>
<td><strong>151-0833-00L</strong></td>
<td><strong>Principles of Nonlinear Finite-Element-Methods</strong></td>
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<tr>
<td><strong>Abstract</strong></td>
<td>Most problems in engineering are of nonlinear nature. The nonlinearities are caused basically due to the nonlinear material behavior, contact conditions and instability of structures. The principles of the nonlinear Finite-Element-Method (FEM) will be based on explicit and implicit formulations. Typical applications of the nonlinear Finite-Element-Methods are simulations of:</td>
</tr>
<tr>
<td><strong>Objective</strong></td>
<td>Special attention will be paid to the modeling of the nonlinear material behavior, thermo-mechanical processes and processes with large plastic deformations. The ability to independently create a virtual model which describes the complex non linear systems will be acquired through accompanying exercises. These will include the Matlab programming of important model components such as constitutive equations</td>
</tr>
<tr>
<td><strong>Content</strong></td>
<td>- Fundamentals of continuum mechanics to characterize large plastic deformations - Elasto-plastic material models - Updated-Lagrange (UL), Euler and combined Euler-Lagrange (ALE) approaches - FEM implementation of constitutive equations - Element formulations - Implicit and explicit FEM methods - FEM formulations of coupled thermo-mechanical problems - Defining of tool contact and the influence of friction - Solvers and convergence - Modeling of crack propagation - Introduction of advanced FE-Methods</td>
</tr>
<tr>
<td><strong>Lecture notes</strong></td>
<td>yes</td>
</tr>
<tr>
<td><strong>Literature</strong></td>
<td></td>
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<td><strong>Prerequisites / notice</strong></td>
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<tr>
<td><strong>227-0447-00L</strong></td>
<td><strong>Image Analysis and Computer Vision</strong></td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Light and perception. Digital image formation. Image enhancement and feature extraction. Unitary transformations. Color and texture. Image segmentation and deformable shape matching. Motion extraction and tracking. 3D data extraction. Invariant features. Specific object recognition and object class recognition.</td>
</tr>
<tr>
<td><strong>Objective</strong></td>
<td>Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.</td>
</tr>
<tr>
<td><strong>Content</strong></td>
<td>The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the properties of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and detect specific features. Finally, the course will end by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.</td>
</tr>
<tr>
<td><strong>Lecture notes</strong></td>
<td>Course material Script, computer demonstrations, exercises and problem solutions</td>
</tr>
<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C. The course language is English.</td>
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<tr>
<th>Lecture notes</th>
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<tr>
<td><strong>252-0535-00L</strong></td>
<td><strong>Machine Learning</strong></td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.</td>
</tr>
<tr>
<td><strong>Objective</strong></td>
<td>Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.</td>
</tr>
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</table>
## Content
The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:

- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher’s LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non-parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

## Literature
- W. Court, Mechanical Behaviour of Materials, McGraw-Hill
- H. Rentschler, Introduction to Dislocations, Cambridge University Press
- S. Ghosh, Applications of Dislocations, Chapman & Hall
- N. P. Chatterjee, Modern Concepts of Fracture, Holt, Rinehart and Winston
- R. Spolenak, Dislocation Theory, Springer

## Prerequisites / notice
Solid basic knowledge in analysis, statistics and numerical methods for CSE. Experience in programming for solving the project tasks.

## Lecture notes
No lecture notes, but slides will be made available on the course webpage.

## Prerequisites / notice
No lecture notes, but slides will be made available on the course webpage.

## Prerequisites / notice
No lecture notes, but slides will be made available on the course webpage.

## 252-0543-01L
### Computer Graphics

<table>
<thead>
<tr>
<th>W</th>
<th>6 credits</th>
<th>3V+2U</th>
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<tbody>
<tr>
<td>M. Gross, O. Sorkine Hornung, J. Novak</td>
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</table>

### Abstract
This course covers some of the fundamental concepts of computer graphics, namely 3D object representations and generation of photorealistic images from digital representations of 3D scenes.

### Objective
At the end of the course the students will be able to build a rendering system. The students will study the basic principles of rendering and image synthesis. In addition, the course is intended to stimulate the students' curiosity to explore the field of computer graphics in subsequent courses or on their own.

### Content
This course covers fundamental concepts of modern computer graphics. Students will learn about 3D object representations and the details of how to generate photorealistic images from digital representations of 3D scenes. Starting with an introduction to 3D shape modeling and representation, texture mapping and ray-tracing, we will move on to acceleration structures, the physics of light transport, appearance modeling and global illumination principles and algorithms. We will end with an overview of modern image-based image synthesis techniques, covering topics such as lightfields and depth-image based rendering.

### Lecture notes
No lecture notes, but slides will be made available on the course webpage.

### Literature

### Prerequisites / notice
Fundamentals of calculus and linear algebra, basic concepts of algorithms and data structures, programming skills in C++, Visual Computing course recommended.

The programming assignments will be in C++. This will not be taught in the class.

## 325-0501-00L
### Metals I

<table>
<thead>
<tr>
<th>W</th>
<th>3 credits</th>
<th>2V+1U</th>
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<tbody>
<tr>
<td>R. Spolenak</td>
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</table>

### Abstract
Repetition and advancement of dislocation theory. Mechanical properties of metals: hardening mechanisms, high temperature plasticity, alloying effects. Case studies in alloying to illustrate the mechanisms.

### Objective
Repetition and advancement of dislocation theory. Mechanical properties of metals: hardening mechanisms, high temperature plasticity, alloying effects. Case studies in alloying to illustrate the mechanisms.

### Content
Dislocation theory:
- Properties of dislocations, motion and kinetics of dislocations, dislocation-dislocation and dislocation-boundary interactions, consequences of partial dislocations, sessile dislocations
- Hardening theory:
  - a. solid solution hardening: case studies in copper-nickel and iron-carbon alloys
  - b. particle hardening: case studies on aluminium-copper alloys
- High temperature plasticity:
  - thermally activated glide
  - power-law creep
  - diffusion creep: Coble, Nabarro-Herring deformation mechanism maps
- Case studies in turbine blades
- Superplasticity
- Alloying effects

### Lecture notes
https://www.met.mat.ethz.ch/education/lect_scripts

### Literature
- Gottstein, Physikalische Grundlagen der Materialkunde, Springer Verlag
- Rössler/Harders/Bäker, Mechanisches Verhalten der Werkstoffe, Teubner Verlag
- Porter/Easterling, Transformations in Metals and Alloys, Chapman & Hall
- Hull/Bacon, Introduction to Dislocations, Butterworth & Heinemann
- Courtney, Mechanical Behaviour of Materials, McGraw-Hill

## 327-4101-00L
### Durability of Engineering Materials

<table>
<thead>
<tr>
<th>W</th>
<th>2 credits</th>
<th>2G</th>
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<td>M. Diener</td>
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### Abstract
Basics of fracture mechanics, an engineering discipline that draws upon the principles of applied mechanics and materials science. The course gives the tools to a successful application of fracture mechanics concepts to failure analysis.

### Objective
The students should know the possibilities and limitations of the use of standard materials as well as get an idea of new innovative development to prevent failure problems. It is an introduction to the field of fracture mechanics, an engineering discipline that draws upon the principles of applied mechanics and materials science. Cracks and crack-like defects are evaluated with a view to understanding and predicting the cracks’ growth tendencies. Such growth may be either stable (relatively slow and safe) or unstable (instantaneous and catastrophic). The course gives the tools to a successful application of fracture mechanics concepts to failure analysis.
Crack-flaws cannot be neglected in engineering analysis. Even microscopic crack flaws can grow over time, ultimately resulting in fractured components. Structures that may have been blindly deemed "safe" could fail disastrously, causing injuries to its users, or the loss of life. Fracture mechanics can be used to:

* Determine how large a crack can be in a structure before it leads to catastrophic failure
* Predict the rate at which a crack can approach a critical size due to fatigue loads or aggressive environmental conditions

The topics covered are

* Introduction to Linear Elastic Fracture Mechanics (LEFM); crack tip stress, strain and displacement fields in linear elastic materials (Modes I, II and III); the stress-intensity factor, K; the fracture toughness Klc and their determination; fracture criterion
* Estimates of crack plastic zones in ductile materials
* The compliance method; experimental determination of compliance
* Introduction to fracture mechanics of nonlinear materials: the J-integral; the Jlc fracture criterion; Jlc testing
* Application of fracture mechanics concepts in the analysis of subcritical crack growth (fatigue, stress corrosion cracking, creep and their combinations)
* Lifetime determination and prediction; failure analysis.

Lecture notes
Copy of the overheads

Literature
K.H. Schwalbe, Bruchmechanik, Carl Hanser Verlag

<table>
<thead>
<tr>
<th>363-0445-00L</th>
<th>Logistics, Operations and Supply Chain Management I W</th>
<th>3 credits</th>
<th>2G</th>
<th>P. Schönleben, E. Scherer Casanova</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>An effective and efficient flow of goods, data, and control in and between companies contributes significantly to the value added for the customer. Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Strategic and tactical concepts in logistics, operations, and supply chain management; conflicts of objectives and strategies and in the entrepreneurial context; business process analysis and fundamental logistics concepts; the MRP II / ERP concept; business processes and methods; the lean / just-in-time and repetitive manufacturing; concepts for product families and one-of-a-kind production; concepts for the process industry.</td>
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This book also serves as textbook for LOS II (spring term) as well as ERP and SCM software systems (autumn term). In addition powerpoint-handouts and documents for case studies.

<table>
<thead>
<tr>
<th>363-0541-00L</th>
<th>Systems Dynamics and Complexity</th>
<th>W</th>
<th>3 credits</th>
<th>F. Schweitzer, P. Mavrodiev</th>
</tr>
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<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>Finding solutions: what is complexity, problem solving cycle.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Implementing solutions: project management, critical path method, quality control feedback loop.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Controlling solutions: Vensim software, feedback cycles, control parameters, instabilities, chaos, oscillations and cycles, supply and demand, production functions, investment and consumption</td>
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<td>A successful participant of the course is able to:</td>
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<td>- understand why most real problems are not simple, but require solution methods that go beyond algorithmic and mathematical approaches</td>
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<td>- calculate project schedules according to the critical path method</td>
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<td>- setup and run systems dynamics models by means of the Vensim software</td>
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<td>- apply the problem solving cycle as a systematic approach to identify problems and their solutions</td>
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<td>- analyse the stability of nonlinear dynamical systems and apply this to macroeconomic dynamics</td>
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<td></td>
<td>Why are problems not simple? Why do some systems behave in an unintended way? How can we model and control their dynamics? The course provides answers to these questions by using a broad range of methods encompassing systems oriented management, classical systems dynamics, nonlinear dynamics and macroeconomic modeling.</td>
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<td>The course is structured along three main tasks:</td>
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<td></td>
<td>1. Finding solutions</td>
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<td>2. Implementing solutions</td>
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<td></td>
<td>3. Controlling solutions</td>
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PART 1 introduces complexity as a system immanent property that cannot be simplified. It introduces the problem solving cycle, used in systems oriented management, as an approach to structure problems and to find solutions.

PART 2 discusses selected problems of project management when implementing solutions. Methods for identifying the critical path of subtasks in a project and for calculating the allocation of resources are provided. The role of quality control as an additional feedback loop and the consequences of small changes are discussed.

PART 3, by far the largest part of the course, provides more insight into the dynamics of existing systems. Examples come from biology (population dynamics), management (inventory modeling, technology adoption, production systems) and economics (supply and demand, investment and consumption). For systems dynamics models, the software program VENSIM is used to evaluate the dynamics. For economic models analytical approaches, also used in nonlinear dynamics and control theory, are applied. These together provide a systematic understanding of the role of feedback loops and instabilities in the dynamics of systems. Emphasis is on oscillating phenomena, such as business cycles and other life cycles.

**Lecture notes**
The lecture slides are provided as handouts - including notes and literature sources - to registered students only. All material is to be found on the Moodle platform. More details during the first lecture.
Self-study tasks (discussion exercises, Vensim exercises) are provided as home work. Weekly exercise sessions (45 min) are used to discuss selected solutions. Regular participation in the exercises is an efficient way to understand the concepts relevant for the final exam.

### 351-0555-00L Open- and User Innovation

**Abstract**
The course introduces the students to the long-standing tradition of actively involving users of technology and other knowledge-intensive products in the development and production process, and through own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies.

**Objective**
The course includes both lectures and exercises alternately. The goal is to understand the opportunity of user innovation for management and develop strategies to harness the value of user-developed ideas and contributions for firms and other organizations.

The students actively participate in discussions during the lectures and contribute presentations of case studies during the exercises. The combination should allow to compare theory with practical cases from various industries.

The course presents and builds upon recent research and challenges the students to devise innovation strategies that take into account the availability of user expertise, free and public knowledge, and the interaction with communities that span beyond one organization.

**Prerequisites / notice**

**Content**
Grading is based on the final exam, the class presentations (including the slides) as well as class participation.

This course on user innovation extends courses on knowledge management and innovation as well as marketing. The students are introduced to the long-standing tradition of actively involving users of technology and other knowledge-intensive products in the development and production process, and through own cases they develop an entrepreneurial understanding of product development under distributed, user-centered, or open innovation strategies. Theoretical underpinnings taught in the course include models of innovation, the structuration of technology, and an introduction to entrepreneurship.

**Lecture notes**
The slides of the lectures are made available and updated continuously through the SMI website:

**Literature**
Relevant literature for the exam includes the slides and the reading assignments. The corresponding papers are either available from the author online or distributed during class.

Reading assignments: please consult the SMI website:

### 363-0711-00L Accounting for Managers

**Abstract**
Overview of financial and managerial accounting
Accounting for current and fixed assets
Liabilities and owners equity
Recording change in balance sheet
Measuring financial performance
Managing financial reporting
Full and variable costing system
Using accounting information for decision making purposes

**Objective**
Understand the different procedures involved in the accounting system
Record change in financial position
Measure business income
Prepare final accounts
Understand the principles of cost accounting
Calculate the different product costs
Make decisions about the acceptance or rejection of a particular product

**Content**
Financial Accounting: Balance sheet, income statement, double-entry accounting, journal and ledger, accounting for merchandising activities, value-added tax, adjustments before final accounts, provisions, depreciation, valuation,

Managerial Accounting: Full costing, variable costing, cost-volume-profit, break-even analysis, activity-based costing

**Prerequisites / notice**
This course is a prerequisite for the course Financial Management.

### 401-0647-00L Introduction to Mathematical Optimization

**Abstract**
Introduction to basic techniques and problems of mathematical optimization.

**Objective**
The goals is to get a good understanding of some of the most important mathematical optimization techniques used to solve linear programs and basic combinatorial optimization problems.

**Content**
Topics covered in this course include:
- Linear programming (simplex method, duality theory, shadow prices, ...).
- Basic combinatorial optimization problems (spanning trees, network flows, knapsack problem, ...).

**Literature**
Information about relevant literature will be given in the lecture.

**Prerequisites / notice**
This course is meant for students who did not already attend the course "Mathematical Optimization", which is a more advance lecture covering similar topics and more.

### 401-5640-00L ZüKoSt: Seminar on Applied Statistics

**Abstract**
About 5 talks on applied statistics.

**Objective**
See how statistical methods are applied in practice.

**Content**
There will be about 5 talks on how statistical methods are applied in practice.

**Prerequisites / notice**
This is no lecture. There is no exam and no credit points will be awarded. The current program can be found on the web: http://stat.ethz.ch/events/zukost

Course language is English or German and may depend on the speaker.

### 401-5650-00L Zurich Colloquium in Applied and Computational Mathematics

**Abstract**
Research colloquium

### 151-0917-00L Mass Transfer

**Abstract**
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.
Objective
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

Content
Fick's laws; application and significance of mass transfer; comparison of Fick's laws with Newton's and Fourier's laws; derivation of Fick's 2nd law; diffusion in dilute and concentrated solutions; rotating disk; dispersion; diffusion coefficients, viscosity and heat conduction (Pr and Sc numbers); Brownian motion; Stokes-Einstein equation; mass transfer coefficients (Nu and Sh numbers); mass transfer across interfaces; Reynolds- and Chilton-Colburn analogies for mass-, heat-, and momentum transfer in turbulent flows; film-, penetration-, and surface renewal theories; simultaneous mass, heat and momentum transfer (boundary layers); homogenous and heterogenous reversible and irreversible reactions; diffusion-controlled reactions; mass transfer and first order heterogenous reaction. Applications.

Literature

Prerequisites / notice
Three tests are offered for practicing the course material. Participation is voluntary.

151-0723-00L Manufacturing of Electronic Devices W 4 credits 3G A. Kunz, A. Guber, R.D. Morson, F. Reichert

Abstract
The lecture follows the value added process sequence of electric and electronic components. It contains: Development of electric and electronic circuits, design of electronic circuits on printed circuit boards as well as in hybrid technology, integrated test technology, planning of production lines, production of highly integrated electronic on a wafer as well as recycling.

Objective
Knowledge about the value added process sequence for electronics manufacturing, planning of electric and electronic product as well as their production, planning of production lines, value added process sequence for photovoltaics.

Content
Nothing works without electronics! Typical products in mechanical engineering such as machine tools, as well as any kind of vehicle contain a significant amount of electric or electronic components of more than 60%. Thus, it is important to master the value added process sequence for electric and electronic components.

The lecture starts with a brief introduction of electronic components and the planning of integrated circuits. Next, an overview will be provided about electronic functional units assembled from these electronic components, on printed circuit boards as well as in hybrid technology. Value added process steps are shown as well as their quality check and their combination for planning a complete manufacturing line. The lecture further describes the manufacturing of integrated circuits, starting from the wafer via the structuring and bonding to the packaging. As an example, the manufacturing of micro-electromechanic and electro-optical systems and actuators is described. Due to similar processes in the electronic production, the value added process sequence for photovoltaics will described too.

The lecture concludes with an excursion to a large manufacturing company. Here, students can the see the application and realization of the manufacturing of electric and electronic devices.

Lecture notes
Lecture notes are handed out during the individual lessons (CHF 20.-).

Help for English speaking students on request.

The lecture is partly given by experts from industry. It is supplemented by an excursion to one of the industry partners.

363-0445-02L Logistics, Operations, and Supply Chain Management W 1 credit 2A P. Schönsleben

I (Additional Cases)

Abstract
Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.

Objective
An effective and efficient flow of goods, data, and control in and between companies contributes significantly to the value added for the customer. Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.

151-0550-00L Adaptive Materials for Structural Applications W 4 credits 3G A. Bergamini

Abstract
Adaptive materials offer appealing ways to extend the design space of structures by introducing time-variable properties into them. In this course, the physical working principles of selected adaptive materials are analyzed and simple models for describing their behavior are presented. Some applications are illustrated, also with laboratory experiments where possible.

Objective
The study of adaptive materials covers topics that range from chemistry to theoretical mechanics.

Content
The aim of this course is to convey knowledge about adaptive materials, their properties and the physical mechanisms that govern their function, so as to develop the skills to deal with this interdisciplinary subject.

This course will provide the students with an insight into the properties and physical phenomena which lead to the features of adaptive materials. Starting from chemomechanical (skeletal muscles), the physical behavior of a wide range of adaptive materials, thermo- and photo-mechanical, electro-mechanical, magneto-mechanical and meta-materials will be thoroughly discussed and analyzed. Up-to-date results on their performance and their implementation in mechanical structures will be detailed and studied in laboratory sessions. Analytical tools and energy based considerations will provide the students with effective instruments for understanding adaptive materials and assess their performance when integrated in structures or when arranged in particular fashions.

Basic concepts: Power conjugated variables, dissipative effects, geometry- and materials-based energy conversion


Thermo-mechanical coupling: Shape memory alloys / polymers
Electromechanical coupling(1): DEA, EBL, electromechanical fluids
Shape control / morphing: Use, requirements, challenges
Morphing applications of variable stiffness structures: Lab work
Electromechanical coupling (2): Piezoelectric, electrostrictive effect
Vibration Reduction: Measurement, passive, semi-active (active) damping methods
Vibration reduction applications of piezoelectric materials: Lab work
Metamaterials: Definition of metamaterials - electromagnetic, acoustical and other metamaterials
Magneto-mechanical coupling: Magnetostrictive effect, mSMA, magnetothermoelectrical fluids, ferrofluids
Energy harvesting and sensing: Energy harvesting with EAP and piezoelectric materials, transducers as sensors: Piezo, resistive,...

Lecture notes
Lecture notes (manuscript and handouts) will be provided.

151-0107-20L High Performance Computing for Science and W 4 credits 4G P. Koumoutsakos, M. Troyer
Engineering (HPCSE) I

Abstract
This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.

Objective
Introduction to HPC for scientists and engineers
Fundamental of:
1. Parallel Computing Architectures
2. MultiCores
3. ManyCores

Content
Programming models and languages:
1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)

Computers and methods:
1. Hardware and architectures
2. Libraries
3. Particles: N-body solvers
4. Fields: PDEs
5. Stochastics: Monte Carlo

Lecture notes
http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1
Class notes, handouts

Skills for Creativity and Innovation
W 4 credits 3G  I. Goller, C. Kobe, M. Meboldt

Abstract
This lecture aims to enhance the knowledge and competency of students regarding their innovation capability. An overview on prerequisites of and different skills for creativity and innovation in individual & team settings is given. The focus of this lecture is clearly on building competencies - not just acquiring knowledge.

Objective
- Basic knowledge about creativity and skills
- Knowledge about individual prerequisites for creativity
- Development of individual skills for creativity
- Knowledge about teams
- Development of team-oriented skills for creativity
- Knowledge and know-how about transfer to idea generation teams

Content
Basic knowledge about creativity and skills:
- Introduction into creativity & innovation: definitions and models

Knowledge about individual prerequisites for creativity:
- Personality, motivation, intelligence

Development of individual skills for creativity:
- Focus on creativity as problem analysis & solving
- Individual skills in theoretical models
- Individual competencies: exercises and reflection

Knowledge about teams:
- Definitions and models
- Roles in innovation processes

Development of team-oriented skills for creativity:
- Idea generation and development in teams
- Cooperation & communication in innovation teams

Knowledge and know-how about transfer to idea generation teams:
- Self-reflection & development planning
- Methods of knowledge transfer

Lecture notes
Slides, script and other documents will be distributed via moodle.ethz.ch (access only for students registered to this course)

Literature
Please refer to lecture script.

Colloquium on Manufacturing Technology
W 4 credits 3K  K. Wegener, F. Kuster

Abstract
Future training on selected current topics of the manufacturing technology. Per afternoon a selected topic is presented in several lectures, by the majority by experts from the industry. The students prepare a summary of the lectures given and prepare themselves on the basis of these lectures and own information search.

Objective
Continuous further training to current topics of the manufacturing technique. Exchange of experience and knowledge with the industry and other universities.

Content
Selected actual topics on manufacturing methods and tools, machine tools, NC-control and drives, components and measuring methods and devices. Topics are changing every year.

Lecture notes
no Script

Prerequisites / notice
- Students must have participated and passed the courses Manufacturing, Production Machines I and Forming Technology III - Forming Processes.
- Further training with specialized lectures and large participation from the industry.

Language: Help for English speaking students on request.

Aeroelasticity
W 4 credits 2V+1U  F. Campanile

Abstract
Introduction to the basics and methods of Aeroelasticity. An overview of the main static and dynamic phenomena arising from the interaction between structural and aerodynamic loads.

Objective
The course will give you a physical basic overview of current-structure phenomena. Furthermore you will get to know the most important phenomena in the statistical and dynamical aeroelastic as well as an introduction to the methods for mathematical descriptions and for the wording of quantitative forecasts.
Content

Ruderwirkung und -umkehr. Auswirkung der Flügelbegehung auf statische aeroelastische Phänomene.
Grundelemente der instationären Aerodynamik.
Einführung in die Modalanalyse
Einführung in weitere Phänomene der dynamischen Aeroelastik.
Weitere Informationen unter: www.structures.ethz.ch/education/master/intro/compulsory/aeroelasticity

Literature


376-1177-00L Human Factors I W 2 credits 2V M. Menozzi Jäckli, R. Boutellier, R. Huang, M. Siegrist

Abstract

Every day humans interact with various systems. Strategies of interaction, individual needs, physical & mental abilities, and system properties are important factors in controlling the quality and performance in interaction processes. In the lecture, factors are investigated by basic scientific approaches. Discussed topics are important for optimizing people's satisfaction & overall performance.

Objective

The goal of the lecture is to empower students in better understanding the applied theories, principles, and methods in various applications. Students are expected to learn about how to enable an efficient and qualitatively high standing interaction between human and the environment, considering costs, benefits, health, and safety as well. Thus, an ergonomic design and evaluation process of products, tasks, and environments may be promoted in different disciplines. The goal is achieved in addressing a broad variety of topics and embedding the discussion in macroscopic factors such as the behavior of consumers and objectives of economy.

Content

- Physiological, physical, and cognitive factors in sensation and perception
- Experimental techniques in assessing human performance and well-being
- Human factors and ergonomics in system designs, product development and innovation
- Human information processing and biological cybernetics
- Interaction among consumers, environments, behavior, and tasks

Literature


151-0511-00L Mechanics of Nano- and Micro-Materials W 4 credits 2V+1U C. Daraio

Abstract

Does not take place this semester.

The course provides an introduction to the mechanics of nano- and micro-materials and devices, in the quasistatic and dynamic domains. It reviews scale effects in materials, surveys available characterization techniques and describes the effects of surfaces and microscale contacts. Recent applications of nano- and micro-materials in engineering systems will be discussed.

Objective

Explore applications and devices exploiting the response of materials at small scales.

Content

Follows soon

Lecture notes

Slides and notes from the course will be provided.

Literature

Relevant articles and reading materials will be provided. Various books will be recommended pertaining to the topics covered.

Prerequisites / notice

Mechanics I, II, III

151-3203-00L Grand Challenges in Engineering Design W 1 credit 3S P. Ermanni, M. Meboldt, K. Shea

Abstract

The course is structured in three main blocks, each of them addressing a specific grand challenge in engineering design. Each block is composed of an introductory lecture and two to three invited talks, considering a good mix between speakers coming from academia and industry. Each talk is introduced and moderated by the students.

Objective

The aim of the course is to introduce students to the engineering design research and practice in a multitude of Mechanical Engineering disciplines and convey knowledge from both academia and industry about state of the art methods, tools and processes.

Content

The students are exposed to a variety of topics in the field of Engineering Design. Topics are bundled in three main grand challenges and include an introductory lecture held by one of the responsible Professors and 2-3 invited talks of 45 min. each, addressing specific issues. The success of the course is largely dependant on active involvement of the students. Accordingly, a small group of students (1-3) is asked to introduce and moderate each external talk. The group will therefore gather adequate information about the speaker and topic, read and synthesize relevant documents and scientific papers, prepare questions to motivate the interaction with the audience and summarize, at the end of the lecture, the discussed points and outcome.

Prerequisites / notice

Offered in English and German

151-0765-00L Leading and Coaching Focus Project Teams (Basic Course) W 0 credits 1.5G+0.5A R. P. Haas, I. Goller

Abstract

This course is the first part of a two-semester course.

The course "Leading and Coaching Focus Project Teams (Basic Course)" for Autumn Semester is examined together with the course "Leading and Coaching Focus Project Teams (Advanced Course)" for Spring Semester with 4 ECTS.

Objective

Aim is enhancement of knowledge and competency regarding coaching skills. Participants should be coaches of focus projects. Topics: Overview of the role and mind set of a coach as, introduction into coaching methodology, building competencies by doing and exchanging good practices from former focus projects.

Basic knowledge about role and mindset of a coach;
Knowledge and reflection about the classical problems in coaching of a focus project;
Development of personal coaching skills;
Knowledge and know-how about coaching methods;
Reflection and exchange of experiences about personal coaching situations;
Inspiration and learning from good cases regarding organizational and team management aspects.
Topics that will be covered include: Uncertainty quantification under the course will teach fundamental concepts of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.


2. Einfache generalisierte Kraftgesetze: Generalisierte Kraft und Kraftrichtung, einfache Kraftgesetze, Zerlegung mengenwertiger Kraftgesetze in Upr- und Sgn-Grundelemente, Parallel- und Reihenschaltung von Grundelementen, geometrische und kinematische Stufenbindung und einseitige Bindung, einseitiger Kontakt, Freilauf, Reibung, vorgespannte Federn


4. Stoßfreie Bewegung: Kraftgesetze auf Lage-, Geschwindigkeits- und Beschleunigungsebene, lineares Komplementaritätsproblem und quadratisches Programm zur Bestimmung der Richtungsbeschleunigungen

5. Stoßfreie Bewegung bei Coulombreibung: Kontaktmodell, Anwendung der stoßfreien Bewegung auf Coulombreibung, Sätze zur Eindeutigkeit und Existenz, Systeme mit gleitenden Kontakten, Freilauf, Reibung, vorgespannte Federn


Prerequisites / notice
Participants (Students, PhD Students, Postdocs) should be part of the coaching team of focus project teams.

The course "Leading and Coaching Focus Project Teams (Basic Course)" (HS) is examined together with "Leading and Coaching Focus Project Teams (Advanced Course)" (FS) in FS with 4 ECTS.

151-0104-00L Uncertainty Quantification for Engineering & Life Sciences W 4 credits 3G J. Beck, P. Koumoutsakos

Abstract
Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

Objective
The course will teach fundamental concepts of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

Content
Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Lecture notes
Slides, script and other documents will be distributed via electronically (access only for participants registered to this course).

Literature
Please refer to lecture script.

Prerequisites / notice

151-0536-00L Dynamics of Structure-Variant Systems W 4 credits 2V+1U C. Glocker

Abstract
Contents: inequality problems in dynamics, in particular friction and impact problems: discontinuities in velocity and acceleration, accumulation points, combinational problems, set-valued constitutive laws, unilateral contacts, spray clutches, friction, pre-stressed springs, impact equations and impact laws, linear complementarity, quadratic optimization.

Objective
The lecture provides the students an introduction to modern methods for inequality problems in dynamics. The contents of the lecture are fitted to frictional contact problems in mechanics, but can be transferred to a large class of inequality problems in technical sciences. The purpose of the lecture is to acquaint the students with a consistent generalization of classical mechanics towards systems with discontinuities, and to make them familiar with inequalities treated as set-valued constitutive laws.

Content
1. Einführende Beispiele: Mengenwertige und regulisierte Kenlinien für Reibung und einseitige Kontakte, eindimensionales lineares Komplementaritätsproblem, Eindeutigkeits- und Existenzprobleme bei Coulombreibung am Beispiel, Geschwindigkeits- und Beschleunigungssprünge, Häufungspunkte von Unstetigkeiten, kombinatorische Probleme in der Dynamik

2. Einfache generalisierte Kraftgesetze: Generalisierte Kraft und Kraftrichtung, einfache Kraftgesetze, Zerlegung mengenwertiger Kraftgesetze in Upr- und Sgn-Grundelemente, Parallel- und Reihenschaltung von Grundelementen, geometrische und kinematische Stufenbindung und einseitige Bindung, einseitiger Kontakt, Freilauf, Reibung, vorgespannte Federn


4. Stoßfreie Bewegung: Kraftgesetze auf Lage-, Geschwindigkeits- und Beschleunigungsebene, lineares Komplementaritätsproblem und quadratisches Programm zur Bestimmung der Richtungsbeschleunigungen

5. Stoßfreie Bewegung bei Coulombreibung: Kontaktmodell, Anwendung der stoßfreien Bewegung auf Coulombreibung, Sätze zur Eindeutigkeit und Existenz, Systeme mit gleitenden Kontakten, Minimalkoordinaten und Gleitreibung

6. Stoßfreie Bewegung bei Coulombreibung: Kontaktmodell, Anwendung der stoßfreien Bewegung auf Coulombreibung, Sätze zur Eindeutigkeit und Existenz, Systeme mit gleitenden Kontakten, Minimalkoordinaten und Gleitreibung

Lecture notes

Prerequisites / notice
Railway Vehicle Dynamics

**Abstract**

After an introduction to the railway vehicle design, the modelling of the contact between wheel and rail, and the building of a simulation model and the fundamentals of the track guiding will be explained. The applications of simulations in the development of railway vehicles will be presented and illustrated on examples.

**Objective**

Development of the theoretical basics regarding the track guiding and the vehicle running dynamics. Understanding the background of multi-body dynamics simulation tools and their application in the development of railway vehicles.

**Content**

- Use of multi-body simulations in the railway vehicle industry, simulation programmes.
- Vehicle model: Modelling of coil springs, rubber to metal springs, air springs and suspension components with friction.
- Wheel/rail contact: Contact geometry, contact area, normal forces, tangential forces.
- Track models. Modelling of track irregularities.
- Linearization of the contact geometry wheelset-track.
- Fundamentals of track guiding.
- Eigenbehaviour, calculation of eigenvalues.
- Linearised and nonlinear calculation of running stability: Methods and assessment criteria. Influence of vehicle design on the running stability.
- Ride comfort assessment.
- Testing and simulations for the acceptance of running characteristics of railway vehicles. Validation of simulation models for the application in context of vehicle acceptance.

**Lecture notes**

Script will be provided.

**Prerequisites / notice**

Fundamentals of mechanics and physics.

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Railway Systems I

**Abstract**

Basic characteristics of railway vehicles and their interfaces with the railway infrastructure:

- Transportation tasks and vehicle types
- Running dynamics
- Mechanical part of rail vehicles
- Brakes
- Traction chain and auxiliary supply
- Railway power supply
- Signalling systems
- Traffic control and maintenance

**Objective**

- Overview of the technical characteristics of railway systems
- Know-how about the design and construction principles of rail vehicles
- Interrelationship between different fields of engineering sciences (mechanics, electro and information technology, transport systems)
- Understanding tasks and opportunities of engineers working in an environment which has strong economical and political boundaries
- Insight into the activities of the railway vehicle industry and railway operators in Switzerland
- Motivation of young engineers to start a career in the railway industry or with railway operators

**Content**

EST I (Frühjahrsemester) - Begriffen, Grundlagen, Merkmale

1 Einführung:
  1.1 Geschichte und Struktur des Bahnsystems
  1.2 Fahrdynamik

2 Vollbahnfahrzeuge:
  2.1 Mechanik: Kasten, Drehgestelle, Lauftechnik, Adhäsion
  2.2 Bremsen
  2.3 Traktionsantriebssysteme
  2.4 Hilfsbetriebe und Komfortanlagen
  2.5 Steuerung und Regelung

3 Infrastruktur:
  3.1 Fahrweg
  3.2 Bahnstromversorgung
  3.3 Sicherungsanlagen

4 Betrieb:
  4.1 Interoperabilität, Normen und Zulassung
  4.2 RAMS, LCC
  4.3 Anwendungsebeispiele

Voraussichtlich ein oder zwei Gastreferate

Geplante Exkursionen:

- Betriebszentrale SBB, Zürich Flughafen
- Reparatur und Unterhalt, SBB Zürich Altstetten
- Fahrzeugfertigung, Stadler Bussnang

**Lecture notes**

Abgabe der Unterlagen (gegen eine Schutzgebühr) zu Beginn des Semesters. Rechtzeitig eingeschriebene Teilnehmer können die Unterlagen auf Wunsch und gegen eine Zusatzgebühr auch in Farbe beziehen.

**Prerequisites / notice**

Dozent:

Dr. Markus Meyer, Emkamatik GmbH

Voraussichtlich ein oder zwei Gastvorträge von anderen Referenten.

EST I (Herbstsemester) kann als in sich geschlossene einsemestrige Vorlesung besucht werden. EST II (Frühjahrssemester) dient der weiteren Vertiefung der Fahrzeugtechnik und der Integration in die Bahninfrastruktur.

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Microscale Acoustofluidics

**Abstract**

In this lecture the basics as well as practical aspects (from modelling to design and fabrication) are described from a solid and fluid mechanics perspective with applications to microsystems and lab on a chip devices.

**Objective**

Understanding acoustophoresis, the design of devices and potential applications

**Content**

- Linear and nonlinear acoustics, foundations of fluid and solid mechanics and piezoelectricity, Gorkov potential, numerical modelling, acoustic streaming, applications from ultrasoronic microrobotics to surface acoustic wave devices
Various books will be recommended covering the topics discussed in class.

**151-0735-00L**

**Dynamic Behavior of Materials and Structures**

**Abstract**
Lectures and computer labs concerned with the modeling of the deformation response and failure of engineering materials (metals, polymers and composites) subject to extreme loadings during manufacturing, crash, impact and blast events.

**Objective**
Students will learn to apply, understand and develop computational models of a large spectrum of engineering materials to predict their dynamic deformation response and failure in finite element simulations. Students will become familiar with important dynamic testing techniques to identify material model parameters from experiments. The ultimate goal is to provide the students with the knowledge and skills required to engineer modern multi-material solutions for high performance structures in automotive, aerospace and naval engineering.

**Content**
Topics include viscoelasticity, temperature and rate dependent plasticity, dynamic brittle and ductile fracture; impulse transfer, impact and wave propagation in solids; computational aspects of material model implementation into hydrocodes; simulation of dynamic failure of structures.

**Lecture notes**
Slides of the lectures, relevant journal papers and users manuals will be provided.

**Literature**
Various books will be recommended covering the topics discussed in class.

**Prerequisites / notice**
Course in continuum mechanics (mandatory), finite element method (recommended)

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### Robotics, Systems and Control

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>376-1279-00L</td>
<td>Virtual Reality in Medicine</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>R. Rienner, M. Harders</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>Virtual Reality has the potential to support medical training and therapy. This lecture will derive the technical principles of multi-modal (audiovisual, haptic, tactile etc.) input devices, displays and rendering techniques. Examples are presented in the fields of surgical training, intra-operative augmentation, and rehabilitation. The lecture is accompanied by practical courses and excursions.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Provide theoretical and practical knowledge of new principles and applications of multi-modal simulation and interface technologies in medical education, therapy, and rehabilitation.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Virtual Reality has the potential to provide descriptive and practical information for medical training and therapy while relieving the patient and/or the physician. Multi-modal interactions between the user and the virtual environment facilitate the generation of high-fidelity sensory impressions, by using not only visual and auditory modalities, but also kinesthetic, tactile, and even olfactory feedback. On the basis of the existing physiological constraints, this lecture will derive the technical requirements and principles of multi-modal input devices, displays, and rendering techniques. Several examples are presented that are currently being developed or already applied for surgical training, intra-operative augmentation, and rehabilitation. The lecture will be accompanied by several practical courses on graphical and haptic display devices as well as excursions to facilities equipped with large-scale VR equipment.</td>
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<td><strong>Prerequisites / notice</strong></td>
<td>The course language is English. Basic experience in Information Technology and Computer Science will be of advantage. More details will be announced in the lecture.</td>
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| 151-0563-01L    | Dynamic Programming and Optimal Control    | W    | 4    | 3G    | R. D’Andrea                           |
| **Abstract**    | Introduction to Dynamic Programming and Optimal Control. |
| **Objective**   | Covers the fundamental concepts of Dynamic Programming & Optimal Control. |
| **Content**     | Dynamic Programming Algorithm; Deterministic Systems and Shortest Path Problems; Infinite Horizon Problems, Bellman Equation; Deterministic Continuous-Time Optimal Control. |
| **Prerequisites / notice** | Requirements: Knowledge of advanced calculus, introductory probability theory, and matrix-vector algebra. |

| 151-0567-00L    | Engine Systems                             | W    | 4    | 3G    | C. Onder                              |
| **Abstract**    | Introduction to current and future engine systems and their control systems |
| **Objective**   | Introduction to methods of control and optimization of dynamic systems. Application to real engines. Understand the structure and behavior of drive train systems and their quantitative descriptions. |
| **Content**     | Physical description and mathematical models of components and subsystems (mixture formation, load control, supercharging, emissions, drive train components, etc.). Case studies of model-based optimal design and control of engine systems with the goal of minimizing fuel consumption and emissions. |
| **Prerequisites / notice** | Combined homework and testbench exercise (air-to-fuel-ratio control or idle-speed control) in groups |

| 151-0569-00L    | Vehicle Propulsion Systems               | W    | 4    | 3G    | C. Onder, P. Elbert                   |
| **Abstract**    | Introduction to current and future propulsion systems and the electronic control of their longitudinal behavior |
| **Objective**   | Introduction to methods of system optimization and controller design for vehicles. Understanding the structure and working principles of conventional and new propulsion systems. Quantitative descriptions of propulsion systems. |
| **Content**     | Understanding of physical phenomena and mathematical models of components and subsystems (manual, automatic and continuously variable transmissions, energy storage systems, electric drive trains, batteries, hybrid systems, fuel cells, road/wheel interaction, automatic braking systems, etc.). Presentation of mathematical methods, CAE tools and case studies for the model-based design and control of propulsion systems with the goal of minimizing fuel consumption and emissions. |

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Data: 06.02.2019 13:00  Autumn Semester 2015  Page 970 of 1434
### 151-0573-00L System Modeling

**Abstract**
Generic modeling approaches for control-oriented models based on first principles, Lagrangian formalism and experimental data. Model parameterization, planning of experiments, linear and nonlinear estimation techniques for “gray-box” models. Analysis of linear systems, model scaling, linearization, order reduction, and balancing. Analysis of nonlinear models.

**Objective**
Introduction to system modeling for control. Analysis and optimization of linear and nonlinear systems. Parameter identification. Case studies.

**Content**
Introduction to generic system modeling approaches for control-oriented models based on first principles and on experimental data. Examples: mechatronic, energy, and process engineering systems. Model scaling, linearization, order reduction, and balancing. Planning of experiments, estimation techniques for “gray-box” models (linear and nonlinear least-squares methods). The exercises are solved in teams. One larger case study is to be solved.

**Lecture notes**
The handouts in English will be sold in the first lecture. A list of references is included in the handouts.

**Literature**
Lectures of Dr. Ch. Onder are also possible to be held in German.

### 151-0593-00L Embedded Control Systems

**Abstract**
This course provides a comprehensive overview of embedded control systems. The concepts introduced are implemented and verified on a microprocessor-controlled haptic device.

**Objective**
Familiarize students with main architectural principles and concepts of embedded control systems.

**Content**
An embedded system is a microprocessor used as a component in another piece of technology, such as cell phones or automobiles. In this intensive two-week block course the students are presented the principles of embedded digital control systems using a haptic device as an example for a mechatronic system. A haptic interface allows for a human to interact with a computer through the sense of touch.

Subjects covered in lectures and practical lab exercises include:
- The application of C-programming on a microprocessor
- Digital I/O and serial communication
- Quadrature decoding for wheel position sensing
- Queued analog-to-digital conversion to interface with the analog world
- Pulse width modulation
- Timer interrupts to create sampling time intervals
- System dynamics and virtual worlds with haptic feedback
- Introduction to rapid prototyping

**Lecture notes**
Lecture notes, lab instructions, supplemental material

**Prerequisites / notice**
Prerequisite courses are Control Systems I and Informatics I.

This course is restricted to 33 students due to limited lab infrastructure. Interested students please contact Marianne Schmid (E-Mail: schmid@idsc.mavt.ethz.ch)

After your reservation has been confirmed please register online at www.mystudies.ethz.ch.

Detailed information can be found on the course website http://www.idsc.ethz.ch/education/lectures/embedded-control-systems.html

### 151-0601-00L Theory of Robotics and Mechatronics

**Abstract**
This course provides an introduction and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. Its a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.

**Objective**
Robotics is often viewed from three perspectives: perception (sensing), manipulation (affecting changes in the world), and cognition (intelligence). Robotic systems integrate aspects of all three of these areas. This course provides an introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. This course is a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.

**Content**

<table>
<thead>
<tr>
<th>Lecture notes</th>
<th>Notice</th>
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<tr>
<td>available</td>
<td>The course will be taught in English.</td>
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</table>

### 376-1219-00L Rehabilitation Engineering II: Rehabilitation of Sensory and Vegetative Functions

**Abstract**
Rehab Engineering is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.

**Objective**
Provide knowledge on the anatomy and physiology of the human sensory system, related dysfunctions and pathologies, and how rehabilitation engineering can provide sensory restoration and substitution.
Content
Introduction, problem definition, overview
Rehabilitation of visual function
- Anatomy and physiology of the visual sense
- Technical aids (glasses, sensor substitution)
- Retina and cortex implants
Rehabilitation of hearing function
- Anatomy and physiology of the auditory sense
- Hearing aids
- Cochlea Implants
Rehabilitation and use of kinesthetic and tactile function
- Anatomy and physiology of the kinesthetic and tactile sense
- Tactile/haptic displays for motion therapy (incl. electrical stimulation)
- Role of displays in motor learning
Rehabilitation of vestibular function
- Anatomy and physiology of the vestibular sense
- Rehabilitation strategies and devices (e.g. BrainPort)
Rehabilitation of vegetative Functions
- Cardiac Pacemaker
- Phrenic stimulation, artificial breathing aids
- Bladder stimulation, artificial sphincter
Brain stimulation and recording
- Deep brain stimulation for patients with Parkinson, epilepsy, depression
- Brain-Computer Interfaces

Literature
Introductory Books:

Selected Journal Articles and Web Links:

Prerequisites / notice

| 151-0851-00L | Robot Dynamics | W | 4 credits | 2V+1U | R. Siegwart, M. Hutter, K. Rudin, T. Staastny |

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 972 of 1434
The primary objective of this course is that the student deepens an applied understanding of how to model the most common robotic systems. The student receives a solid background in kinematics, dynamics, and rotations of multi-body systems. On the basis of state of the art applications, he/she will learn all necessary tools to work in the field of design or control of robotic systems.

The course consists of three parts: First, we will refresh and deepen the student’s knowledge in kinematics, dynamics, and rotations of multi-body systems. In this context, the learning material will build upon the courses for mechanics and dynamics available at ETH, with the particular focus on the application to robotic systems. The goal is to foster the conceptual understanding of similarities and differences among the various types of robots. In the second part, we will apply the learned material to classical robotic arms as well as legged systems and discuss kinematic constraints and interaction forces. In the third part, focus is put on modeling fixed wing aircraft, along with related design and control concepts. In this context, we also touch aerodynamics and flight mechanics to an extent typically required in robotics. The last part finally covers different helicopter types, with a focus on quadrotors and the coaxial configuration which we see today in many UAV applications. Case studies on all main topics provide the link to real applications and to the state of the art in robotics.

The lecture will be taught in English. The contents of the following ETH Bachelor lectures or equivalent are assumed to be known: Mechanics and Dynamics, Control, Basics in Fluid Dynamics.

Prerequisites / notice
The contents of the following ETH Bachelor lectures or equivalent are assumed to be known: Mechanics and Dynamics, Control, Basics in Fluid Dynamics.

Abstract
We will provide an overview on how to kinematically and dynamically model typical robotic systems such as robot arms, legged robots, rotary wing systems, or fixed wing.

Objective
The primary objective of this course is that the student deepens an applied understanding of how to model the most common robotic systems. The student receives a solid background in kinematics, dynamics, and rotations of multi-body systems. On the basis of state of the art applications, he/she will learn all necessary tools to work in the field of design or control of robotic systems.

Content
The course consists of three parts: First, we will refresh and deepen the student's knowledge in kinematics, dynamics, and rotations of multi-body systems. In this context, the learning material will build upon the courses for mechanics and dynamics available at ETH, with the particular focus on the application to robotic systems. The goal is to foster the conceptual understanding of similarities and differences among the various types of robots. In the second part, we will apply the learned material to classical robotic arms as well as legged systems and discuss kinematic constraints and interaction forces. In the third part, focus is put on modeling fixed wing aircraft, along with related design and control concepts. In this context, we also touch aerodynamics and flight mechanics to an extent typically required in robotics. The last part finally covers different helicopter types, with a focus on quadrotors and the coaxial configuration which we see today in many UAV applications. Case studies on all main topics provide the link to real applications and to the state of the art in robotics.

Prerequisites / notice
The contents of the following ETH Bachelor lectures or equivalent are assumed to be known: Mechanics and Dynamics, Control, Basics in Fluid Dynamics.

227-0225-00L Linear System Theory

Abstract
The class is intended to provide a comprehensive overview of the theory of linear dynamical systems, their use in control, filtering, and estimation and their applications to areas ranging from avionics to systems biology.

Objective
By the end of the class students should be comfortable with the fundamental results in linear system theory and the mathematical tools used to derive them.

Content
- Rings, fields and linear spaces, normed linear spaces and inner product spaces.
- Ordinary differential equations, existence and uniqueness of solutions.
- Continuous and discrete time, time varying linear systems. Time domain solutions. Time invariant systems treated as a special case.
- Controllability and observability, canonical forms, Kalman decomposition. Time invariant systems treated as a special case.
- Stability and stabilization, observers, state and output feedback, separation principle.
- Realization theory.

Lecture notes
see above

Prerequisites / notice
Prerequisites: Control systems (227-0216-0 or equivalent) and sufficient mathematical maturity.

227-0920-00L Seminar in Systems and Control

Abstract
Current topics in Systems and Control presented mostly by external speakers from academia and industry

Objective

151-0604-00L Microrobotics

Abstract
Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.

Objective
The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.

Content
Main topics of the course include:
- Scaling laws at micro/nano scales
- Electrostatics
- Electromagnetism
- Low Reynolds number flows
- Observation tools
- Materials and fabrication methods
- Applications of biomedical microrobots

Lecture notes
The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

Prerequisites / notice
The lecture will be taught in English.

151-0917-00L Mass Transfer

Abstract
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

Objective
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

Content
Fick's laws; application and significance of mass transfer; comparison of Fick's laws with Newton's and Fourier's laws; derivation of Fick's 2nd law; diffusion in dilute and concentrated solutions; rotating disk; dispersion; diffusion coefficients, viscosity and heat conduction (Pr and Sc numbers); Brownian motion; Stokes-Einstein equation; mass transfer coefficients (Nu and Sh numbers); mass transfer across interfaces; Reynolds- and Chilton-Colburn analogies for mass-, heat-, and momentum transfer in turbulent flows; film-, penetration-, and surface renewal theories; simultaneous mass, heat and momentum transfer (boundary layers); homogeneous and heterogeneous reversible and irreversible reactions; diffusion-controlled reactions; mass transfer and first order heterogeneous reaction. Applications.

Literature

Prerequisites / notice
Three tests are offered for practicing the course material. Participation is voluntary.

376-1504-00L Physical Human Robot Interaction (pHRI)

Abstract
This course focuses on the emerging, interdisciplinary field of physical human-robot interaction, bringing together themes from robotics, real-time control, human factors, haptics, virtual environments, interaction design and other fields to enable the development of human-oriented robotic systems.

Number of participants limited to 26.
The objective of this course is to give an introduction to the fundamentals of physical human robot interaction, through lectures on the underlying theoretical/mechatronics aspects and application fields, in combination with a hands-on lab tutorial. The course will guide students through the design and evaluation process of such systems.

By the end of this course, you should understand the critical elements in human-robot interactions - both in terms of engineering and human factors - and use these to evaluate and de-sign safe and efficient assistive and rehabilitative robotic systems. Specifically, you should be able to:

1) identify critical human factors in physical human-robot interaction and use these to derive design requirements;
2) compare and select mechatronic components that optimally fulfill the defined design requirements;
3) derive a model of the device dynamics to guide and optimize the selection and integration of selected components into a functional system;
4) design control hardware and software and implement and test human-interactive control strategies on the physical setup;
5) characterize and optimize such systems using both engineering and psychophysical evaluation metrics;
6) investigate and optimize one aspect of the physical setup and convey and defend the gained insights in a technical presentation.

This course provides an introduction to fundamental aspects of physical human-robot interaction. After an overview of human haptic, visual and auditory sensing, neurophysiology and psychophysics, principles of human-robot interaction systems (kinematics, mechanical transmissions, robot sensors and actuators used in these systems) will be introduced. Throughout the course, students will gain knowledge of interaction control strategies including impedance/admittance and force control, haptic rendering basics and issues in device design for humans such as transparency and stability analysis, safety hardware and procedures. The course is organized into lectures that aim to bring students up to speed with the basics of these systems, readings on classical and current topics in physical human-robot interaction, laboratory sessions and lab visits.

Students will attend laboratory sessions where they will implement the theoretical aspects learned during the lectures. Here the salient features of device haptic design will be identified and theoretical aspects will be implemented in a haptic system based on the haptic paddle (http://edu.haptics.org/index.php/HapticDevices/HapticPaddles), by creating simple dynamic haptic virtual environments and understanding the performance limitations and causes of instabilities (direct/virtual coupling, friction, damping, time delays, sampling rate, sensor/quantization, automation, rendering of different mechanical properties).

Objective

1) identify critical human factors in physical human-robot interaction and use these to derive design requirements;
2) compare and select mechatronic components that optimally fulfill the defined design requirements;
3) derive a model of the device dynamics to guide and optimize the selection and integration of selected components into a functional system;
4) design control hardware and software and implement and test human-interactive control strategies on the physical setup;
5) characterize and optimize such systems using both engineering and psychophysical evaluation metrics;
6) investigate and optimize one aspect of the physical setup and convey and defend the gained insights in a technical presentation.

Content

This course provides an introduction to fundamental aspects of physical human-robot interaction. After an overview of human haptic, visual and auditory sensing, neurophysiology and psychophysics, principles of human-robot interaction systems (kinematics, mechanical transmissions, robot sensors and actuators used in these systems) will be introduced. Throughout the course, students will gain knowledge of interaction control strategies including impedance/admittance and force control, haptic rendering basics and issues in device design for humans such as transparency and stability analysis, safety hardware and procedures. The course is organized into lectures that aim to bring students up to speed with the basics of these systems, readings on classical and current topics in physical human-robot interaction, laboratory sessions and lab visits.

Students will attend laboratory sessions where they will implement the theoretical aspects learned during the lectures. Here the salient features of device haptic design will be identified and theoretical aspects will be implemented in a haptic system based on the haptic paddle (http://edu.haptics.org/index.php/HapticDevices/HapticPaddles), by creating simple dynamic haptic virtual environments and understanding the performance limitations and causes of instabilities (direct/virtual coupling, friction, damping, time delays, sampling rate, sensor/quantization, automation, rendering of different mechanical properties).

Literature


Prerequisites / notice

Notice:
The registration is limited to 26 students
There are 4 credit points for this lecture.
The lecture will be held in English.
The students are expected to have basic control knowledge from previous classes.
http://www.relab.ethz.ch/education/courses/phRI
Introduction to modeling: Black-box and grey-box models; Parametric and non-parametric models; ARX, ARMAX (etc.) models.

Predictive, open-loop, black-box identification methods. Time and frequency domain methods. Subspace identification methods.

Optimal experimental design, Cramer-Rao bounds, input signal design.

Parametric identification methods. On-line and batch approaches.

Closed-loop identification strategies. Trade-off between controller performance and information available for identification.


Control systems (227-0216-00L) or equivalent.

227-0517-00L Electrical Drive Systems II

W 6 credits 4G P. Steimer, G. Scheuer, C. A. Stulz

Abstract

In the course "Drive System II" the power semiconductors are repeated. The creation of converters based on the combination of switches/cells and based topologies is explained. Another main focus is on the 3-level inverter with its switching and transfer functions. Further topics are the control of the synchronous machine, of line-side converters and issues with converter-fed machines.

Objective

The students establish a deeper understanding in regards of the design of the main components of an electrical drive system. They establish knowledge on the most important interaction with the grid and the machine and their related high dynamic control.

Content

Converter topologies (switch or cell based), multi-pulse diode rectifiers, system aspects of transformer and electrical machines, 3-level inverter with its switching and transfer functions, grid side harmonics, modeling and control of synchronous machines (including permanent magnet machines), control of line-side converters, reflection effects with power cables, winding isolation and bearing stress. Field trip to ABB Semiconductors.

Literature

Skript is sold at the beginning of the lectures or can be downloaded from Ilias

Lecture notes

Prerequisites / notice

Skript of lecture; References in skript to related technical publications and books

Prerequisites: Electrical Drive Systems I (recommended), Basics in electrical engineering, power electronics, automation and mechatronics

151-0107-20L High Performance Computing for Science and Engineering (HPCSE I)

W 4 credits 4G P. Koumoutsakos, M. Troyer

Abstract

This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.

Objective

Introduction to HPC for scientists and engineers
Fundamental of:
1. Parallel Computing Architectures
2. MultiCores
3. ManyCores

Content

Programming models and languages:
1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)

Computers and methods:
1. Hardware and architectures
2. Libraries
3. Particles: N-body solvers
4. Fields: PDEs
5. Stochastics: Monte Carlo

Lecture notes

http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1
Class notes, handouts

151-0655-00L Skills for Creativity and Innovation

W 4 credits 3G I. Goller, C. Kobe, M. Mebold

Abstract

This lecture aims to enhance the knowledge and competency of students regarding their innovation capability. An overview on prerequisites of and different skills for creativity and innovation in individual & team settings is given. The focus of this lecture is clearly on building competencies - not just acquiring knowledge.

Objective

- Basic knowledge about creativity and skills
- Knowledge about individual prerequisites for creativity
- Development of individual skills for creativity
- Knowledge about teams
- Development of team-oriented skills for creativity
- Knowledge and know-how about transfer to idea generation teams

Content

Basic knowledge about creativity and skills:
- Introduction into creativity & innovation: definitions and models

Knowledge about individual prerequisites for creativity:
- Personality, motivation, intelligence

Development of individual skills for creativity:
- Focus on creativity as problem analysis & solving
- Individual skills in theoretical models
- Individual competencies: exercises and reflection

Knowledge about teams:
- Definitions and models
- Roles in innovation processes

Development of team-oriented skills for creativity:
- Idea generation and development in teams
- Cooperation & communication in innovation teams

Knowledge and know-how about transfer to idea generation teams:
- Self-reflection & development planning
- Methods of knowledge transfer
The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

### Literature

- Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.
- Fundamentals of Probability, Fundamentals of Computational Modeling
- Probability Theory: The Logic of Science by E. T. Jaynes
- Class Notes

### Prerequisites / notice

- Students must have participated and passed the courses Manufacturing, Production Machines I and Forming Technology III - Forming Processes.
- Further training with specialized lectures and large participation from the industry.

### Micro & Nanosystems

#### Number 151-0620-00L

**Title:** Embedded MEMS Labs

**Type:** W

**ECTS:** 5 credits

**Hours:** 3P

**Lecturers:** C. Hierold, S. Blunier, M. Haluska

**Abstract**

Practical course: Students are introduced to the process steps required for the fabrication of MEMS (Micro Electro Mechanical System) and carry out the fabrication and testing steps in the clean rooms by themselves. Additionally, they learn the requirements for working in clean rooms. Processing and characterization will be documented and analyzed in a final report. Limited access.

**Objective**

Students learn the individual process steps that are required to make a MEMS (Micro Electro Mechanical System). Students carry out the process steps themselves in laboratories and clean rooms. Furthermore, participants become familiar with the special requirements (cleanliness, safety, operation of equipment and handling hazardous chemicals) of working in the clean rooms and laboratories. The entire production, processing, and characterization of the MEMS is documented and evaluated in a final report.

**Content**

- Photolithography, dry etching, wet etching, sacrificial layer etching, critical point drying, various cleaning procedures
- Packaging and electrical connection of a MEMS device
- Testing and characterization of the MEMS device
- Written documentation and evaluation of the entire production, processing and characterization

**Lecture notes / Literature**

A document containing theory, background and practical course content is distributed at the first meeting of the course.

**Prerequisites / notice**

Participating students are required to attend all scheduled lectures and meetings of the course. Participating students are required to provide proof that they have personal accident insurance prior to the start of the laboratory portion of the course.

This master's level course is limited to 15 students per semester for safety and efficiency reasons. If there are more than 15 students registered, we regret to restrict access to this course by the following rules:

**Priority 1:** master students of the master's program in "Micro and Nanosystems".

**Priority 2:** master students of the master's program in "Mechanical Engineering" with a specialization in Microsystems and Nanoscale Engineering (MAVT-tutors Profs Danso, Dual, Hierold, Koumoutsakos, Nistor, Norris, Park, Fouilletakos, Pratsinis, Stemmer), who attended the bachelor course "151-0621-00L Microsystems Technology" successfully.

**Priority 3:** master students, who attended the bachelor course "151-0621-00L Microsystems Technology" successfully.

**Priority 4:** all other students (PhD, bachelor, master) with a background in silicon or Microsystems process technology.

If there are more students in one of these priority groups than places available, we will decide by drawing lots.

Students will be notified at the first lecture of the course (introductory lecture) as to whether they are able to participate.

The course is offered in autumn and spring semester.
Abstract From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles.

Intermolecular forces, their macroscopic manifestations, and ways to control such interactions.

Self-assembly and directed assembly of 2D and 3D structures.

Special emphasis on the emerging field of molecular electronic devices.

Familiarizes students with basic science and engineering principles governing the nano domain.

The course addresses basic science and engineering principles ruling the nano domain. We particularly work out the links between topics that are traditionally taught separately.

Topics are treated in 2 blocks:

(I) From Quantum to Continuum From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles.

(II) Interaction Forces on the Micro and Nano Scale Intermolecular forces, their macroscopic manifestations, and ways to control such interactions. Self-assembly and directed assembly of 2D and 3D structures.

Literature

Prerequisites / notice
Lectures and Mini-Review presentations: Thursday 10-13, ML F 36

Homework: Mini-Reviews Students select a paper (list distributed in class) and expand the topic into a Mini-Review that illuminates the particular field beyond the immediate results reported in the paper.

151-0642-00L Seminar on Micro and Nanosystems Z 0 credits 1S C. Hierold
Abstract Scientific presentations from the field of Micro- and Nanosystems
Objective In particular, the seminar addresses students, who are interested in scientific work in the field of Micro- and Nanosystem technologies, or who have started already with it. Respectively, current examples in the research will be discussed.
Content Current themes in the field of Micro- and Nanosystem technologies using the examples of intern and extern research groups, as well as ongoing themes of study-, diploma- and doctoral thesis will be introduced and discussed. The scope of the seminar is broadened by occasional guest speakers.
Lecture notes -
Literature -
Prerequisites / notice Master of MNS, MAVT, ITET, Physics

151-0604-00L Microrobotics W 4 credits 3G B. Nelson
Abstract Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.
Objective The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.
Content Main topics of the course include:
- Scaling laws at micro/nano scales
- Electrostatics
- Electromagnetism
- Low Reynolds number flows
- Observation tools
- Materials and fabrication methods
- Applications of biomedical microbots
Lecture notes The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.
Prerequisites / notice The lecture will be taught in English.

151-0931-00L Seminar on Particle Technology Z 0 credits 3S S. E. Pratsinis
Abstract The goal of the lecture is to convey a basic knowledge in the area of FV materials as well as their construction and production processes and to empower the students to apply the knowledge gained to address current problems in research and practice.
Objective Students attend and give research presentations for the research they plan to do and at the end of the semester they defend their results and answer questions from research scientists. Familiarize the students with the latest in this field.

227-0377-00L Physics of Failure and Failure Analysis of Electronic Devices and Equipment W 3 credits 2V U. Sennhauser
Abstract Failures have to be avoided by proper design, material selection and manufacturing. Properties, degradation mechanisms, and expected lifetime of materials are introduced and the basics of failure analysis and analysis equipment are presented. Failures will be demonstrated experimentally and the opportunity is offered to perform a failure analysis with advanced equipment in the laboratory.
Objective Introduction to the degradation and failure mechanisms and causes of electronic components, devices and systems as well as to methods and tools of reliability testing, characterization and failure analysis.
Mass Transfer

This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore, the application of these principles to important engineering problems is demonstrated.

Content
- Fick's laws; application and significance of mass transfer
- Comparison of Fick's laws with Newton's and Fourier's laws
- Derivation of Fick's laws

Literature

High Performance Computing for Science and Engineering (HPCSE I)

This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and to relevant algorithms in multicore architectures.

Content
- Programming models and languages:
  1. C++ threading (2 weeks)
  2. OpenMP (4 weeks)
  3. MPI (5 weeks)
- Computers and methods:
  1. Hardware and architectures
  2. Libraries
  3. Particles: N-body solvers
  4. Fields: PDEs
  5. Stochastics: Monte Carlo

Uncertainty Quantification for Engineering & Life Sciences

Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

Content
- Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modeling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 978 of 1434
## Bioengineering

### 151-0107-20L High Performance Computing for Science and Engineering (HPCSE) I

**Abstract**
This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.

**Objective**
Introduction to HPC for scientists and engineers

**Content**
Programming models and languages:
1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)

Computers and methods:
1. Hardware and architectures
2. Libraries
3. Particles: N-body solvers
4. Fields: PDEs
5. Stochastics: Monte Carlo

**Lecture notes**
http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1

**Literature**
Lecture notes and references therein.

**Prerequisites / notice**
Fundamentals of Probability, Fundamentals of Computational Modeling

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<th>Lecturers</th>
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### 151-0255-00L Energy Conversion and Transport in Biosystems

**Abstract**
Theory and application of thermodynamics and energy conversion in biological systems and biomedicine at the macro scale and the cellular level.

**Objective**
Theory and application of energy conversion at the macro scale and the cellular level. Understanding of the basic features governing fluid transport in the principal systems of the human cell. Connection of characteristics and patterns from other fields of engineering to biofluidics. Heat and mass transport processes within the human body and relation to biomedical technologies.

**Content**
Mass transfer models for the transport of chemical species in the human cell. Organization and function of the cell membrane and of the cell cytoskeleton. The role of molecular motors in cellular force generation and their function in cell migration. Description of the functionality of these systems and of analytical experimental and computational techniques for understanding of their operation. Introduction to bioengineering approaches for the treatment of common pathogenic conditions of these systems. Introduction to cell metabolism, cellular energy transport and cellular thermodynamics.

**Lecture notes**
Script as well as additional material in the form of hand-outs will be distributed.

**Literature**
Lecture notes and references therein.

<table>
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<tbody>
<tr>
<td>151-0255-00L</td>
<td>Energy Conversion and Transport in Biosystems</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>D. Poulikakos, A. Ferrari</td>
</tr>
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</table>

### 151-0317-00L Visualization, Simulation and Interaction - Virtual Reality II

**Abstract**
This lecture provides deeper knowledge on the possible applications of virtual reality, its basic technology, and future research fields. The goal is to provide a strong knowledge on Virtual Reality for a possible future use in business processes.

**Objective**
Virtual Reality can not only be used for the visualization of 3D objects, but also offers a wide application field for small and medium enterprises (SME). This could be for instance an enabling technology for net-based collaboration, the transmission of images and other data, the interaction of the human user with the digital environment, or the use of augmented reality systems. The goal of the lecture is to provide a deeper knowledge of today's VR environments that are used in business processes. The technical background, the algorithms, and the applied methods are explained more in detail. Finally, future tasks of VR will be discussed and an outlook on ongoing international research is given.

**Content**
Introduction into Virtual Reality; basics of augmented reality; interaction with digital data, tangible user interfaces (TUI); basics of simulation; compression procedures of image-, audio-, and video signals; new materials for force feedback devices; introduction into data security; cryptography; definition of free-form surfaces; digital factory; new research fields of virtual reality

**Lecture notes**
The handout is available in German and English.

**Prerequisites**
Prerequisites:
"Visualization, Simulation and Interaction - Virtual Reality I" is recommended.

**Didactical concept**
The course consists of lectures and exercises.

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<tr>
<td>151-0317-00L</td>
<td>Visualization, Simulation and Interaction - Virtual Reality II</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>A. Kunz</td>
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</table>

### 151-0917-00L Mass Transfer

**Abstract**
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

**Objective**
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

**Content**
Fick's laws; application and significance of mass transfer; comparison of Fick's laws with Newton's and Fourier's laws; derivation of Fick's 2nd law; diffusion in dilute and concentrated solutions; rotating disk; dispersion; diffusion coefficients, viscosity and heat conduction (Pr and Sc numbers); Brownian motion; Stokes-Einstein equation; mass transfer coefficients (Nu and Sh numbers); mass transfer across interfaces; Reynolds- and Chilton-Colburn analogies for mass-, heat-, and momentum transfer in turbulent flows; film-, penetration-, and surface renewal theories; simultaneous mass, heat and momentum transfer (boundary layers); homogeneous and heterogeneous reversible and irreversible reactions; diffusion-controlled reactions; mass transfer and first order heterogenous reaction. Applications.

**Literature**

**Prerequisites**
Three tests are offered for practicing the course material. Participation is voluntary.

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<tr>
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<tbody>
<tr>
<td>151-0917-00L</td>
<td>Mass Transfer</td>
<td>W</td>
<td>4 credits</td>
<td>2V+2U</td>
<td>R. Büchel, S. E. Pratsinios</td>
</tr>
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</table>

### 227-0385-10L Biomedical Imaging

**Abstract**
Introduction to bioengineering approaches for the treatment of common pathogenic conditions of these systems. Introduction to cell metabolism, cellular energy transport and cellular thermodynamics.

**Literature**
Lecture notes and references therein.

**Prerequisites**
Fundamentals of Probability, Fundamentals of Computational Modeling

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<tr>
<td>227-0385-10L</td>
<td>Biomedical Imaging</td>
<td>W</td>
<td>6 credits</td>
<td>5G</td>
<td>S. Kozerke, U. Moser, K. P. Prüssmann, M. Rudin</td>
</tr>
</tbody>
</table>
Introduction into neuro- and electrophysiology. Functional analysis of peripheral nerves, muscles, sensory organs and the central nervous system.

Abstract
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.

Objective
Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

Content
The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes the aspects of quantitative evaluation of tomographic data sets like segmentation, morphometry and statistics. (absorption-, phase- and darkfield contrast) will be discussed and their use in daily research, in particular biology, is presented. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

Objective
To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.

Content
- X-ray imaging
- Computed tomography
- Single photon emission tomography
- Positron emission tomography
- Magnetic resonance imaging
- Ultrasound/Doppler imaging

Objective
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

Content
Introduction into the basic concepts of X-ray tomographic imaging, image analysis and data quantification at the micro and nano scale with results from recent research and technological innovations in biology.

Objective
Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The focus is on learning the concepts that govern common medical instruments and the most important organs from an engineering point of view. In addition, the most recent achievements and trends of the field of biomedical engineering are also outlined.

Content

Introduction into Biomedical Engineering by Enderle, Banchard, and Bronzino

AND

https://www1.ethz.ch/lbb/Education/BME
Synchrotron-based X-ray micro- and nano-tomography is today a powerful technique for non-destructive, high-resolution investigations of a broad range of materials. The high-brilliance and high-coherence of third generation synchrotron radiation facilities allow quantitative, three-dimensional imaging at the micro and nanometer scale and extend the traditional absorption imaging technique to edge-enhanced and phase-sensitive measurements, which are particularly suited for investigating biological samples.

The lecture includes a general introduction to the principles of tomographic imaging from image formation to image reconstruction. It provides the physical and engineering basics to understand how imaging beamlines at synchrotron facilities work, looks into the recently developed phase contrast methods, and explores the first applications of X-ray nano-tomographic experiments.

The course finally provides the necessary background to understand the quantitative evaluation of tomographic data, from basic image analysis to complex morphometrical computations and 3D visualization, keeping the focus on biomedical applications.

Lecture notes
Available online

Literature
Will be indicated during the lecture.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
<th>Type</th>
<th>Hours</th>
<th>Authors</th>
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<tr>
<td>376-1219-00L</td>
<td>Rehabilitation Engineering II: Rehabilitation of Sensory and Vegetative Functions</td>
<td>3</td>
<td>W</td>
<td>2V</td>
<td>R. Riener, R. Gassert, L. Marchal Crespo</td>
</tr>
</tbody>
</table>

Abstract
Rehab. Engineering is the application of science and technology to ameliorate the handicaps of individuals with disabilities to reintegrate them into society. The goal is to present classical and new rehabilitation engineering principles applied to compensate or enhance motor, sensory, and cognitive deficits. Focus is on the restoration and treatment of the human sensory and vegetative system.

Objective
Provide knowledge on the anatomy and physiology of the human sensory system, related dysfunctions and pathologies, and how rehabilitation engineering can provide sensory restoration and substitution.

Content
Introduction, problem definition, overview
Rehabilitation of visual function
- Anatomy and physiology of the visual sense
- Technical aids (glasses, sensor substitution)
- Retina and cortex implants
Rehabilitation of hearing function
- Anatomy and physiology of the auditory sense
- Hearing aids
- Cochlea Implants
Rehabilitation and use of kinesthetic and tactile function
- Anatomy and physiology of the kinesthetic and tactile sense
- Tactile/haptic displays for motion therapy (incl. electrical stimulation)
- Role of displays in motor learning
Rehabilitation of vestibular function
- Anatomy and physiology of the vestibular sense
- Rehabilitation strategies and devices (e.g. BrainPort)
Rehabilitation of vegetative Functions
- Cardiac Pacemaker
- Phrenic stimulation, artificial breathing aids
- Bladder stimulation, artificial sphincter
Brain stimulation and recording
- Deep brain stimulation for patients with Parkinson, epilepsy, depression
- Brain-Computer Interfaces
Provide theoretical and practical knowledge of new principles and applications of multi-modal simulation and interface technologies in Virtual Reality has the potential to provide descriptive and practical information for medical training and therapy while relieving the patient.

### Introductory Books:


### Prerequisites / notice

**Target Group:**
- Students of higher semesters and PhD students of - D-MAVT, D-ITET, D-INFK, D-HEST - Biomedical Engineering, Robotics, Systems and Control - Medical Faculty, University of Zurich
- Students of other departments, faculties, courses are also welcome

### Literature

- **Book:** Virtual Reality in Medicine. Riener, Robert; Harders, Matthias; 2012 Springer.

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**Data: 06.02.2019 13:00**

**Autumn Semester 2015**

**Page 982 of 1434**
The objective of this course is to give an introduction to the fundamentals of physical human robot interaction, through lectures on the underlying theoretical/mechatronics aspects and application fields, in combination with a hands-on lab tutorial. The course will guide students through the design and evaluation process of such systems.

By the end of this course, you should understand the critical elements in human-robot interactions - both in terms of engineering and human factors - and use these to evaluate and de-sign safe and efficient assistive and rehabilitative robotic systems. Specifically, you should be able to:

1) identify critical human factors in physical human-robot interaction and use these to derive design requirements;
2) compare and select mechatronic components that optimally fulfill the defined design requirements;
3) derive a model of the device dynamics to guide and optimize the selection and integration of selected components into a functional system;
4) design control hardware and software and implement and test human-interactive control strategies on the physical setup;
5) characterize and optimize such systems using both engineering and psychophysical evaluation metrics;
6) investigate and optimize one aspect of the physical setup and convey and defend the gained insights in a technical presentation.

This course provides an introduction to fundamental aspects of physical human-robot interaction. After an overview of human haptic, visual and auditory sensing, neurophysiology and psychophysics, principles of human-robot interaction systems (kinematics, mechanical transmissions, robot sensors and actuators used in these systems) will be introduced. Throughout the course, students will gain knowledge of interaction control strategies including impedance/admittance and force control, haptic rendering basics and issues in device design for humans such as transparency and stability analysis, safety hardware and procedures. The course is organized into lectures that aim to bring students up to speed with the basics of these systems, readings on classical and current topics in physical human-robot interaction, laboratory sessions and lab visits.

The students are expected to have basic control knowledge from previous classes. The lecture will be held in English.

4 credits

The course language is English.

Number of participants limited to 26.

The course is organized into lectures that aim to bring students up to speed with the basics of these systems, readings on classical and current topics in physical human-robot interaction, laboratory sessions and lab visits.

The course is organized into lectures that aim to bring students up to speed with the basics of these systems, readings on classical and current topics in physical human-robot interaction, laboratory sessions and lab visits.

The students are expected to have basic control knowledge from previous classes.

More details will be announced in the lecture.

Be advised that the lectures will be held in English.
Introduction to Trauma Biomechanics

**Objective**

The class consists of three parts:
1. **Introduction** into molecular characteristics of molecules involved in the materials-to-biology interface. Molecular design of biomaterials.
2. The concept of bio compatibility.
3. **Introduction** into methodology used in biomaterials research and application.

**Content**

Introduction into native and polymeric biomaterials used for medical applications. The concepts of bio compatibility, biodegradation and the consequences of degradation products are discussed on the molecular level. Different classes of materials with respect to potential applications in tissue engineering and drug delivery are introduced. Strong focus lies on the molecular interactions between materials having very different bulk and/or surface chemistry with living cells, tissues and organs. In particular the interface between the materials surfaces and the eukaryotic cell surface and possible reactions of the cells with an implant material are elucidated. Techniques to design, produce and characterize materials in vitro as well as in vivo analysis of implanted and explanted materials are discussed. In addition, a link between academic research and industrial entrepreneurship is established by external guest speakers.

**Lecture notes**

Handouts can be accessed online.

**Literature**

*Comprehensive Biomaterials, Ducheyne P. et al., 1st Edition, 2011* (available online via ETH library)

Handouts provided during the classes and references therein.

**376-1985-00L Trauma Biomechanics**

**Abstract**

Trauma biomechanics in an interdisciplinary research field investigating the biomechanics of injuries and related subjects such as prevention. The lecture provides an introduction to the basic principles of trauma biomechanics.

**Objective**

Introduction to the basic principles of trauma biomechanics.

**Content**

This lecture serves as an introduction to the field of trauma biomechanics. Emphasis is placed on the interdisciplinary nature of impact biomechanics, which includes the combination of fundamental engineering principles and advanced medical technologies to develop injury prevention measures. Topics include: accident statistics and accident reconstruction, biomechanical response of the human to impact loading, injury mechanisms and injury criteria, test methods (including animal tests), computer simulations using multi-body and finite element modelling techniques, aspects of passive safety systems (focusing on restraint systems and vehicle compatibility). Real world examples mainly from automobile safety are used to augment lecture material.

**Lecture notes**

Available via homepage.

**Literature**


**402-0341-00L Medical Physics I**

**Abstract**

Introduction to the fundamentals of medical radiation physics. Functional chain due to radiation exposure from the primary physical effect to the radiobiological and medically manifest secondary effects. Dosimetric concepts of radiation protection in medicine. Mode of action of radiation sources used in medicine and its illustration by means of Monte Carlo simulations.

**Objective**

Understanding the functional chain from primary physical effects of ionizing radiation to clinical radiation effects. Dealing with dose as a quantitative measure of medical exposure. Getting familiar with methods to generate ionizing radiation in medicine and learn how they are applied for medical purposes. Eventually, the lecture aims to show the students that medical physics is a fascinating and evolving discipline where physics can directly be used for the benefits of patients and the society.

**Content**

The lecture is covering the basic principles of ionizing radiation and its physical and biological effects. The physical interactions of photons as well as of charged particles will be reviewed and their consequences for medical applications will be discussed. The concept of Monte Carlo simulation will be introduced in the excercises and will help the student to understand the characteristics of ionizing radiation in simple and complex situations. Fundamentals in dosimetry will be provided in order to understand the physical and biological effects of ionizing radiation. Deterministic as well as stochastic effects will be discussed and fundamental knowledge about radiation protection will be provided. In the second part of the lecture series, we will cover the generation of ionizing radiation. By this means, the x-ray tube, the clinical linear accelerator, and different radioactive sources in radiology, radiotherapy and nuclear medicine will be addressed. Applications in radiology, nuclear medicine and radiotherapy will be described with a special focus on the physics underlying these applications.

**Lecture notes**

A script will be provided.

**551-0319-00L Cellular Biochemistry (Part I)**

**Abstract**

Concepts and molecular mechanisms underlying the biochemistry of the cell, providing advanced insights into structure, function and regulation of individual cell components. Particular emphasis will be put on the spatial and temporal integration of different molecules and signaling pathways into global cellular processes such as intracellular transport, cell division & growth, and cell migration.

**Objective**

The full-year course (551-0319-00 & 551-0320-00) focuses on the molecular mechanisms and concepts underlying the biochemistry of cellular physiology, investigating how these processes are integrated to carry out highly coordinated cellular functions. The molecular characterisation of complex cellular functions requires a combination of approaches such as biochemistry, but also cell biology and genetics. This course is therefore the occasion to discuss these techniques and their integration in modern cellular biochemistry.

The students will be able to describe the structural and functional details of individual cell components, and the spatial and temporal regulation of their interactions. In particular, they will learn to explain the integration of different molecules and signaling pathways into complex and highly dynamic cellular processes such as intracellular transport, cytoskeletal rearrangements, cell motility, cell division and cell growth. In addition, they will be able to illustrate the relevance of particular signaling pathways for cellular pathologies such as cancer.

**Content**

Structural and functional details of individual cell components, regulation of their interactions, and various aspects of the regulation and compartmentalisation of biochemical processes.

**Lecture notes**

Scripts and additional material will be provided during the semester. Please contact Dr. Alicia Smith for assistance with the learning materials. (alicia.smith@bc.biol.ethz.ch)

**Literature**

Recommended supplementary literature (review articles and selected primary literature) will be provided during the course.

**Prequisites / notice**

To attend this course the students must have a solid basic knowledge in chemistry, biochemistry and general biology. The course will be taught in English.

**227-0981-00L Cross-Disciplinary Research and Development in Medicine and Engineering**

A maximum of 12 medical degree students and 12 (biomedical) engineering degree students can be admitted, their number should be equal.

**Abstract**

Cross-disciplinary research and development in medicine and engineering.

**Objective**

To foster collaboration and innovation between medical and engineering disciplines.

**Content**

Topics include: biophysical and electrical properties of membranes; viral membranes; structural and functional insights into intracellular transport and targeting; vesicular trafficking and phagocytosis; post-transcriptional regulation of gene expression.

**Lecture notes**

A script will be provided.
Cross-disciplinary collaboration between engineers and medical doctors is indispensable for innovation in health care. This course will bring together engineering students from ETH Zurich and medical students from the University of Zurich to experience the rewards and challenges of such interdisciplinary work in a project based learning environment.

The main goal of this course is to demonstrate the differences in communication between the fields of medicine and engineering. Since such differences become the most evident during actual collaborative work, the course is based on a current project in physiology research that combines medicine and engineering. For the engineering students, the specific aims of the course are to:

- Acquire a working understanding of the anatomy and physiology of the investigated system;
- Identify the engineering challenges in the project and communicate them to the medical students;
- Develop and implement, together with the medical students, solution strategies for the identified challenges;
- Present the found solutions to a cross-disciplinary audience.

After a general introduction to interdisciplinary communication and detailed background on the collaborative project, the engineering students will receive tailored lectures on the anatomy and physiology of the relevant system. They will then team up with medical students who have received a basic introduction to engineering methodology to collaborate on said project. In the process, they will be coached both by lecturers from ETH Zurich and the University of Zurich, receiving lectures customized to the project. The course will end with each team presenting their solution to a cross-disciplinary audience.

Handouts and relevant literature will be provided.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Group</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-151-00L</td>
<td>Clinical and Movement Biomechanics</td>
<td>4 credits</td>
<td>3G</td>
<td>S. Lorenzetti, R. List, N. Singh</td>
</tr>
<tr>
<td>151-3205-00L</td>
<td>Experimental Ergonomics</td>
<td>4 credits</td>
<td>2V + 2A</td>
<td>J. Held</td>
</tr>
<tr>
<td>151-0104-00L</td>
<td>Uncertainty Quantification for Engineering &amp; Life Sciences</td>
<td>4 credits</td>
<td>3G</td>
<td>J. Beck, P. Koumoutsakos</td>
</tr>
<tr>
<td>376-1177-00L</td>
<td>Human Factors I</td>
<td>2 credits</td>
<td>2V</td>
<td>M. Menozzi Jäckli, R. Boutellier, R. Huang, M. Siegrist</td>
</tr>
</tbody>
</table>

Handouts and relevant literature will be provided.


3. Class Notes

- Field study of system and task analysis, including on-site visits of complex work stations (Hospital OR/ICU or Air traffic/Railway Control Rooms).

Handouts and relevant literature will be provided.

Experiments and field studies in teams of 2-3 students are obligatory.

The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

Fundamentals of Probability, Fundamentals of Computational Modeling

Every day humans interact with various systems. Strategies of interaction, individual needs, physical & mental abilities, and system properties are important factors in controlling the quality and performance in interaction processes. In the lecture, factors are investigated by basic scientific approaches. Discussed topics are important for optimizing people's satisfaction & overall performance.

The goal of the lecture is to empower students in better understanding the applied theories, principles, and methods in various applications. Students are expected to learn about how to enable an efficient and qualitatively high standing interaction between human and the environment, considering costs, benefits, health, and safety as well. Thus, an ergonomic design and evaluation process of products, tasks, and environments may be promoted in different disciplines. The goal is achieved in addressing a broad variety of topics and embedding the discussion in macroscopic factors such as the behavior of consumers and objectives of economy.
Design, Computation, Product Development & Manufacturing

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>363-1065-00L</td>
<td>Design Thinking: Human-Centred Solutions to Real World Challenges</td>
<td>W</td>
<td>5</td>
<td>5G</td>
<td>A. Cabello Llamas, S. Brusoni, C. Hölscher, M. Meboldt, F. Rittiner</td>
</tr>
</tbody>
</table>

Abstract

All interested students are invited to apply for this course by sending a one-page motivation letter until 07.09.2015 to Florian Rittiner (frittiner@ethz.ch).

Additionally please enroll via mystudies. Places will be assigned after the first lecture on the basis of your motivation letter and commitment for the class.

Objective

- Generate deep insights through the systematic observation and interaction of key stakeholders.
- Engage in collaborative ideation with a multidisciplinary (student) team.
- Rapidly prototype and iteratively test ideas and concepts by using various materials and techniques.

151-3205-00L Experimental Ergonomics

Abstract

You will learn how to apply the scientific discipline of ergonomics for system analysis and product development “in order to optimise human well-being and overall system performance” (www.iea.cc). The course offers the framework of models, concepts, methods and tools of applied ergonomics. Teaching is combined with learning-by-doing and research-based learning.

Objective

Knowledge of:
- Principles and rules of applied ergonomic system and product design.
- Methods and tools of ergonomic analysis and evaluation.
- Practical experiences and hands-on skills in:
  - Conducting a study in system and task analysis.
  - Analysing human-product interactions.
  - Applying ergonomic knowledge for product and system improvements.

Content

- Definition and role of applied ergonomics in engineering and design.
- Framework of ergonomic analysis and design.
- Design principles and rules.
- Methods and tools for system and task analysis.
- Hands-on experience in team work:
  - Experimental study of human-product interaction and usability through eye-tracking
  - Field study of system and task analysis, including on-site visits of complex work stations (Hospital OR/ ICU or Air traffic/Railway Control Rooms)

Lecture notes

Handout at the start of the course.

Literature


Prerequisites / notice

Max. number of participants is 15.
Experiments and field studies in teams of 2-3 students are obligatory.

151-0104-00L Uncertainty Quantification for Engineering & Life Sciences

Abstract

Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

Objective

The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

Content

Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

Lecture notes

The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

Literature

1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

Prerequisites / notice

Fundamentals of Probability, Fundamentals of Computational Modeling

151-3209-00L Engineering Design Optimization

Abstract

The course covers fundamentals of computational optimization methods in the context of engineering design. It develops skills to formally state and model engineering design tasks as optimization problems and select appropriate methods to solve them.

Number of participants limited to 25.

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 986 of 1434
Objective: The lecture and exercises teach the fundamentals of optimization methods in the context of engineering design. After taking the course, students will be able to express engineering design problems as formal optimization problems. Students will also be able to select and apply a suitable optimization method given the nature of the optimization model. They will understand the links between simulation, optimization, and engineering design in order to design more efficient and performance-optimized technical products. The exercises are MATLAB based.

Content:
1. Optimization modeling and theory
2. Linear methods
3. Non-linear methods
4. Constrained methods
5. Meta-heuristic optimization and search
6. Multi-objective optimization

Lecture Notes:
1. Slides of the lectures, relevant journal papers, and user manuals will be provided.
2. Lectures and computer labs concerned with the modeling of the deformation response and failure of engineering materials (metals, polymers, and composites) subject to extreme loadings during manufacturing, crash, impact, and blast events.
3. Students will learn to apply, understand, and develop computational models of a large spectrum of engineering materials to predict their dynamic deformation response and failure in finite element simulations. Students will become familiar with important dynamic testing techniques to identify material model parameters from experiments. The ultimate goal is to provide the students with the knowledge and skills required to engineer modern multi-material solutions for high-performance structures in automotive, aerospace, and naval engineering.
4. Topics include viscoelasticity, temperature and rate-dependent plasticity, dynamic brittle and ductile fracture; impulse transfer, impact and wave propagation in solids; computational aspects of material model implementation into hydrocodes; simulation of dynamic failure of structures.

Literature:
Various books will be recommended covering the topics discussed in class.

Prerequisites / Notice:
Course in continuum mechanics (mandatory), finite element method (recommended).

Multidisciplinary Courses
The students are free to choose individually from the entire course offer of ETH Zurich, ETH Lausanne, and the Universities of Zurich and St. Gallen.

Semester Project
The subject of the Semester Project and the choice of the supervisor (ETH professor) are to be approved in advance by the tutor.

Objective:
The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

Abstract:
The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program.

Industrial Internship
The main objective of the 12-week internship is to expose master's students to the industrial work environment. During this period, students have the opportunity to be involved in ongoing projects at the host institution.

Objective:
The main objective of the 12-week internship is to expose master's students to the industrial work environment.

Compulsory Electives in Humanities, Social, and Political Sciences
Recommended GESS compulsory elective courses (Type B) for D-MAVT.

Master Thesis
Only students who fulfill the following criteria are allowed to begin with their Master's Thesis:

a. Successful completion of the Bachelor's programme
b. Any additional requirements for admission to the degree programme have been fulfilled
c. Successful completion of the Semester Project and Industrial Internship (the corresponding credits have been acquired)

The subject of the Master's Thesis and the choice of the supervisor (ETH professor/titular professor) are to be approved by the tutor.

To choose a titular professor of D-MAVT as a supervisor (https://www.mavt.ethz.ch/the-department/people/titular-professors.html), please contact the D-MAVT Student Administration.

Abstract:
Master's programs are concluded by the master's thesis. The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem. The subject of the master's thesis, as well as the project plan and roadmap, are proposed by the tutor and further elaborated with the student.
Objective

The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem.

Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>406-0173-AAL</td>
<td>Linear Algebra I and II</td>
<td>E-</td>
<td>6 credits</td>
<td>13R</td>
<td>N. Hungerbühler</td>
</tr>
</tbody>
</table>

Enrolment only for MSc students who need this course as additional admission requirement.

Abstract

Linear algebra is an indispensable tool of engineering mathematics. The course is an introduction to basic methods and fundamental concepts of linear algebra and its applications to engineering sciences.

Objective

After completion of this course, students are able to recognize linear structures and to apply adequate tools from linear algebra in order to solve corresponding problems from theory and applications. In addition, students have a basic knowledge of the software package Matlab.

Content


Linear maps, kernel and image, coordinates and matrices, coordinate transformations, norm of a matrix, orthogonal matrices, eigenvalues and eigenvectors, algebraic and geometric multiplicity, eigenbasis, diagonalizable matrices, symmetric matrices, orthonormal basis, condition number, linear differential equations, Jordan decomposition, singular value decomposition, examples in MATLAB, applications.

Reading:

Gilbert Strang “Introduction to linear algebra”. Wellesley-Cambridge Press: Chapters 1-6, 7.1-7.3, 8.1, 8.2, 8.6


406-0353-AAL | Analysis III | E- | 4 credits | 9R | A. Iozzi

Enrolment only for MSc students who need this course as additional admission requirement.

Abstract

Introduction to partial differential equations. Differential equations which are important in applications are classified and solved. Elliptic, parabolic and hyperbolic differential equations are treated. The following mathematical tools are introduced: Laplace transforms, Fourier series, separation of variables, methods of characteristics.

Objective

Mathematical treatment of problems in science and engineering. To understand the properties of the different types of partial differential equations.

Content

Laplace Transforms:

- Laplace Transform, Inverse Laplace Transform, Linearity, s-Shifting
- Transforms of Derivatives and Integrals, ODEs
- Unit Step Function, t-Shifting
- Short Impulses, Dirac's Delta Function, Partial Fractions
- Convolution, Integral Equations
- Differentiation and Integration of Transforms

Fourier Series, Integrals and Transforms:

- Fourier Series
- Functions of Any Period p=2L
- Even and Odd Functions, Half-Range Expansions
- Forced Oscillations
- Approximation by Trigonometric Polynomials
- Fourier Integral
- Fourier Cosine and Sine Transform

Partial Differential Equations:

- Basic Concepts
- Modeling: Vibrating String, Wave Equation
- Solution by separation of variables; use of Fourier series
- D'Alembert Solution of Wave Equation, Characteristics
- Heat Equation: Solution by Fourier Series
- Heat Equation: Solutions by Fourier Integrals and Transforms
- Modeling Membrane: Two Dimensional Wave Equation
- Laplacian in Polar Coordinates: Circular Membrane, Fourier-Bessel Series
- Solution of PDEs by Laplace Transform

Literature


For reference/complement of the Analysis I/II courses:

Christian Blatter: Ingenieur-Analysis (Download PDF)

Up-to-date information about this course can be found at:

http://www.math.ethz.ch/education/bachelor/lectures/hs2013/other/analysis3_ltet
## Mechanical Engineering Master - Key for Type

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
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</table>

## Key for Hours

<table>
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<tr>
<th>Code</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS (European Credit Transfer and Accumulation System)

- Special students and auditors need special permission from the lecturers.
### Educational Science

General course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0240-00L</td>
<td>Human Learning (EW1)</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>E. Stern</td>
</tr>
</tbody>
</table>

**Abstract**

This course looks into scientific theories and also empirical studies on human learning and relates them to the school.

**Objective**

Anyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.

**Content**

- Understand research methods used in the empirical educational sciences
- Understand findings relevant for education
- Get information about recent literature on learning and instruction
- Understand pedagogically relevant findings from the empirical educational sciences
- Get to know intelligence tests
- Get to know cognitively activating instructions in MINT subjects
- Understand research methods used in the empirical human sciences
- Understand and critically examine information from scientific journals and media
- Understand and critically examine information from scientific journals and media
- Understand pedagogically relevant findings from the empirical educational sciences
- Get to know intelligence tests
- Get to know cognitively activating instructions in MINT subjects
- Understand research methods used in the empirical educational sciences
- Understand and critically examine information from scientific journals and media
- Understand pedagogically relevant findings from the empirical educational sciences

**Lecture notes**

Folien werden zur Verfügung gestellt.

**Literature**


**Prerequisites / notice**

This course is only apt for students who intend to enrol in the programs "Lehrdiplom" or "Didaktisches Zertifikat". It is about learning in childhood and adolescence.

### 851-0242-05L

**Title**

Cognitively Activating Instructions in MINT Subjects

**Type**

W

**ECTS**

2 credits

**Hours**

2S

**Lecturers**

R. Schumacher

**Abstract**

This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW1)"

**Objective**

- Get to know cognitively activating instructions in MINT subjects
- Get information about recent literature on learning and instruction

**Prerequisites / notice**

Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

### 851-0242-07L

**Title**

Human Intelligence

**Type**

W

**ECTS**

1 credit

**Hours**

1S

**Lecturers**

E. Stern, P. Edelsbrunner, B. Rütsche

**Abstract**

This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW1)"

**Objective**

- Understanding of research methods used in the empirical human sciences
- Getting to know intelligence tests
- Understanding findings relevant for education

### 851-0242-08L

**Title**

Research Methods in Educational Science

**Type**

W

**ECTS**

1 credit

**Hours**

1S

**Lecturers**

P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler

**Abstract**

This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW1)"

**Objective**

- Literature from the learning sciences is critically discussed with a focus on research methods.
- At the first meeting, working groups will be assembled and two further meetings will be set up.
- In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.
- Understand research methods used in the empirical educational sciences
- Understand and critically examine information from scientific journals and media
- Understand pedagogically relevant findings from the empirical educational sciences

### 851-0240-22L

**Title**

Coping with Psychosocial Demands of Teaching (EW4 W)

**Type**

DZ

**ECTS**

2 credits

**Hours**

3S

**Lecturers**

A. Deiglmayr, P. Greutmann, S. Hofer
The successful participation in EW1 ("Human Learning") and EW2 ("Designing Learning Environments for School") is recommended, but not a mandatory prerequisite.

Abstract
In this class, students will learn concepts and skills for coping with psychosocial demands of teaching.

Objective
Students possess theoretical knowledge and practical competences to be able to cope with the psychosocial demands of teaching.

(1) They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents).

(2) They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions).

Subject Didactics and Professional Training

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1079-00L</td>
<td>Teaching Internship including Examination Lessons Mechanical and Process Engineering</td>
<td>W</td>
<td>6</td>
<td>13P</td>
<td>S. P. Kaufmann, J. Dual</td>
</tr>
</tbody>
</table>

The teaching internship can just be visited if all other courses of TC are completed. Repetition of the teaching internship is excluded even if the examination lessons are to be repeated.

Abstract
Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as assessed as Examination Lessons.

Objective
- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils' work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Content

Lecture notes
Dokument: schriftliche Vorbereitung für Prüfungslektionen.

Prerequisites / notice
Dieses Unterrichtspraktikum ist für Studierende, die sich ab dem HS 2011 ins DZ eingeschrieben haben. Alle anderen Lehrveranstaltungen des DZ sind erfolgreich abgeschlossen.

Further Subject Didactics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1061-00L</td>
<td>Subject Didactics I for D-MAVT and D-ITET</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>S. P. Kaufmann, J. Dual, M. Thaler</td>
</tr>
</tbody>
</table>

Abstract
Didactical methods in mechanical and electrical engineering.

Objective
- The students can plan, conduct and critically reflect single lessons.
- They orient themselves towards the academic goals and take into account existing knowledge, the professional environment and the ambitions of the students.
- They can apply the basic teaching principles meaningfully in their subject and suitably structure the learning phases.
- They can reduce and present complex technical content such that it is in a form suitable for the students to learn.
- They have considered examples of the common conceptual errors encountered by students

Content
- Didactic analysis
- Competences and goals
- Preparation and wrap-up of lessons
- Process and structure of a typical lesson
- Teaching techniques (informative introduction to lessons, Advance Organizer, learning assignments, frontal teaching, questions, assignments, feedback)
- Assignments and short tests
- Media and language competence
- Conceptual change, misconceptions,
- Integration of the subcomponents of a lesson.

Literature

Prerequisites / notice
Voraussetzung: Erziehungswissenschaftliche Lehrveranstaltung schon absolviert oder gleichzeitig.

Mentored Work in Didactics of Mechanical and Process Engineering

In their mentored work, the students combine and extend their knowledge of didactics of engineering to develop a syllabus. Based on didactical literature, they combine different teaching techniques and methods.

The students are able to develop a syllabus.

They reflect different forms of assessments and are able to use them appropriately.

Eine kurze Anleitung steht zur Verfügung.

Der Einsatz von geeigneter Literatur ist Teil des Leistungsauftrages.

Voraussetzung: Beide Fachdidaktik-Lehrveranstaltungen absolviert.

Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

### Mechanical and Process Engineering TC - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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</table>

### Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

### ECTS

- European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
### Examination Block A

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-0261-GUL</td>
<td>Analysis I</td>
<td>O</td>
<td>8 credits</td>
<td>5V+4U</td>
<td>U. Lang</td>
</tr>
</tbody>
</table>

**Abstract**
Differential and integral calculus for functions of one and several variables; vector analysis; ordinary differential equations of first and of higher order, systems of ordinary differential equations; power series. The mathematical methods are applied in a large number of examples from mechanics, physics and other areas which are basic to engineering.

**Objective**
Introduction to the mathematical foundations of engineering sciences, as far as concerning differential and integral calculus.

**Lecture notes**
U. Stammbach: Analysis I/II

**Prerequisites / notice**
Die Übungsaufgaben (inkl. Multiple Choice) sind ein wichtiger Bestandteil der Lehrveranstaltung. Es wird erwartet, dass Sie mindestens 75% der wöchentlichen Serien bearbeiten und zur Korrektur einreichen.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0151-00L</td>
<td>Linear Algebra</td>
<td>O</td>
<td>4 credits</td>
<td>3G+2U</td>
<td>V. C. Gradinaru</td>
</tr>
</tbody>
</table>

**Abstract**
Contents: Linear systems - the Gaussian algorithm, matrices - LU decomposition, determinants, vector spaces, least squares - QR decomposition, linear maps, eigenvalue problem, normal forms - singular value decomposition; numerical aspects; introduction to MATLAB.

**Objective**
Einführung in die Lineare Algebra für Ingenieure unter Berücksichtigung numerischer Aspekte

**Lecture notes**
K. Nipp / D. Stoffer, Lineare Algebra, vdf Hochschulverlag, 5. Auflage 2002

**Literature**
K. Nipp / D. Stoffer, Lineare Algebra, vdf Hochschulverlag, 5. Auflage 2002

### Examination Block B

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-3001-02L</td>
<td>Chemistry I</td>
<td>O</td>
<td>4 credits</td>
<td>2V+2U</td>
<td>C. Padeste, P. J. Walde, W. R. Caseri</td>
</tr>
</tbody>
</table>

**Abstract**
General Chemistry I: Stoichiometry, atoms, molecules, chemical bond and molecular structure, gases, solutions, chemical equilibrium, solubility, acids and bases, thermodynamics, electrochemistry, kinetics.

**Objective**
Introduction to general and inorganic chemistry.

**Content**
1. Stoichiometry: mole, chemical formulas and equations,
2. The atom (atomic properties and periodic system), the chemical bond (ionic oder covalent), Lewis formulas, resonance, electronegativity and polar bonds, VSEPR-model.
3. Ideal gases: Gas laws, kinetic gas theory.
4. Liquids, solutions, concentration.
5. Chemical equilibrium in the gas phase.
6. Solubility equilibria
8. Thermodynamics: Thermochemistry, enthalpy, entropy, Gibbs energy, Delta G and K, van't Hoff's equation.
9. Electrocchemistry: Oxidation number, half-reactions, electrochemical cells, standard potentials and the Nernst equation.

**Literature**

### Examination Block C

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-0103-00L</td>
<td>Introduction to Materials Science</td>
<td>O</td>
<td>3 credits</td>
<td>3G</td>
<td>L. Heyderman, M. Niederberger, P. Uggowitzer</td>
</tr>
</tbody>
</table>

**Abstract**
Fundamental knowledge and understanding of the atomistic and macroscopic concepts of material science.

**Objective**
Basic concepts in materials science.

**Content**
Contents:
- Atomic structure
- Atomic bonds
- Crystalline structure, perfection - imperfection
- Diffusion
- Mechanical and thermal properties
- Phase diagrams
- Kinetics
- Structural materials
- Electric, magnetic and optical properties of materials
- Materials selection criteria

**Literature**
James F. Shackelford
Introduction to Materials Science for Engineers

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-0104-00L</td>
<td>Crystallography</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>M. Fiebig</td>
</tr>
</tbody>
</table>

**Abstract**
Introduction into the fundamental relationships between chemical composition, crystal structure, symmetry and physical properties of solids. Emphasis: group-theoretical introduction into symmetry, discussion of the factors governing the formation of crystal structures, structural dependence of physical properties, fundamentals of experimental techniques probing the crystal structure.

**Objective**
Introduction into the fundamental relationships between chemical composition, crystal structure, symmetry and physical properties of solids.
Content
Symmetry and order: lattices, point groups, space groups.

Crystal chemistry: geometrical, physical and chemical factors governing the formation of crystal structures; close sphere packings; typical basic crystal structures; lattice energy; magnetic crystals; quasicrystals.

Structure/property relationships: Example quartz (piezoelectricity); perowskite and derivative structures (ferroelectrics and high-temperature superconductors); magnetic materials.

Materials characterization: diffraction techniques, optical techniques.

Lecture notes
A script of the lecture until 2014 is available. New script: to be decided.

Literature

Prerequisites / notice
Organisation: Two hours of lectures per week accompanied by one hour of exercises.

Additional Basic Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-0105-00L</td>
<td>Introduction to Scientific Practice for Material Scientists I</td>
<td>O</td>
<td>1</td>
<td>1G</td>
<td>S. Morgenthaler Kobas,</td>
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<td>M. B. Willeke</td>
</tr>
<tr>
<td>Abstract</td>
<td>The students are introduced to the scientific method, as it is applied in research and industry. The students practise acquiring, analysing and synthesising scientific information and data, and communicating their findings in written and oral form.</td>
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<tr>
<td>Objective</td>
<td>Learning Objectives:</td>
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<tr>
<td></td>
<td>The students</td>
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<tr>
<td></td>
<td>- can protocol lab experiments correctly in a lab journal.</td>
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<td></td>
<td>- can analyze and present data efficiently.</td>
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<td>- can write lab reports according to standard scientific criteria.</td>
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<td>- are familiar with key rhetorical and communication rules for oral presentations.</td>
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<td></td>
<td>- can create effective oral presentations on scientific content.</td>
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<tr>
<td>Content</td>
<td>Laborjournal führen</td>
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<tr>
<td></td>
<td>Datenauswertung</td>
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<tr>
<td></td>
<td>Berichte schreiben</td>
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<tr>
<td></td>
<td>Präsentationstechnik</td>
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<tr>
<td></td>
<td>Prüfungsvorbereitung</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Handouts werden laufend abgegeben.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Koordiniert mit der Lehrveranstaltung &quot;Praktikum I &amp; II&quot;.</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>327-0110-00L</th>
<th>Research Lab I</th>
<th>O</th>
<th>1 credit</th>
<th>1P</th>
<th>P. Uggowitzer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>A first look at the world of materials research</td>
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</tr>
<tr>
<td>Objective</td>
<td>Get to know the Department: Who is who? What kind of activities take place? What research is being done?</td>
<td></td>
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<tr>
<td></td>
<td>Get to know the scientific staff: Who can I ask for help?</td>
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<tr>
<td></td>
<td>A first look at materials research: Increase motivation through information</td>
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<tr>
<td></td>
<td>First experience in the research laboratory: Increase motivation through instruction</td>
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<tr>
<td>Content</td>
<td>Each student is assigned a tutor (selected by the Department Secretary) for the period of one semester. It is the task of the tutor to introduce his/her students to the world of materials through regular supervision and instruction. Students will accompany the tutor in his/her research work and so gain an insight into research routines.</td>
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<td></td>
<td>At the end of the semester students must deliver a report to the leader of the research group. This report is a prerequisite for receiving course credit.</td>
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<td></td>
<td>Tutors are also responsible for answering curriculum queries.</td>
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<td></td>
<td>Each semester tutors will be re-assigned.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>327-0111-00L</th>
<th>Practical Laboratory Course I</th>
<th>O</th>
<th>6 credits</th>
<th>6P</th>
<th>M. B. Willeke, M. R. Dusseiller, S. Morgenthaler Kobas, P. J. Walde</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Practical introduction into concepts and basic principles of Materials Science and Chemistry. To become acquainted with important chemical and physical methods.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Practical introduction into concepts and basic principles of Materials Science and Chemistry. To become acquainted with important chemical and physical methods. Close collaboration with the course &quot;Wissenschaftliches Arbeiten&quot; (planning of experiments, writing reports, techniques for oral presentations). General introduction at the beginning of the practical laboratory course I about safety and general behaviour in the laboratory.</td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>Content: Experiments in the field of synthetic and analytical chemistry, fracture mechanics, mechanical/thermal properties, surface techniques, thermodynamics, nanotechniques as well as corrosion and electroplating.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>The lab manual and further information for each experiment (aim of the experiment, theory, experimental procedure, data analysis) can be downloaded from the web (<a href="https://praktikum.mat.ethz.ch">https://praktikum.mat.ethz.ch</a> bzw. <a href="http://www.mat.ethz.ch/education/bachelor_degree/lab_courses">http://www.mat.ethz.ch/education/bachelor_degree/lab_courses</a>).</td>
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<table>
<thead>
<tr>
<th>401-0251-K0L</th>
<th>Analysis I</th>
<th>E-</th>
<th>0 credits</th>
<th>1K</th>
<th>U. Lang</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Tutorial for Analysis I</td>
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</table>

3. Semester

Basic Courses Part 2

Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0051-00L</td>
<td>Analytical Chemistry I</td>
<td>O</td>
<td>3</td>
<td>3G</td>
<td>D. Günter, M.O. Ebert, R. Zenobi</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction into the most important spectroscopical methods and their applications to gain structural information.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>Knowledge about the necessary theoretical background of spectroscopical methods and their practical applications</td>
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</tbody>
</table>
Die folgenden Kapitelnummern beziehen sich auf die Vorlesung grundlegende Lehrbuch "Biology" (Campbell & Rees, 7th edition, 2005).

Kapitel 1-4 des Lehrbuchs werden als Grundwissen vorausgesetzt

1. Aufbau der Zelle

Kapitel 5: Struktur und Funktion biologischer Makromoleküle
Kapitel 6: Eine Tour durch die Zelle
Kapitel 7: Membranstruktur und Funktion
Kapitel 8: Regulation des Stoffwechsels
Kapitel 9: Zelluläre Atmung und Speicherung chemischer Energie
Kapitel 10: Photosynthese
Kapitel 12: Der Zellzyklus
Kapitel 17: Vom Gen zum Protein

2. Allgemeine Genetik

Kapitel 13: Meiose und Reproduktionszyklen
Kapitel 14: Mendelsche Genetik
Kapitel 15: Die chromosomale Basis der Vererbung
Kapitel 16: Die molekulare Grundlage der Vererbung
Kapitel 18: Genetik von Bakterien und Viren
Kapitel 46: Tierische Reproduktion

Grundlagen des Stoffwechsels und eines Überblicks über molekulare Genetik

Der Vorlesungsstoff ist sehr nahe am Lehrbuch gehalten, Skripte werden ggf. durch die Dozenten zur Verfügung gestellt.
Das folgende Lehrbuch ist Grundlage für die Vorlesungen Biologie I und II:


### Examination Block 2

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0603-00L</td>
<td>Stochastics (Probability and Statistics)</td>
<td>O</td>
<td>4</td>
<td>2V+1U</td>
<td>J. Teichmann</td>
</tr>
<tr>
<td>Abstract</td>
<td>This class covers the following concepts: random variables, probability, discrete and continuous distributions, joint and conditional probabilities and distributions, the law of large numbers, the central limit theorem, descriptive statistics, statistical inference, inference for normally distributed data, point estimation, and two-sample tests.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>Knowledge of the basic principles of probability and statistics.</td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>Introduction to probability theory, some basic principles from mathematical statistics and basic methods for applied statistics.</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Literature</td>
<td>Lecture notes</td>
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### Examination Block 3

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-0300-00L</td>
<td>Programming Techniques in Materials Science</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>C. Ederer</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course introduces the general computing and programming skills which are necessary to perform numerical computations and simulations in materials science. This is achieved using the numerical computing environment Matlab and through the use of many practical examples and exercises.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>On passing this course, the students should be able to develop their own programs for performing numerical computations and simulations, and they should be able to analyse and amend existing code.</td>
<td></td>
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<tr>
<td>Content</td>
<td>Introduction to Matlab; input/output; structured programming using loops and conditional execution; modular Programming using functions; flow diagrams; numerical accuracy; example: random walk model.</td>
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</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-0301-00L</td>
<td>Materials Science I</td>
<td>O</td>
<td>3</td>
<td>3G</td>
<td>J. F. Löffler, A. R. Studart, P. Uggowitzer</td>
</tr>
<tr>
<td>Abstract</td>
<td>Basic concepts of metal physics, ceramics, polymers and their technology.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>Based on the lecture 'Introduction to Materials Science' this lecture aims to give a detailed understanding of important aspects of materials science, with special emphasis on metallic and ceramic materials.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Thermodynamics and phase diagrams, crystal interfaces and microstructure, diffusional transformations in solids, and diffusionless transformations will be presented for metallic alloys.

The basics of the ionic and covalent chemical bonds, the bond energy, the crystalline structure, four important structural ceramics, and the properties of glasses and glass ceramics will be presented for ceramic materials.

For metals see: http://www.methphys.mat.ethz.ch/education/courses/mat_wiss1/details

For ceramics see: http://www.complex.mat.ethz.ch/education/lectures.html

Metals:
D. A. Porter, K. E. Easterling
Phase Transformations in Metals and Alloys - Second Edition
ISBN: 0-7487-5741-4

Nelson Thorns

Ceramics:
- diverse CEN ISO Standards given in the slides
- Barsoum MW: Fundamentals of Ceramics:

- "Brevieral Ceramics" published by the "Verband der Keramischen Industrie e.V.", ISBN 3-924158-77-0. partly its contents may be found in the internet @ http://www.keramverband.de/brevier_engl/brevier.htm or on our homepage

- Silicon-Based Structural Ceramics (Ceramic Transactions), Stephen C. Danforth (Editor), Brian W. Sheldon, American Ceramic Society, 2003,
- Phase relationships in the zirconia-ytrria system, HGM Scott - Journal of Materials Science, 1975, Springer
- In the first part of the lecture the bases are obtained for metals. In the second part the basics of cermics will be presented.

Prerequisites / notice
- The lecture will be generally in German.

### Additional Basic Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-0311-00L</td>
<td>Practical Laboratory Course III ■</td>
<td>O</td>
<td>3 credits</td>
<td>6P</td>
<td>M. B. Willeke, J. Patscheider, S. Pokrant, P. J. Walde</td>
</tr>
</tbody>
</table>

Abstract
- To impart basic knowledge and experimental competence using selected examples from chemistry and physics.

Objective
- To impart basic knowledge and experimental competence using selected examples from chemistry and physics.

Content
Chemistry III: Synthesis of PMMA via Transesterification; manufacture of poly(methylmethacrylat) via radical polymerization of methylmethacrylat; 3D-printing.

Physics I: Powder diffractometry, single crystal radiography, capillary rheometry, viscoelasticity of the polymer melt (or an equivalent exp.), 2 physics Experiment at the EMPA: e.g. X-ray floourescence analysis, impedance measurements of batteries, cathode manufacturing for a Li-ion battery or texture measurement; and two further physics experiments at D-Phys (e.g. about "elastic constants" or "inference and diffraction")

Lecture notes
Notes with information for each experiment (aim of the experiment, theory, experimental procedure, data analysis) can be downloaded from the web (https://praktikum.mat.ethz.ch or http://www.mat.ethz.ch/education/bachelor_degree/lab_courses).

Prerequisites / notice

### Bachelor Studies (Programme Regulations 2012)

#### 3. Semester

#### Basic Courses Part 2

#### Examination Block 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0051-00L</td>
<td>Analytical Chemistry I</td>
<td>O</td>
<td>3 credits</td>
<td>3G</td>
<td>D. Günther, M.O. Ebert, R. Zenobi</td>
</tr>
</tbody>
</table>

Abstract
- Knowledge about the necessary theoretical background of spectroscopical methods and their practical applications

Objective
- Application oriented basics of organic and inorganic instrumental analysis and of the empirical employment of structure elucidation methods

Content
- Mass spectrometry; Ionization methods, mass separation, isotope signals, rules of fragmentation, rearrangements.
- NMR spectroscopy; Experimental basics, chemical shift, spin-spin coupling.
- IR spectroscopy; Revisiting topics like harmonic oscillator, normal vibrations, coupled oscillating systems (in accordance to the basics of the related lecture in physical chemistry); sample preparation, acquisition techniques, law of Lambert and Beer, interpretation of IR spectra; Raman spectroscopy
- UV/VIS spectroscopy; Basics, interpretation of electron spectra. Circular dichroism (CD) und optical rotation dispersion (ORD).
- Atomic absorption, emission, and X-ray fluorescence spectroscopy; Basics, sample preparation.
Stochastics (Probability and Statistics)

2V+1U

This class covers the following concepts: random variables, probability, discrete and continuous distributions, joint and conditional probabilities and distributions, the law of large numbers, the central limit theorem, descriptive statistics, statistical inference, inference for normally distributed data, point estimation, and two-sample tests.

401-0603-00L

Stochastics (Probability and Statistics)

- Basic Concepts
- Modeling: Vibrating String, Wave Equation
- Solution by separation of variables; use of Fourier series
- D'Alembert Solution of Wave Equation, Characteristics
- Heat Equation: Solution by Fourier Series
- Heat Equation: Solutions by Fourier Integrals and Transforms
- Modeling Membrane: Two Dimensional Wave Equation
- Solution of PDEs by Laplace Transform

Analysis III

2V+1U

Introduction to partial differential equations. Differential equations which are important in applications are classified and solved. Elliptic, parabolic and hyperbolic differential equations are treated. The following mathematical tools are introduced: Laplace transforms, Fourier series, separation of variables, methods of characteristics.

401-0363-10L

Analysis III

- Laplace Transforms:
  - Laplace Transform, Inverse Laplace Transform, Linearity, s-Shifting
  - Transforms of Derivatives and Integrals, DEs
  - Unit Step Function, t-Shifting
  - Short Impulses, Dirac's Delta Function, Partial Fractions
  - Convolution, Integral Equations
  - Differentiation and Integration of Transforms

- Fourier Series, Integrals and Transforms:
  - Fourier Series
  - Functions of Any Period p=2L
  - Even and Odd Functions, Half-Range Expansions
  - Forced Oscillations
  - Approximation by Trigonometric Polynomials
  - Fourier Integral
  - Fourier Cosine and Sine Transform

Part 5: Partial Differential Equations

- Basic Concepts
- Modeling: Vibrating String, Wave Equation
- Solution by separation of variables; use of Fourier series
- D'Alembert Solution of Wave Equation, Characteristics
- Heat Equation: Solution by Fourier Series
- Heat Equation: Solutions by Fourier Integrals and Transforms
- Modeling Membrane: Two Dimensional Wave Equation
- Solution of PDEs by Laplace Transform

Data: 06.02.2019 13:00 Autumn Semester 2015
For metals see:

For reference/complement of the Analysis I/II courses:
Christian Blatter: Ingenieur-Analysis (Download PDF)
Up-to-date information about this course can be found at:
http://www.math.ethz.ch/education/bachelor/lectures/hs2013/other/analysis3_itet

327-0308-00L Programming Techniques in Materials Science

Abstract
This course introduces the general computing and programming skills which are necessary to perform numerical computations and simulations in materials science. This is achieved using the numerical computing environment Matlab and through the use of many practical examples and exercises.

Objective
On passing this course, the students should be able to develop their own programs for performing numerical computations and simulations, and they should be able to analyse and amend existing code.

Content
Introduction to Matlab; input/output; structured programming using loops and conditional execution; modular Programming using functions; flow diagrams; numerical accuracy; example: random walk model.

Examination Block 3

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>327-0301-00L</td>
<td>Materials Science I</td>
<td>O</td>
<td>3</td>
<td>3G</td>
<td>J. F. Löffler, A. R. Studart, P. Uggowitzer</td>
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</table>

Abstract
Basic concepts of metal physics, ceramics, polymers and their technology.

Objective
Based on the lecture 'Introduction to Materials Science' this lecture aims to give a detailed understanding of important aspects of materials science, with special emphasis on metallic and ceramic materials.

Content
Thermodynamics and phase diagrams, crystal interfaces and microstructure, diffusionless transformations will be presented for metallic alloys.
Thermodynamics and phase diagrams, crystal interfaces and microstructure, diffusionless transformations will be presented for metallic alloys.

Lecture notes
For metals see:
http://www.metphys.mat.ethz.ch/education/courses/mat_wiss1/details
For ceramics see:
http://www.complex.mat.ethz.ch/education/lectures.html

Literature
Metals:
D. A. Porter, K. E. Easterling
Phase Transformations in Metals and Alloys - Second Edition
ISBN : 0-7487-5741-4
Nelson Thornes

Ceramics:
diverse CEN ISO Standards given in the slides
- Barsoum MW: Fundamentals of Ceramics:

- "Brevieral Ceramics" published by the "Verband der Keramischen Industrie e.V.", ISBN 3-924158-77-0. partly its contents may be found in the internet @ http://www.keramverband.de/brevier_engl/brevier.htm or on our homepage

- Silicon-Based Structural Ceramics (Ceramic Transactions), Stephen C. Danforth (Editor), Brian W. Sheldon, American Ceramic Society, 2003,
- Phase relationships in the zirconia-ytrria system, HGM Scott - Journal of Materials Science, 1975, Springer

Prerequisites / notice
For metals:
- "Brevieral Ceramics" published by the "Verband der Keramischen Industrie e.V.", ISBN 3-924158-77-0. partly its contents may be found in the internet @ http://www.keramverband.de/brevier_engl/brevier.htm or on our homepage
- Silicon-Based Structural Ceramics (Ceramic Transactions), Stephen C. Danforth (Editor), Brian W. Sheldon, American Ceramic Society, 2003,

For ceramics:
- Phase relationships in the zirconia-ytrria system, HGM Scott - Journal of Materials Science, 1975, Springer
Die folgenden Kapitelnummern beziehen sich auf das der Vorlesung zugrundeliegende Lehrbuch "Biology" (Campbell & Rees, 7th edition, 2005)
Kapitel 1-4 des Lehrbuchs werden als Grundwissen vorausgesetzt

1. Aufbau der Zelle
Kapitel 5: Struktur und Funktion biologischer Makromoleküle
Kapitel 6: Eine Tour durch die Zelle
Kapitel 7: Membranstruktur und -funktion
Kapitel 8: Einführung in den Stoffwechsel
Kapitel 9: Zelluläre Atmung und Speicherung chemischer Energie
Kapitel 10: Photosynthese
Kapitel 12: Der Zellzyklus
Kapitel 17: Vom Gen zum Protein

2. Allgemeine Genetik
Kapitel 13: Meiose und Reproduktionszyklen
Kapitel 14: Mendelsche Genetik
Kapitel 15: Die chromosomale Basis der Vererbung
Kapitel 16: Die molekulare Grundlage der Vererbung
Kapitel 18: Genetik von Bakterien und Viren
Kapitel 46: Tierische Reproduktion

Grundlagen des Stoffwechsels und eines Überblicks über molekulare Genetik

Lecture notes
Der Vorlesungsstoff ist sehr nahe am Lehrbuch gehalten, Skripte werden ggf. durch die Dozenten zur Verfügung gestellt.

Literature
Das folgende Lehrbuch ist Grundlage für die Vorlesungen Biologie I und II:

Prerequisites / notice

Additional Basic Courses

<table>
<thead>
<tr>
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<tr>
<td>327-0311-00L</td>
<td>Practical Laboratory Course III</td>
<td>O</td>
<td>3 credits</td>
<td>6P</td>
<td>M. B. Wilkeke, J. Pat scheider, S. Pokrant, P. J. Walde</td>
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Abstract
To impart basic knowledge and experimental competence using selected examples from chemistry and physics.

Objective
To impart basic knowledge and experimental competence using selected examples from chemistry and physics.

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Chemistry III: Synthesis of PMMA via Transesterification; manufacture of poly(methylenacrylat) via radical polymerization of methylmethacrylat; 3D-printing.
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Lecture notes
Notes with information for each experiment (aim of the experiment, theory, experimental procedure, data analysis) can be downloaded from the web (https://praktikum.mat.ethz.ch or http://www.mat.ethz.ch/education/bachelor_degree/lab_courses).

Prerequisites / notice

5. Semester

Basic Courses Part 2

Exam block 5

<table>
<thead>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>327-0407-00L</td>
<td>Basic Principles of Materials</td>
<td>O</td>
<td>6 credits</td>
<td>3V+2U</td>
<td>P. Gambardella</td>
</tr>
</tbody>
</table>

Abstract
This course introduces classical and quantum mechanical concepts for the understanding of material properties from a microscopic point of view. The lectures focus on the static and dynamic properties of crystals, the formation of chemical bonds and electronic bands in molecules, insulators, metals, and semiconductors, and on the thermal and electrical properties that emerge from this analysis.

Objective
Providing physical concepts for the understanding of material properties:
Understanding the electronic properties of solids is at the heart of modern society and technology. The aim of this course is to provide fundamental concepts that allow the student to relate the microscopic structure of matter and the quantum mechanical behavior of electrons to the macroscopic properties of materials. Beyond fundamental curiosity, such level of understanding is required in order to develop and appropriately describe new classes of materials for future technology applications. By the end of the course the student should have developed a semi-quantitative understanding of basic concepts in solid state physics and be able to appreciate the pertinence of different models to the description of specific material properties.
PART I: Structure of solid matter, real and reciprocal space

The crystal lattice, Bravais lattices, primitive cells and unit cells, Wigner-Seitz cell, primitive lattice vectors, lattice with a basis, examples of 3D and 2D lattices.

Fourier transforms and reciprocal space, reciprocal lattice vectors, Brillouin zones


PART II: Dynamics of atoms in crystals

Lattice vibrations and phonons in 1D, phonons in 1D chains with monoatomic basis, phonon in 1D chains with a diatomic basis, optical and acoustic modes, phase and group velocities, phonon dispersion and eigenvectors. Phonons in 2D and 3D.

Quantum mechanical description of lattice waves in solids, the harmonic oscillator, the concept of phonon, phonon statistics, Bose-Einstein distribution, phonon density of states, Debye and Einstein models, thermal energy, heat capacity of solids.

PART III: Electron states and energy bands in molecules and solids

Electronic properties of materials, classical concepts: electrical conductivity, Hall effect, thermoelectric effects. Drude model. Transition to quantum models and review of quantum mechanical concepts.

Introduction to molecular orbital theory and linear combination of atomic orbitals (LCAO). The H2+ molecule, homonuclear and heteronuclear molecules, benzene, sigma and pi bonds, sp3 and sp2 hybridization. From molecules to periodic crystal structures.

The free electron gas: Fermi statistics, Fermi energy and Fermi surface, density of states in k-space and as a function of energy. Inadequacy of the free electron model.


PART IV: Electrical and heat conduction

Dynamics of electrons in energy bands, phase and group velocity, crystal momentum, the effective mass concept, scattering phenomena. The equilibrium and non-equilibrium distribution function for electrons. The Boltzmann equation in the presence of external fields in the relaxation time approximation.

Electrical and thermal conductivities revisited. Electron transport due to electric fields (drift) and concentration gradients (diffusion). Einstein's relations. Transport of heat by electrons, Seebeck effect and thermopower, Peltier effect, thermoelectric cooling, thermoelectric energy conversion.

PART V: Semiconductors: concepts and devices


Literature
- H. Ibach, H. Lüth: Solid-State Physics (Springer: 2003), available as eBook from the ETH library, also in German.
- C. Kittel, Introduction to Solid State Physics (Wiley, 2005), also available in German.

Prerequisites / notice
Physics I and II. Knowledge of basic quantum mechanical concepts. The lecture will be given in English. The script will be available in English.

327-0504-00L Simulation Techniques in Materials Science

Abstract
Introduction to simulation techniques that are relevant for material science. Simulation methods for continua (finite differences, finite elements), mesoscopic methods (cellular automata, mesoscopic Monte Carlo methods), microscopic methods (Molecular Dynamics, Monte-Carlo simulations, Density Functional Theory).

Objective
Learn techniques which are used in the computer-based study of the physics of materials; Obtain an overview of which simulation techniques are useful for which type of problems; develop the capability to transform problems in materials science into a form suitable for computer studies, including writing the computer program and analyzing the results.

Content
- Modeling and simulation techniques in materials science.
- Simulation methods for continua (finite differences, basic idea of finite elements).
- Mesoscopic methods (Cellular automata, phase-field models, mesoscopic Monte Carlo methods).
- Microscopic methods (Molecular dynamics, Monte-Carlo simulation for many-particle systems, basic idea of density functional theory).

Literature
### Metals I

**Abstract**
Repetition and advancement of dislocation theory. Mechanical properties of metals: hardening mechanisms, high temperature plasticity, alloying effects. Case studies in alloying to illustrate the mechanisms.

**Objective**
Repetition and advancement of dislocation theory. Mechanical properties of metals: hardening mechanisms, high temperature plasticity, alloying effects. Case studies in alloying to illustrate the mechanisms.

**Content**
- Dislocation theory:
  - Properties of dislocations, motion and kinetics of dislocations, dislocation-dislocation and dislocation-boundary interactions, consequences of partial dislocations, sessile dislocations
- Hardening theory:
  - a. solid solution hardening: case studies in copper-nickel and iron-carbon alloys
  - b. particle hardening: case studies on aluminium-copper alloys
- High temperature plasticity:
  - thermally activated glide
  - power-law creep
  - diffusional creep: Coble, Nabarro-Herring
  - deformation mechanism maps
- Case studies in turbine blades
- Superplasticity
- Alloying effects

**Lecture notes**
https://www.met.mat.ethz.ch/education/lect_scripts

**Literature**
- Gottstein, Physikalische Grundlagen der Materialkunde, Springer Verlag
- Haasen, Physikalische Metallkunde, Springer Verlag
- Rösler/Harders/Bäker, Mechanisches Verhalten der Werkstoffe, Teubner Verlag
- Porter/Easterling, Transformations in Metals and Alloys, Chapman & Hall
- Hull/Bacon, Introduction to Dislocations, Butterworth & Heinemann
- Courtney, Mechanical Behaviour of Materials, McGraw-Hill

### Polymers I

**Abstract**
Physical foundations of single polymer molecules and interacting chains.

**Objective**
The course offers a modern approach to the understanding of universal static and dynamic properties of polymers.

**Content**
- Polymer Physics:
  1. Introduction to Polymer Physics, Random Walks
  2. Excluded Volume
  3. Structure Factor from Scattering Experiments
  4. Persistence
  5. Solvent and Temperature Effects
  6. Flory theory
  7. Self-consistent field theory
  8. Interacting Chains, Phase Separation and Critical Phenomena
  9. Rheology
  10. Numerical methods in polymer physics, computer experiments

**Lecture notes**
A script can be found at http://www.polyphys.mat.ethz.ch/education/polymer_physics

**Literature**

**Prerequisites / notice**
Computer experiments will use the simple MATLAB programming language and will be made available, if necessary or useful.

### Ceramics I

**Abstract**
Introduction to ceramic processing.

**Objective**
The aim is the understanding of the basic principles of ceramic processing.

**Content**
- Basic chemical processes for powder production.
- Liquid-phase synthesis methods.
- Sol-Gel processes.
- Classical crystallization theory.
- Gas phase reactions.
- Basics of the colloidal chemistry for suspension preparation and control.
- Characterization techniques for powders and colloids.
- Shaping techniques for bulk components and thin films.
- Sintering processes and microstructural control.

**Lecture notes**
See: https://www.multimat.mat.ethz.ch/education/courses/ceramics1

**Literature**
Books and references will be given on the lecture notes.

### Biological and Bio-inspired Materials

**Abstract**
The aim of this course is to impart knowledge on the underlying principles governing the design of biological materials and on strategies to fabricate synthetic model systems whose structural organization resembles those of natural materials.

**Objective**
The course first offers a comprehensive introduction to evolutionary aspects of materials design in nature and a general overview about the most common biopolymers and biominerals found in biological materials. Next, current approaches to fabricate bio-inspired materials are presented, followed by a detailed evaluation of their structure-property relationships with focus on mechanical, optical, surface and adaptive properties.
Content

This course is structured in 3 blocks:

Block (I): Fundamentals of engineering in biological materials
- Biological engineering principles
- Basic building blocks found in biological materials

Block (II): Replicating biological design principles in synthetic materials
- Biological and bio-inspired materials: polymer-reinforced and ceramic-toughened composites
- Lightweight biological and bio-inspired materials
- Functional biological and bio-inspired materials: surfaces, self-healing and adaptive materials

Block (III): Bio-inspired design and systems
- Bio-inspiration in the building environment
- Future developments in bio-inspired materials

Lecture notes

Copies of the slides will be made available for download before each lecture.

Literature

The course is mainly based on the books listed below. Additional references will be provided during the lectures.


Basic Courses Part 3

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>327-0511-00L</td>
<td>Practical Course V</td>
<td>O</td>
<td>6 credits</td>
<td>8P</td>
<td>M. B. Willeke, J. F. Löffler, P. Uggowitzer</td>
</tr>
</tbody>
</table>

Abstract

Acquisition of independent scientific-technical skills; project management; organization and undertaking of experiments; interpretation, scientifically and technically correct project presentation in oral and written form.

Objective

Acquisition of independent scientific/technical skills; project management; organization and conducting of experiments; interpretation and scientifically/technically correct presentation of projects in oral and written form.

Content

Supervision by DMATL research groups
Groups of students (2 or 3 per group) each work on a research project throughout the semester.

Prerequisites / notice

Prerequisite: Successful participation in the "Praktika I - IV" (courses within the material science bachelor study at ETH) or comparable practical lab courses.

Compensatory Courses

Only possible after consultation with the Director of Studies.

Industrial Internship or Project

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-0001-00L</td>
<td>Industrial Internship ▲</td>
<td>W</td>
<td>10 credits</td>
<td>external organisers</td>
<td></td>
</tr>
</tbody>
</table>

Abstract

12 weeks of industrial internship which is completed with a written report.

Objective

The main objective of the 12-week internship is to expose bachelor's students to the industrial work environment. During this period, students have the opportunity to be involved in on-going projects at the host institution.

327-0002-00L | Project ▲                     | W    | 10 credits | 21P   | Lecturers                      |

Abstract

Project in a research group at ETH or at an University of 12 weeks. The project is completed with a written report.

Objective

The main objective of the 12-week research project is to expose bachelor's students to the professional research environment. During this period, students have the opportunity to be involved in on-going projects at the host institution.

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-MATL.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Materials Science Bachelor - Key for Type

| O  | Compulsory       | E-  | Recommended, not eligible for credits |
| W+ | Eligible for credits and recommended | Z   | Courses outside the curriculum |
| W  | Eligible for credits | Dr  | Suitable for doctorate |

Key for Hours

| V  | lecture         | P   | practical/laboratory course |
| G  | lecture with exercise | A   | independent project |
| U  | exercise        | D   | diploma thesis |
| S  | seminar         | R   | revision course / private study |
| K  | colloquium      |     |                             |

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Materials Science Master

Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-0505-00L</td>
<td>Surfaces, Interfaces and their Applications</td>
<td>W</td>
<td>3</td>
<td>2V+1U</td>
<td>N. Spencer, M. P. Heuberger, L. Isa</td>
</tr>
</tbody>
</table>

Abstract
After being introduced to the physical/chemical principles and importance of surfaces and interfaces, the student is introduced to the most important techniques that can be used to characterize surfaces. Later, liquid interfaces are treated, followed by an introduction to the fields of tribology (friction, lubrication, and wear) and corrosion.

Objective
To gain an understanding of the physical and chemical principles, as well as the tools and applications of surface science, and to be able to choose appropriate surface-analytical approaches for solving problems.

Content

- Physical Structure of Surfaces
- Surface Forces (static and dynamic)
- Adsorbates on Surfaces
- Surface Thermodynamics and Kinetics
- The Solid-Liquid Interface
- Electron Spectroscopy
- Vibrational Spectroscopy on Surfaces
- Scanning Probe Microscopy
- Introduction to Tribology
- Introduction to Corrosion Science

Lecture notes
Script Download: https://www.surface.mat.ethz.ch/education/courses/surfaces Interfaces_and_their_applications_i

Literature

- Script (20 CHF)

Prerequisites / notice
Chemistry:
- General undergraduate chemistry
- including basic chemical kinetics and thermodynamics

Physics:
- General undergraduate physics
- including basic theory of diffraction and basic knowledge of crystal structures

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-1201-00L</td>
<td>Transport Phenomena I</td>
<td>W Dr</td>
<td>4</td>
<td>4G</td>
<td>H. C. Öttinger</td>
</tr>
</tbody>
</table>

Abstract
Phenomenological approach to "Transport Phenomena" based on balance equations supplemented by thermodynamic considerations to formulate the undetermined fluxes in the local species mass, momentum, and energy balance equations; fundamentals, applications, and simulations

Objective
The teaching goals of this course are on five different levels:

1. Deep understanding of fundamentals: local balance equations, constitutive equations for fluxes, entropy balance, interfaces, idea of dimensionless numbers, ...
2. Ability to use the fundamental concepts in applications
3. Insight into the role of boundary conditions
4. Knowledge of a number of applications
5. Flavor of numerical techniques: finite elements, finite differences, lattice Boltzmann, Brownian dynamics, ...

Content

- Approach to Transport Phenomena
- Diffusion Equation
- Brownian Dynamics
- Refreshing Topics in Equilibrium Thermodynamics
- Balance Equations
- Forces and Fluxes
- Measuring Transport Coefficients
- Pressure-Driven Flows
- Heat Exchangers
- Complex Fluids

Lecture notes
A detailed manuscript is provided; this manuscript will be developed into a book entitled "A Modern Course in Transport Phenomena" by David C. Venerus and Hans Christian Öttinger

Literature


Prerequisites / notice

Complex numbers. Vector analysis (integrability; Gauss' divergence theorem), Laplace and Fourier transforms. Ordinary differential equations (basic ideas). Linear algebra (matrices; functions of matrices; eigenvectors and eigenvalues; eigentations). Probability theory (Gaussian distributions; Poisson distributions; averages; moments; variances; random variables). Numerical mathematics (integration), Equilibrium thermodynamics (Gibbs' fundamental equation; thermodynamic potentials; Legendre transforms), Maxwell equations, Programming and simulation techniques (Matlab, Monte Carlo simulations).

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<tr>
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</thead>
<tbody>
<tr>
<td>327-1202-00L</td>
<td>Solid State Physics and Chemistry of Materials</td>
<td>W Dr</td>
<td>4</td>
<td>4G</td>
<td>N. Spaldin</td>
</tr>
</tbody>
</table>

Abstract
In this course we study how the properties of solids are determined from the chemistry and arrangement of the constituent atoms, with a focus on materials that are not well described by conventional band theories because their behavior is governed by strong quantum-mechanical interactions.

Objective
Electronic properties and band theory description of conventional solids
- Electron-lattice coupling and its consequences in functional materials
- Electron-spin/orbit coupling and its consequences in functional materials
- Structure/property relationships in strongly-correlated materials

Content
In this course we study how the properties of solids are determined from the chemistry and arrangement of the constituent atoms, with a focus on materials that are not well described by conventional band theories because their behavior is governed by strong quantum-mechanical interactions. We begin with a review of the successes of band theory in describing many properties of metals, semiconductors and insulators, and we practise building up band structures from atoms and describing the resulting properties. Then we explore classes of systems in which the coupling between the electrons and the lattice is so strong that it drives structural distortions such as Peierls instabilities, John-Teller distortions, and ferroelectric transitions. Next, we move on to strong couplings between electronic charge and spin-and/or orbital- angular momentum, yielding materials with novel magnetic properties. We end with examples of the complete breakdown of single-particle band theory in so-called strongly correlated materials, which comprise for example heavy-fermion materials, frustrated magnets, materials with unusual metal-insulator transitions and the high-temperature superconductors.

Literature
Hand-outs with additional reading will be made available during the course.

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 1004 of 1434
Complex Materials I: Synthesis & Assembly

W Dr 4 credits 4G M. Niederberger, D. Koziej

Introduction to materials synthesis concepts based on the assembly of differently shaped objects of varying chemical nature and length scales.

Objective
The aim is a) to learn how to design and create objects as building blocks with a particular shape and a defined recognition pattern, b) to understand the chemistry that allows for the creation of such hard and soft objects within a certain size range, and c) to master the concepts to assemble these objects into hierarchically structured materials.

Content
The course is divided into two parts: I) synthesis of 0-, 1-, 2-, and 3-dimensional building blocks with a length scale from nm to µm, and II) assembly of these building blocks into 1-, 2- and 3-dimensional structures over several length scales up to cm. In part I, various methodologies for the synthesis of the building blocks will be discussed, including Turkevich and Brust-Schiffrin-method for gold nanoparticles, hot-injection for semiconducting quantum dots, aqueous and nonaqueous sol-gel chemistry for metal oxides, or gas- and liquid-phase routes to carbon nanostructures.

Part II is focused on self- and directed assembly methods that can be used to create higher order architectures from those building blocks connecting the microscopic with the macroscopic world. Examples include photonic crystals, nanocrystal solids, colloidal molecules, mesocrystals or particle-based foams and aerogels.

Materials at Work I

W Dr 4 credits 4S R. Spolenak, R. Koopmans

This course attempts to prepare the student for a job as a materials engineer in industry. The gap between fundamental materials science and the materials engineering of products should be bridged. The focus lies on the practical application of fundamental knowledge allowing the students to experience application related materials concepts with a strong emphasis on case-study mediated learning.

Objective
Teaching goals:

- to learn how materials are selected for a specific application
- to understand how materials around us are produced and manufactured
- to understand the value chain from raw material to application
- to be exposed to state of the art technologies for processing, joining and shaping
- to be exposed to industry related materials issues and the corresponding language (terminology) and skills
- to create an impression of how a job in industry "works", to improve the perception of the demands of a job in industry
- to be exposed to state of the art technologies for processing, joining and shaping
- to understand the value chain from raw material to application
- to create an impression of how a job in industry "works", to improve the perception of the demands of a job in industry

Content
This course is designed as a two semester class and the topics reflect the contents covered in both semesters.

Lectures and case studies encompass the following topics:

- Strategic Materials (where do raw materials come from, who owns them, who owns the IP and can they be substituted)
- Materials Selection (what is the optimal material (class) for a specific application)
- Materials systems (subdivisions include all classical materials classes)
- Processing
- Joining (assembly)
- Shaping
- Materials and process scaling (from nm to m and vice versa, from mg to tons)
- Sustainable materials manufacturing (cradle to cradle) Recycling (Energy recovery)

After a general part of materials selection, critical materials and materials and design four parts consisting of polymers, metals, ceramics and coatings will be addressed.

In the fall semester the focus is on the general part, polymers and alloy case studies in metals. The course is accompanied by hands-on analysis projects on everyday materials.

Soft Materials II

W Dr 4 credits 4G J. Vermant, L. Isa

In the second part of the course we will introduce the experimental tools to study the materials at the invariably wide range of length scales, which are embedded in the microstructures that generate the desired properties.

Objective
Students should be able to learn which experimental tools may help to troubleshoot a problem. A key aspect is that students should learn to see which are the "knobs that can be turned", by playing with the chemistry of the building blocks, the formulation, the physical chemistry or not the process technology.

Advanced Composite and Adaptive Material Systems

W 4 credits 2V+2U G. P. Terrasi, F. J. Clemens
Crack-flaws cannot be neglected in engineering analysis. Even microscopic crack flaws can grow over time, ultimately resulting in fractured components. Structures that may have been blindly deemed "safe" could fail disastrously, causing injuries to its users, or the loss of life.

The course gives the tools to a successful application of fracture mechanics concepts to failure analysis. The aim of this course is to impart knowledge on the underlying principles governing the design of biological materials and on strategies to fabricate synthetic model systems whose structural organization resembles those of natural materials.

The students should know the possibilities and limitations of the use of standard materials as well as get an idea of new innovative materials and processes. The course gives the tools to a successful application of fracture mechanics concepts to failure analysis.

The topics covered are:

- Introduction to Linear Elastic Fracture Mechanics (LEFM): crack tip stress, strain and displacement fields in linear elastic materials (Modes I, II and III); the stress-intensity factor, K; the fracture toughness KIC and their determination; fracture criterion
- Estimates of crack plastic zones in ductile materials
- The compliance method; experimental determination of compliance
- Introduction to fracture mechanics of nonlinear materials: the J-integral; the JIc fracture criterion; JIc testing
- Application of fracture mechanics concepts in the analysis of subcritical crack growth (fatigue, stress corrosion cracking, creep and their combinations)
- Lifetime determination and prediction; failure analysis.


Prerequisite:

- ETH-course 327-0610 Composite Materials or similar course

Course content:

Objective

The course gives tools to a successful application of fracture mechanics concepts to failure analysis. The aim of this course is to impart knowledge on the underlying principles governing the design of biological materials and on strategies to fabricate synthetic model systems whose structural organization resembles those of natural materials.

The topics covered are:

- Introduction to Linear Elastic Fracture Mechanics (LEFM): crack tip stress, strain and displacement fields in linear elastic materials (Modes I, II and III); the stress-intensity factor, K; the fracture toughness KIC and their determination; fracture criterion
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- Application of fracture mechanics concepts in the analysis of subcritical crack growth (fatigue, stress corrosion cracking, creep and their combinations)
- Lifetime determination and prediction; failure analysis.


Prerequisite:

- ETH-course 327-0610 Composite Materials or similar course

Course content:
This course is structured in 3 blocks:

### Block (I): Fundamentals of Engineering in Biological Materials
- Biological engineering principles
- Basic building blocks found in biological materials

### Block (II): Replicating Biological Design Principles in Synthetic Materials
- Biological and bio-inspired materials: polymer-reinforced and ceramic-toughened composites
- Lightweight biological and bio-inspired materials
- Functional biological and bio-inspired materials: surfaces, self-healing and adaptive materials

### Block (III): Bio-inspired Design and Systems
- Bio-inspiration in the building environment
- Future developments in bio-inspired materials

**Lecture notes**
Copies of the slides will be made available for download before each lecture.

**Literature**
The course is mainly based on the books listed below. Additional references will be provided during the lectures.


<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>327-0702-00L</td>
<td>EM-Practical Course in Materials Science</td>
<td>W 2 credits</td>
<td>H. Gross, R. Erni, S. Gerstl, F. Gramm, F. Krumeich, K. Kunze, J. F. Löffler, J. Reuteler, R. A. Wepf</td>
</tr>
<tr>
<td>Abstract</td>
<td>Practical work on a TEM and on SEM, treatment of typical problems, data analysis, writing of a report</td>
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<tr>
<td>Objective</td>
<td>Application of basic electron microscopic techniques to materials science problems</td>
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<td></td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prerequisite: the lecture Electron Microscopy (327-0703-00L) has to be attended with success, maximum number of participants 15, work in groups of 3 people.</td>
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<tr>
<td>Abstract</td>
<td>A comprehensive understanding of the interaction of electrons with condensed matter and details on the instrumentation and methods designed to use these probes in the structural and chemical analysis of various materials.</td>
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<tr>
<td>Objective</td>
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<tr>
<td>Content</td>
<td>This course provides a general introduction into electron microscopy of organic and inorganic materials. In the first part, the basics of transmission- and scanning electron microscopy are presented. The second part includes the most important aspects of specimen preparation, imaging and image processing. In the third part, recent applications in materials science, solid state physics, structural biology, structural geology and structural chemistry will be reported.</td>
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<tr>
<td>Lecture notes</td>
<td>Englisch</td>
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<tr>
<td>327-2105-00L</td>
<td>Supramolecular Aspects of Polymers</td>
<td>W 2 credits</td>
<td>P. J. Walde</td>
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<tr>
<td>Abstract</td>
<td>Preparation, characterization and applications of polymeric aggregates formed from amphiphilic block copolymers.</td>
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<tr>
<td>Objective</td>
<td>To become acquainted with the principles of the self-assembly of amphiphilic block copolymers into micelles and vesicles and to become acquainted with some of the properties and applications of these aggregates.</td>
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<tr>
<td>Content</td>
<td>With selected recent examples on the self-assembly of amphiphilic block copolymers several basic aspects and possible applications will be discussed. The focus will mainly be on micelles and vesicles.</td>
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<tr>
<td>Lecture notes</td>
<td>no script</td>
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<tr>
<td>151-0605-00L</td>
<td>Nanosystems</td>
<td>W 4 credits</td>
<td>A. Stemmer, J. N. Tisserant</td>
</tr>
<tr>
<td>Abstract</td>
<td>From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles. Intermolecular forces, their macroscopic manifestations, and ways to control such interactions. Self-assembly and directed assembly of 2D and 3D structures. Special emphasis on the emerging field of molecular electronic devices.</td>
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<tr>
<td>Objective</td>
<td>Familiarize students with basic science and engineering principles governing the nano domain.</td>
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<tr>
<td>Content</td>
<td>The course addresses basic science and engineering principles ruling the nano domain. We particularly work out the links between topics that are traditionally taught separately. Special emphasis is placed on the emerging field of molecular electronic devices, their working principles, applications, and how they may be assembled. Topics are treated in 2 blocks:</td>
<td></td>
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<tr>
<td>(I) From Quantum to Continuum</td>
<td>From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles.</td>
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<tr>
<td>(II) Interaction Forces on the Micro and Nano Scale</td>
<td>Intermolecular forces, their macroscopic manifestations, and ways to control such interactions. Self-assembly and directed assembly of 2D and 3D structures.</td>
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</tbody>
</table>
Course format:
Lectures and Mini-Review presentations: Thursday 10-13, ML F 36

Homework: Mini-Reviews
Students select a paper (list distributed in class) and expand the topic into a Mini-Review that illuminates the particular field beyond the immediate results reported in the paper.

Abstract
The course gives an introduction to the use of synchrotron radiation in materials science. It treats the generation of intense x-ray beams at synchrotron radiation sources and their use for the characterisation of materials properties at different length scales. As part of the course, experiments will be carried out at the Swiss Light Source, Paul Scherrrer Institut.

Objective
A comprehensive understanding of the interaction of x-rays with condensed matter and their use in materials analysis; acquiring hands-on experience with the use of synchrotron radiation.

Content
Interaction of x-rays with matter:
- Elastic scattering from bound electron, atom and assemblies of atoms; Compton scattering; principles of diffraction from crystals and scattering from disordered systems; thermal diffuse scattering, small-angle scattering from nanometre-sized objects; X-ray absorption spectroscopy; microscopy; comparison with neutron scattering, where appropriate.
- The generation of high-brilliance x-ray beams at synchrotron radiation sources:
- Undulators, wigglers and bending magnets; comparison with conventional lab sources; the future x-ray free electron laser.

New methods:
Coherent x-ray scattering and diffractive imaging.

Determination of materials properties:
Crystal structure; defects and strain fields; structure of surfaces and interfaces; chemical bonding properties.

Prerequisites / notice
Part of the course is in the form of practical work at the Swiss Light Source. During two days (dates to be agreed), the following experiments will be performed: (1) elastic and Compton scattering, (2) liquid scattering and powder diffraction, and (4) X-ray absorption spectroscopy.

Literature

The lab course has been designed by J. Als-Nielsen in collaboration with staff from the SLS.
There is no specific literature recommendation. Numerous references will be provided for an easy access to the original literature.

### Content

I. Anionic polymerization

1. General
2. Living polymerization
3. Group transfer polymerization (GTP)
4. Some recent developments

II. Cationic polymerization

1. General
2. Some applications (macromonomer and telechelics)

III. Ziegler/Natta- and metallocene polymerization

1. General
2. Mechanism
3. Some applications

IV. Ring-opening metathesis polymerization

1. Comments on history
2. Monomers, catalysts, polymer structures
3. Mechanism, direct NMR monitoring
4. Termination
5. Examples

V. Controlled radical polymerization

1. Nitroxide mediated polymerization (NMP)
2. Atom transfer radical polymerization (ATRP)
3. Reversible addition fragmentation chain transfer polymerization (RAFT)

For step-growth procedures and other topics (dendrimers, bottle-brushes, macrocycles, topochemical polymerizations etc.) see Advanced Polymer Synthesis

#### Literature

There is no specific literature recommendation. Numerous references will be provided for an easy access to the original literature.

#### Prerequisites / notice

The course will be taught in English. Complicated expressions will be explained in German. Questions can be asked in both languages. The examination will be in English; answers are acceptable in both languages. PhD students who need recognized credit points are required to pass the written exam.

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<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Lectures</th>
<th>Credits</th>
<th>Literature</th>
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<tr>
<td>752-2314-00L</td>
<td>Physics of Food Colloids</td>
<td>W</td>
<td>3 credits</td>
<td>P. A. Fischer, R. Mezzenga</td>
</tr>
<tr>
<td>327-1220-00L</td>
<td>Crystal Optics with Intense Light Sources</td>
<td>W Dr</td>
<td>4 credits</td>
<td>M. Fiebig</td>
</tr>
<tr>
<td>327-0811-00L</td>
<td>Industrial Research and Development at the Interface of Biomaterials and Drug Delivery</td>
<td>W Dr</td>
<td>1 credit</td>
<td>L. B. Uebersax, J. Goldhahn, F. Schlottig, R. Streicher</td>
</tr>
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*Autumn Semester 2015*

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Data: 06.02.2019 13:00 Autumn Semester 2015 Page 1009 of 1434
Abstract
This course will provide an up-to-date, comprehensive review of the industrial perspective at the interface of biomaterials and drugs. This covers regulatory, clinical, pre-clinical and manufacturing concepts. The presentations are provided in an effort to maximize the interaction of student and lecturer.

Objective
- The student will be able to categorize a drug-biomaterial as a "drug" or a "material" from a regulatory perspective and can summarize general regulatory pathways for material/drug development.
- The student will be able to summarize the current concepts and challenges for the industry at the material-drug interface.

Content
This course will provide an up-to-date comprehensive review of the industrial perspective at the interface of biomaterials and drugs. General concepts related to regulatory affairs or such as cost-conscious planning of manufacturing processes will be covered by interactive case-studies and in close interaction between students and lecturers. The course covers the future at the biomaterial - implant interface - as it is seen by the industry today - and will be reviewed by experienced and long-standing faculty from industry with the aim to provide a balanced, insightful perspective. From that, clinical development concepts, regulatory pathways and real-life case studies will be discussed with the students. Finally the students - working in small groups of 4-5 - will outline a development pathway for an industrial project and present it to the course and in presence of all faculty to receive maximum feedback to their approaches.

The student will become familiar with the major elements required for a successful development and which challenges have to be taken into account to translate an idea into a successful product.

Projects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<td>327-1210-00L</td>
<td>Project I</td>
<td>O</td>
<td>12 credits</td>
<td>26A</td>
<td>Professors</td>
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<tr>
<td>Abstract</td>
<td>Independent scientific practice of 6 weeks which is completed with a written report.</td>
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<tr>
<td>Objective</td>
<td>Projects, with themes from the chosen scientific fields of interest, are intended to familiarise candidates with scientific procedures and operational methodologies through supervised participation in current research work.</td>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>327-1211-00L</td>
<td>Project II</td>
<td>O</td>
<td>12 credits</td>
<td>26A</td>
<td>Professors</td>
</tr>
<tr>
<td>Abstract</td>
<td>Independent scientific practice of 6 weeks which is completed with a written report.</td>
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<td>Objective</td>
<td>Projects, with themes from the chosen scientific fields of interest, are intended to familiarise candidates with scientific procedures and operational methodologies through supervised participation in current research work.</td>
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Master Thesis

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>327-9000-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30 credits</td>
<td>64D</td>
<td>Professors</td>
</tr>
<tr>
<td>Abstract</td>
<td>Independent scientific work of current topics in the field of materials science. Duration 6 months. The work is documented in a written form.</td>
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<tr>
<td>Objective</td>
<td>Master thesis is a six month fulltime project and will encourage the students to work independently and in a structured and scientific way. It is guided by a professor of the Department of Materials.</td>
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</table>

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-MATL.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capacity

see GESS Compulsory Electives: Language Courses ETH/UZH

Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>327-0401-AAL</td>
<td>Materials Science II</td>
<td>E-</td>
<td>3 credits</td>
<td>6R</td>
<td>A. D. Schlüter, J. Kübler</td>
</tr>
<tr>
<td>Abstract</td>
<td>Physical properties and fracture mechanics of brittle materials.</td>
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<tr>
<td>Objective</td>
<td>The composition and microstructures of the most important ceramic materials are introduced. Microstructures and heterogenous phase equilibria and the properties of the four most important structural ceramics and glass are given. An introduction to fracture mechanics of brittle materials will allow to predict the survival probabilities and life time of components under static and dynamic load.</td>
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<tr>
<td>Content</td>
<td>To achieve a basic understanding for what polymers are like, how one can make them accessible and characterize them and, finally, which properties result from their chemical structure.</td>
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<tr>
<td></td>
<td>The basics of the chemical bonds of ceramics and glass will be presented. Heterogenous phase equilibria and the properties of the four most important structural ceramics are given. An introduction to fracture mechanics of brittle materials will allow to predict the survival probabilities and life time of components under static and dynamic load.</td>
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<tr>
<td></td>
<td>This introductory course discusses definitions, introduces types of polyreactions, and compares chain and step-growth polymerizations. It also treats the constitution of homo- and copolymers and networks as well as the configuration and conformation of polymers. Topics of interest are contour length, coil formation, the mobility in polymers, glass temperature, rubber elasticity, molecular weight distribution, energetics of polyreactions, and examples for polyreactions (polyadditions, polycondensations, polymerizations). Selected polymerization mechanisms and procedures are discussed. Some methods of molecular weight determination are introduced.</td>
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</tbody>
</table>

Lecture notes
For ceramics see:
http://www.complex.mat.ethz.ch/education/lectures.html
The course provides a solid working knowledge in thermodynamics (as the appropriate language for treating a variety of problems in materials science) and in statistical mechanics (as a systematic tool to find thermodynamic potentials for specific problems).

The second part of the lecture gives an introduction to polymers, their composition and properties.

- Modern Ceramic Engineering; David Richerson, Ed. 2, Dekker, 1992.


Prerequisites / notice

Both literatures will be made available in the course upon request.

In the first part of the lecture the bases are obtained for structural ceramics.

327-0406-AAL

<table>
<thead>
<tr>
<th>Basic Principles of Materials Physics A</th>
<th>E-</th>
<th>5 credits</th>
<th>11R</th>
<th>A. Gusev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enrolment only for MSc students who need this course as additional admission requirement.</td>
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</tbody>
</table>

Abstract

Foundations and applications of equilibrium thermodynamics and statistical mechanics, supplemented by an elementary theory of transport phenomena.

Objective

The course provides a solid working knowledge in thermodynamics (as the appropriate language for treating a variety of problems in materials science) and in statistical mechanics (as a systematic tool to find thermodynamic potentials for specific problems).

Content

Thermodynamics, Statistical Mechanics
1. Introduction
2. Foundations of Thermodynamics
3. Applications of Thermodynamics
4. Foundations of Classical Statistical Mechanics
5. Applications of Classical Statistical Mechanics
6. Elementary Theory of Transport Phenomena

Lecture notes

Ein Leitfaden und ein zusammenfassender Artikel werden auf der oben angegebenen Website zur Lehrveranstaltung zur Verfügung gestellt.

Literature


327-0407-AAL

<table>
<thead>
<tr>
<th>Basic Principles of Materials Physics B</th>
<th>E-</th>
<th>6 credits</th>
<th>13R</th>
<th>P. Gambardella</th>
</tr>
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<tbody>
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<td>Enrolment only for MSc students who need this course as additional admission requirement.</td>
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</tbody>
</table>

Abstract

This course introduces classical and quantum mechanical concepts for the understanding of material properties from a microscopic point of view. The lectures focus on the static and dynamic properties of crystals, the formation of chemical bonds and electronic bands in molecules, insulators, metals, and semiconductors, and on the thermal and electrical properties that emerge from this analysis.

Objective

Providing physical concepts for the understanding of materials properties.

Content

PART I: Structure of solid matter, real and reciprocal space
The crystal lattice, Bravais lattices, primitive cells and unit cells, Wigner-Seitz cell, primitive lattice vectors, lattice with a basis, examples of 3D and 2D lattices. Fourier transforms and reciprocal space, reciprocal lattice vectors, Brillouin zones Elastic and inelastic scattering of elementary particles with matter (x-rays, neutrons, electrons). Interaction of x-rays with matter. X-ray diffraction, Bragg condition, atomic scattering factors, scattering length, absorption and refraction.

PART II: Dynamics of atoms in crystals
Lattice vibrations and phonons in 1D, phonons in 1D chains with monoatomic basis, phonon in 1D chains with a diatomic basis, optical and acoustic modes, phase and group velocities, phonon dispersion and eigenvectors. Phonons in 2D and 3D. Quantum mechanical description of lattice waves in solids, the harmonic oscillator, the concept of phonon, phonon statistics, Bose-Einstein distribution, phonon density of states, Debye and Einstein models, thermal energy, heat capacity of solids.

PART III: Electron states and energy bands in molecules and solids

PART IV: Electrical and heat conduction
Dynamics of electrons in energy bands, phase and group velocity, crystal momentum, the effective mass concept, scattering phenomena. The equilibrium and non-equilibrium distribution function for electrons. The Boltzmann equation in the presence of external fields in the relaxation time approximation. Electrical and thermal conductivities revisited. Electron transport due to electric fields (drift) and concentration gradients (diffusion). Einstein's relations. Transport of heat by electrons, Seebeck effect and thermopower, Peltier effect, thermoelectric cooling, thermoelectric energy conversion.

PART V: Semiconductors: concepts and devices

Lecture notes

will be available.
Literature

- H. Ibach, H. Lüth: Solid-State Physics (Springer: 2003), available as eBook from the ETH library, also in German.
- C. Kittel, Introduction to Solid State Physics (Wiley, 2005), also available in German.

Prerequisites / notice

The lecture will be given in English. The script will be available in English.

327-0506-AAL  Materials Physics  E-  2 credits  4R  P. Gambardella

Enrolment only for MSc students who need this course as additional admission requirement.

Abstract

Extended concepts of material physics and analytical description of material-physical problems.

Objective

Building on the lectures 'Introduction to Materials Science' and 'Materials Science I + II' this lecture aims to give a deepened physical understanding of Materials Science.

Content

1. Thermal vacancies and diffusion
2. Nucleation and growth; diffusion-controlled and diffusion-less phase transitions
3. Spinodal decomposition and anharmonic effects
4. Dislocation energy/stacking faults; recovery; recrystallization; solidification

Lecture notes

See http://www.metphys.mat.ethz.ch/education/courses/matphysik

Literature

- H. Ibach, H. Lüth: Solid-State Physics (Springer: 2003), available as eBook from the ETH library, also in German.
- C. Kittel, Introduction to Solid State Physics (Wiley, 2005), also available in German.

327-0503-AAL  Ceramics I  E-  3 credits  6R  M. Niederberger, T. Graule, A. R. Studart

Enrolment only for MSc students who need this course as additional admission requirement.

Abstract

Introduction to ceramic processing

Objective

The aim is the understanding of the basic principles of ceramic processing.

Content

Basic chemical processes for powder production.
Liquid-phase synthesis methods.
Sol-Gel processes.
Classical crystallization theory.
Gas phase reactions.
Characterization techniques for powders and colloids.
Shaping techniques for bulk components and thin films.
Sintering processes and microstructural control.

Lecture notes

See: https://www.multimat.mat.ethz.ch/education/courses/ceramics1

Literature


327-0603-AAL  Ceramics II  E-  3 credits  6R  A. R. Studart, K. Conder

Enrolment only for MSc students who need this course as additional admission requirement.

Abstract

Introduction to ceramic processing

Objective

The aim is the understanding of the basic principles of ceramic processing.

Content

Basic chemical processes for powder production.
Liquid-phase synthesis methods.
Sol-Gel processes.
Solubility product.
Principle of Le Chatelier.
Classical crystallization theory.
Gas phase reactions.
Characterization techniques for powders and colloids.
Shaping techniques for bulk components and thin films.
Sintering processes and microstructural control.

Lecture notes

See: https://www.multimat.mat.ethz.ch/education/courses/ceramics1

Literature


327-0502-AAL  Polymers I  E-  3 credits  6R  M. Kröger

Enrolment only for MSc students who need this course as additional admission requirement.

Abstract

Physical foundations of single polymer molecules and interacting chains.

Objective

The course offers a modern approach to the understanding of universal static and dynamic properties of polymers.

Content

Polymer Physics:
1. Introduction to Polymer Physics, Random Walks
2. Excluded Volume
3. Structure Factor from Scattering Experiments
4. Persistence
5. Solvent and Temperature Effects
6. Flory Theory
7. Self-consistent field theory
8. Interacting Chains, Phase Separation and Critical Phenomena
9. Rheology
10. Numerical methods in polymer physics, computer experiments

Lecture notes

A script can be found at http://www.polypphys.mat.ethz.ch/education/polymer_physics

Literature


Prerequisites / notice

Computer experiments will use the simple MATLAB programming language and will be made available, if necessary or useful.

327-0606-AAL  Polymers II  E-  3 credits  6R  P. Smith, T.B. Schweizer,
Enrolment only for MSc students who need this course as additional requirement.

**Abstract**

Principles of polymer technology

**Objective**

To obtain an understanding of the engineering aspects of structure and properties of solid polymers. Influence of polymer processing on properties of solid polymers.

**Content**

1. Crystallization of semi-crystalline polymers
2. Glass transition of amorphous polymers
3. Mechanical properties of solid polymers
4. Examples of polymer processing
5. Laboratory exercises

**Lecture notes**

http://www.polytech.mat.ethz.ch/education/courses/PolymerI

**Literature**

W. Kaiser, Kunststoffchemie für Ingenieure (Hanser, München, 2005)

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**327-0501-AAL**  **Metals I**  **E-**  **3 credits**  **6R**  **R. Spolenak**

Enrolment only for MSc students who need this course as additional admission requirement.

**Abstract**

Repetition and advancement of dislocation theory. Mechanical properties of metals: hardening mechanisms, high temperature plasticity, alloying effects. Case studies in alloying to illustrate the mechanisms.

**Objective**

Repetition and advancement of dislocation theory. Mechanical properties of metals: hardening mechanisms, high temperature plasticity, alloying effects. Case studies in alloying to illustrate the mechanisms.

**Content**

Dislocation theory:
- Properties of dislocations, motion and kinetics of dislocations, dislocation-dislocation and dislocation-boundary interactions, consequences of partial dislocations, sessile dislocations
- Hardening theory:
  - a. solid solution hardening: case studies in copper-nickel and iron-carbon alloys
  - b. particle hardening: case studies on aluminium-copper alloys
- High temperature plasticity:
  - thermally activated glide
  - power-law creep
  - diffusional creep: Coble, Nabarro-Herring
- deformation mechanism maps
- Case studies in turbine blades
- superplasticity
- alloying effects

**Lecture notes**

https://www.met.mat.ethz.ch/education/lect_scripts

**Literature**

Gottstein, Physikalische Grundlagen der Materialkunde, Springer Verlag
Haasen, Physikalische Metallkunde, Springer Verlag
Rösler/Harders/Bäker, Mechanisches Verhalten der Werkstoffe, Teubner Verlag
Porter/Easterling, Transformations in Metals and Alloys, Chapman & Hall
Hull/Bacon, Introduction to Dislocations, Butterworth & Heinemann
Courtney, Mechanical Behaviour of Materials, McGraw-Hill

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**327-0612-AAL**  **Metals II**  **E-**  **3 credits**  **6R**  **R. Spolenak, M. Diener**

Enrolment only for MSc students who need this course as additional requirement.

**Abstract**

Introduction to materials selection. Basic knowledge of major metallic materials: aluminium, magnesium, titanium, copper, iron and steel. Selected topics in high temperature materials: nickel and iron-base superalloys, intermetallics and refractory metals.

**Objective**

Introduction to materials selection. Basic knowledge of major metallic materials: aluminium, magnesium, titanium, copper, iron and steel. Selected topics in high temperature materials: nickel and iron-base superalloys, intermetallics and refractory metals.

**Content**

This course is divided into five parts:

A. Materials selection
- Principles of materials properties maps
- Introduction to the 'Materials selector' software package
- Case studies

B. Light metals and alloys
- Aluminium, magnesium, titanium
- Properties and hardening mechanisms
- Case studies in technological applications

C. Copper and its alloys

D. Iron and steel
- The seven pros for steel
- Fine grained steels, heat resistant steels
- Steel and corrosion phenomena
- Selection and application

E. High temperature alloys
- Superalloys: iron, nickel, cobalt
- Intermetallics: properties and application

**Lecture notes**

http://www.met.mat.ethz.ch/education/lect_scripts

**Literature**

Gottstein, Physikalische Grundlagen der Materialkunde, Springer Verlag
Ashby/Jones, Engineering Materials 1 & 2, Pergamon Press
Ashby, Materials Selection in Mechanical Design, Pergamon Press
Porter/Easterling, Transformations in Metals and Alloys, Chapman & Hall
Bürgel, Handbuch Hochtemperatur-Werkstofftechnik, Vieweg Verlag

**Prerequisites / notice**

Prerequisites: Metals I

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**327-0610-AAL**  **Advanced Composites**  **E-**  **3 credits**  **6R**  **F. J. Clemens, A. Winistörfer**

Enrolment only for MSc students who need this course as additional requirement.
Abstract
Introduction of basic concepts for composites with polymer- metal- and ceramic matrix composites; production and properties of composites reinforced with particles, whiskers, short and long fibres; selection criteria, case histories of applications, recycling, future perspectives, and basic concepts for adaptive and functional composites.

Objective
Gain an insight into the diversity of opportunities to change the properties of composites, learn about the most important applications and processing techniques.

Content
1. Introduction
   1.1 What are advanced composites?
   1.2 What are materials by combination?
   1.3 Are composites an idea of today?
   1.4 Delphi foresight
   1.5 Why composites?
   1.6 References for chapter 1

2. Basic modules
   2.1 Particles
   2.2 Short fibres including whiskers
   2.3 Long fibres
   2.4 Matrix materials
   2.4.1 Polymers
   2.4.2 Metals
   2.4.3 Ceramics and glasses
   2.5 References for chapter 2

3. PMC: Polymer Matrix Composites
   3.1 Historical background
   3.2 Types of PMC-laminates
   3.3 Production, processing and machining operation
   3.4 Mechanics of reinforcement, microstructure, interfaces
   3.5 Failure criteria
   3.6 Fatigue behaviour of a multiply composite
   3.7 Adaptive materials systems
   3.8 References for chapter 3

4. MMC: Metal matrix composites
   4.1 Introduction: Definitions, selection criteria und "design"
   4.2 Types von MMCs - examples und typical properties
   4.3 Mechanical and physical properties of MMCs - basics of design, influencing variables and damage mechanisms
   4.4 Production processes
   4.5 Micro structure / interfaces
   4.6 machining operations for MMC
   4.7 Applications
   4.8 References for chapter 4

5. CMC: Ceramic Matrix Composites
   5.1 Introduction and historical background
   5.2 Modes of reinforcement
   5.3 Production processes
   5.4 Mechanisms of reinforcement
   5.5 Micro structure / interfaces
   5.6 Properties
   5.7 Applications
   5.8 Materials testing and quality assurance
   5.9 References for chapter 5

Lecture notes
The script will be delivered at the begin of the semester

Literature
The script is including a comprehensive list of references

Prerequisites / notice
Before each class, students will get a handout. Students will get the power point presentation of each class by e-mail.

The exercises take place in small groups. It is their goal to deepen knowledge gained in the classes

written end of semester examination

Materials Science Master - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
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<td>W+</td>
<td>Eligible for credits and recommended</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
<tr>
<td>ECTS</td>
<td>European Credit Transfer and Accumulation System</td>
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Key for Hours

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<th>Key</th>
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<td>V</td>
<td>lecture</td>
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<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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Special students and auditors need special permission from the lecturers.
### Mathematics (General Courses)

#### Generally Accessible Seminars and Colloquia

<table>
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<th>Number</th>
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<tr>
<td>401-5000-00L</td>
<td>Zurich Colloquium in Mathematics</td>
<td>E-</td>
<td>0</td>
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<td>W. Werner, P. L. Bühlmann, M. Burger, S. Mishra, R. Pandharipande, University lecturers</td>
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<tr>
<td>401-5960-00L</td>
<td>Colloquium on Mathematics, Computer Science, and Education</td>
<td>E-</td>
<td>0</td>
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<td>N. Hungerbühler, M. Akveld, J. Hromkovic, H. Klemenz</td>
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</table>

**Abstract**

Didactics colloquium

#### Major in Insurance Mathematics

Further pieces of information are available at Prof. P. Embrechts’s secretariat, HG F42.

#### Economics and Business Administration

<table>
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<tr>
<th>Number</th>
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<tr>
<td>363-0711-00L</td>
<td>Accounting for Managers</td>
<td>E-</td>
<td>3</td>
<td>2V</td>
<td>J.P. Chardonnens</td>
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</table>

**Abstract**

Overview of financial and managerial accounting

Accounting for current and fixed assets

Liabilities and owners equity

Recording change in balance sheet

Measuring financial performance

Managing financial reporting

Full and variable costing system

Using accounting information for decision making purposes

Record change in financial position

Measure business income

Prepare final accounts

Understand the principles of cost accounting

Calculate the different product costs

Make decisions about the acceptance or rejection of a particular product

Financial Accounting: Balance sheet, income statement, double-entry accounting, journal and ledger, accounting for merchandising activities, value-added tax, adjustments before final accounts, provisions, depreciation, valuation,

Managerial Accounting: Full costing, variable costing, cost-volume profit, break-even analysis, activity-based costing

**Objective**

Understand the different procedures involved in the accounting system

Prerequisites / notice

This course is a prerequisite for the course Financial Management.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<tr>
<td>401-3611-00L</td>
<td>Advanced Topics in Computational Statistics</td>
<td>Z</td>
<td>4</td>
<td>2V</td>
<td>M. H. Maathuis, M. Mächler</td>
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</table>

**Abstract**

This lecture covers selected advanced topics in computational statistics, including various classification methods, the EM algorithm, clustering, handling missing data, and graphical modelling.

**Objective**

Students learn the theoretical foundations of the selected methods, as well as practical skills to apply these methods and to interpret their outcomes.

**Content**

The course is roughly divided in three parts: (1) Supervised learning via (variations of) nearest neighbor methods, (2) the EM algorithm and clustering, (3) handling missing data and graphical models.

**Lecture notes**

Lecture notes.

**Prerequisites / notice**

We assume a solid background in mathematics, an introductory lecture in probability and statistics, and at least one more advanced course in statistics.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<tr>
<td>401-3627-00L</td>
<td>High-Dimensional Statistics</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>P. L. Bühlmann</td>
</tr>
</tbody>
</table>

**Abstract**

“High-Dimensional Statistics” deals with modern methods and theory for statistical inference when the number of unknown parameters is of much larger order than sample size. Statistical estimation and algorithms for complex models and aspects of multiple testing will be discussed.

**Objective**

Knowledge of methods and basic theory for high-dimensional statistical inference

**Content**

Lasso and Group Lasso for high-dimensional linear and generalized linear models; Additive models and many smooth univariate functions; Non-convex loss functions and l1-regularization; Stability selection, multiple testing and construction of p-values; Undirected graphical modeling

**Literature**


**Prerequisites / notice**

Knowledge of basic concepts in probability theory, and intermediate knowledge of statistics (e.g. a course in linear models or computational statistics).

#### Principles of Law and Practical Training

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<tr>
<td>851-0703-00L</td>
<td>Introduction to Law</td>
<td>E-</td>
<td>2</td>
<td>2V</td>
<td>O. Streifl Gnöpff</td>
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</table>

**Abstract**

Students who have attended or will attend the lecture "Introduction to Law for Civil Engineering and Architecture" or "Introduction to Law" (851-0708-00), cannot register for this course unit.

Particularly suitable for students of D-MAVT, D-MATL

This class introduces students into basic features of the legal system. Fundamental issues of constitutional law, administrative law, private law and the law of the EU are covered.

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 1015 of 1434
Objective
Students are able to identify basic structures of the legal system. They understand selected topics of public and private law and are able to apply the fundamentals in more advanced law classes.

Content
Basic concepts of law, sources of law.
Private law: Contract law (particularly contract for work and services), tort law, property law.
Public law: Human rights, administrative law, procurement law, procedural law.
Insights into the law of the EU and into criminal law.

Lecture notes
Jaap Hage, Bram Akkermans (Eds.), Introduction to Law, Cham 2014 (Online Resource ETH Library)

Literature
Further documents will be available online (see https://moodle-app2.let.ethz.ch/course/view.php?id=1596).

Mathematics (General Courses) - Key for Type

<table>
<thead>
<tr>
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<th>Description</th>
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Key for Hours

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ECTS European Credit Transfer and Accumulation System

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First Year Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>401-1261-07L</td>
<td>Analysis I</td>
<td>O</td>
<td>10</td>
<td>6V+3U</td>
<td>H. Knörrer</td>
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<tr>
<td>Abstract</td>
<td>Introduction to the differential and integral calculus in one real variable: fundamentals of mathematical thinking, numbers, sequences, basic point set topology, continuity, differentiable functions, ordinary differential equations, Riemann integration.</td>
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<tr>
<td>Objective</td>
<td>The ability to work with the basics of calculus in a mathematically rigorous way.</td>
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</tr>
<tr>
<td>Literature</td>
<td>K. Koenigsberger: Analysis I, Springer-Verlag</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>R. Courant: Introduction to Calculus and Analysis, Sprotger Verlag</td>
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<tr>
<td></td>
<td>V. Zorich: Mathematical Analysis I, Springer Verlag 2009</td>
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<tr>
<td></td>
<td>H. Heuser: Lehrbuch der Analysis, Teubner Verlag</td>
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<td></td>
<td>W. Walter: Analysis I. Springer Verlag</td>
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<td></td>
<td>O. Forster: Analysis I. Vieweg Verlag</td>
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<tr>
<td></td>
<td>J. Appell: Analysis in Beispielen und Gegenbeispielen, Springer Verlag <a href="http://www.springerlink.com/content/q67803/?p=091fa376aade4c0f982b2145fe2cee40&amp;pi=4">http://www.springerlink.com/content/q67803/?p=091fa376aade4c0f982b2145fe2cee40&amp;pi=4</a></td>
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<tr>
<th>Number</th>
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<th>Hours</th>
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</tr>
</thead>
<tbody>
<tr>
<td>401-1151-00L</td>
<td>Linear Algebra I</td>
<td>O</td>
<td>7</td>
<td>4V+2U</td>
<td>E. Kowalski</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to the theory of vector spaces for mathematicians and physicists including solutions of linear equations, linear transformations, determinants, eigenvalues and eigenvectors, bilinear forms, canonical forms for matrices, and selected applications, part I.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>Mastering basic concepts of Linear Algebra</td>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>402-1701-00L</td>
<td>Physics I</td>
<td>O</td>
<td>7</td>
<td>4V+2U</td>
<td>G. Dissertori</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course gives a first introduction to Physics. The emphasis is on classical mechanics, together with an introduction to thermodynamics.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>Acquiring knowledge of the basic principles regarding the physics of classical mechanics and thermodynamics. Skills in solving physics problems.</td>
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<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>252-0847-00L</td>
<td>Computer Science</td>
<td>O</td>
<td>5</td>
<td>2V+2U</td>
<td>B. Gärtner</td>
</tr>
<tr>
<td>Abstract</td>
<td>This lecture is an introduction to programming based on the language C++. We cover fundamental types, control statements, functions, arrays, and classes. The concepts will be motivated and illustrated through algorithms and applications.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>The goal of this lecture is an algorithmically oriented introduction to programming.</td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>This lecture is an introduction to programming based on the language C++. We cover fundamental types, control statements, functions, arrays, and classes. The concepts will be motivated and illustrated through algorithms and applications.</td>
<td></td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Lecture notes in English and Handouts in German will be distributed electronically along with the course.</td>
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</tbody>
</table>

Compulsory Courses

Examination Block I

In Examination Block I either the course unit 402-2883-00L Physics III or the course unit 402-2203-01L Classical Mechanics must be chosen and registered for an examination. (Students may also enrol for the other of the two course units; within the ETH Bachelor Programme Mathematics, this other course unit cannot be registered for an examination. Knowledge of classical mechanics is presupposed in the spring semester core course 402-0224-00L Theoretical Physics.)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-2303-00L</td>
<td>Complex Analysis</td>
<td>O</td>
<td>6</td>
<td>3V+2U</td>
<td>R. Pandharipande</td>
</tr>
<tr>
<td>Abstract</td>
<td>Complex functions of one variable, Cauchy-Riemann equations, Cauchy theorem and integral formula, singularities, residue theorem, index of closed curves, analytic continuation, special functions, conformal mappings, Riemann mapping theorem.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Working Knowledge with functions of one complex variables; in particular applications of the residue theorem</td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>Th. Gamelin: Complex Analysis. Springer 2001</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>D. Salamon: &quot;Funktionentheorie&quot;. Birkhauser, 2011. (In German)</td>
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<tr>
<td></td>
<td>R. Remmert: Theory of Complex Functions. Springer Verlag</td>
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</tbody>
</table>
**Core Courses**

**Core Courses: Pure Mathematics**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3531-00L</td>
<td>Differential Geometry I</td>
<td>W</td>
<td>10</td>
<td>4+1U</td>
<td>M. Burger</td>
</tr>
</tbody>
</table>

**Objective**: This course is an introduction to differential and Riemannian geometry.

**Literature**:
- W. Boothby "An introduction to differential manifolds and Riemannian geometry"
- J.M. Lee "Introduction to smooth manifolds"
- M.P. Do Carmo "Riemannian Geometry"
### Functional Analysis I

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Lecture Credits</th>
<th>Author(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3461-00L</td>
<td>10</td>
<td>4V+1U</td>
<td>D. A. Salamon</td>
</tr>
</tbody>
</table>

**Abstract**

Baire category; Banach and Hilbert spaces, bounded linear operators; Three Fundamental Principles: Uniform Boundedness, Open Mapping/Closed Graph, Hahn-Banach; Convexity; Dual Spaces: weak and weak* topologies, Banach-Alaoglu, reflexive spaces; Ergodic Theorem; compact operators and Fredholm theory, Closed Image Theorem; Spectral theory, self-adjoint operators.

**Lecture notes**

Lecture Notes on “Functional Analysis” by D.A. Salamon

### Dynamical Systems I

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Lecture Credits</th>
<th>Author(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3371-00L</td>
<td>10</td>
<td>4V+1U</td>
<td>W. Merry</td>
</tr>
</tbody>
</table>

**Abstract**

This course is a Part I of a broad introduction to dynamical systems. Topic covered include topological dynamics, symbolic dynamics, ergodic theory, hyperbolic dynamics. In Part II (FS 2016), we will cover low-dimensional dynamics, complex dynamics, measure-theoretic entropy and Hamiltonian dynamics.

**Objective**

Mastery of the basic methods and principal themes of dynamical systems.

**Content**

The course introduces the principal themes of modern dynamical systems. Topics covered include:

1. Topological dynamics  
   (transitivity, attractors, chaos, structural stability)
2. Symbolic dynamics  
   (Perron-Frobenius theorem, zeta functions)
3. Ergodic theory  
   (Poincare recurrence theorem, Birkhoff ergodic theorem, existence of invariant measures)
4. Hyperbolic dynamics  
   (Groban-Hartman theorem, Shadowing lemma, Closing lemma and applications)

**Literature**

The most relevant textbook for this course is Introduction to Dynamical Systems, Brin and Stuck, CUP, 2002.

Another excellent book (which will be relevant also for Dynamical Systems II) is Lectures on Dynamical Systems, Zehnder, EMS 2010.

A more advanced textbook which covers everything in both Dynamical Systems I and II (and much more) is Introduction to the Modern Theory of Dynamical Systems, Katok and Hasselblatt, CUP, 1995.

**Prerequisites / notice**

The material of the basic courses of the first two years of the program at ETH is assumed. Some basic differential geometry and functional analysis would be useful but not essential.

### Modular Forms

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Lecture Credits</th>
<th>Author(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3132-00L</td>
<td>8</td>
<td>3V+1U</td>
<td>Ö. Imamoglu</td>
</tr>
</tbody>
</table>

**Abstract**

This is a introductory course on automorphic forms covering its basic properties with emphasis on connections with number theory.

**Objective**

The aim of the course is to cover the classical theory of modular forms.

**Content**

Basic definitions and properties of $SL(2, \mathbb{Z})$, its subgroups and modular forms for $SL(2, \mathbb{Z})$, Eisenstein and Poincare series. L-functions of modular forms, Hecke operators. Theta functions. Possibly Maass forms. Possibly automorphic forms for more general groups.

**Literature**

J.P. Serre, A Course in Arithmetic;  
N. Koblitz, Introduction to Elliptic Curves and Modular Forms;  
D. Zagier, The 1-2-3 of Modular Forms;  
H. Iwaniec, Topics in Classical Automorphic Forms.

**Prerequisites / notice**

The material of the basic courses of the first two years of the program at ETH is assumed. Some basic differential geometry and functional analysis would be useful but not essential.

### Commutative Algebra

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits</th>
<th>Lecture Credits</th>
<th>Author(s)</th>
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</thead>
<tbody>
<tr>
<td>401-3371-00L</td>
<td>10</td>
<td>4V+1U</td>
<td>P. D. Nelson</td>
</tr>
</tbody>
</table>

**Abstract**

This course is meant to provide an introduction to commutative algebra that equips the student to start studying the basics of algebraic geometry.

**Objective**

About the course: We shall closely follow the text “Introduction to Commutative Algebra” by M. F. Atiyah and I. G. Macdonald. Wherever possible, there will be extra focus on exercises that lead towards the basics of Algebraic Geometry. Topics include

* Basics about rings, ideals and modules
* Localisation
* Primary decomposition
* Integral dependence and valuations
* Noetherian rings
* Completions
* Basic dimension theory

**Literature**


**Prerequisites / notice**

Prerequisites: Algebra I (or a similar introduction to the basic concepts of ring theory).

---

Core Courses: Pure Mathematics (Mathematics Master)
A selection of the following topics will be covered:

- Elliptic boundary value problems
- Galerkin discretization of linear variational problems
- The primal finite element method
- Mixed finite element methods
- Discontinuous Galerkin Methods
- Boundary element methods
- Spectral methods
- Adaptive finite element schemes
- Singularly perturbed problems
- Sparse grids
- Galerkin discretization of elliptic eigenproblems
- Non-linear elliptic boundary value problems
- Discretization of parabolic initial boundary value problems

Abstract

This course gives a comprehensive introduction into the numerical treatment of linear and non-linear elliptic boundary value problems, related eigenvalue problems and linear, parabolic evolution problems. Emphasis is on theory and the foundations of numerical methods. Practical exercises include MATLAB implementations of finite element methods.

Objective

Participants of the course should become familiar with

- concepts underlying the discretization of elliptic and parabolic boundary value problems
- analytical techniques for investigating the convergence of numerical methods for the approximate solution of boundary value problems
- methods for the efficient solution of discrete boundary value problems
- implementational aspects of the finite element method

Content

A selection of the following topics will be covered:

- Elliptic boundary value problems
- Galerkin discretization of linear variational problems
- The primal finite element method
- Mixed finite element methods
- Discontinuous Galerkin Methods
- Boundary element methods
- Spectral methods
- Adaptive finite element schemes
- Singularly perturbed problems
- Sparse grids
- Galerkin discretization of elliptic eigenproblems
- Non-linear elliptic boundary value problems
- Discretization of parabolic initial boundary value problems

Lecture notes

Course slides will be made available to the audience.

Literature

n.a.

Prerequisites / notice

Practical exercises based on MATLAB

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Core Courses: Applied Mathematics and Further Appl.-Oriented Fields

**Course slides will be made available to the audience.**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-3651-00L</td>
<td>Numerical Methods for Elliptic and Parabolic Partial Differential Equations</td>
<td>W</td>
<td>10 credits</td>
<td>4V+1U</td>
<td>C. Schwab</td>
</tr>
<tr>
<td>401-3601-00L</td>
<td>Probability Theory</td>
<td>W</td>
<td>10 credits</td>
<td>4V+1U</td>
<td>A.S. Sznitman</td>
</tr>
<tr>
<td>401-3621-00L</td>
<td>Fundamentals of Mathematical Statistics</td>
<td>W</td>
<td>10 credits</td>
<td>4V+1U</td>
<td>S. van de Geer</td>
</tr>
<tr>
<td>252-0057-00L</td>
<td>Theoretical Computer Science</td>
<td>W</td>
<td>8 credits</td>
<td>4V+2U+1A</td>
<td>J. Hromkovic, E. Welzl</td>
</tr>
</tbody>
</table>

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**Core Courses: Applied Mathematics and Further Appl.-Oriented Fields (Mathematics Master)**

<table>
<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>401-3651-00L</td>
<td>Numerical Methods for Elliptic and Parabolic Partial Differential Equations</td>
<td>W</td>
<td>10 credits</td>
<td>4V+1U</td>
<td>C. Schwab</td>
</tr>
<tr>
<td>401-3601-00L</td>
<td>Probability Theory</td>
<td>W</td>
<td>10 credits</td>
<td>4V+1U</td>
<td>A.S. Sznitman</td>
</tr>
<tr>
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<td>Fundamentals of Mathematical Statistics</td>
<td>W</td>
<td>10 credits</td>
<td>4V+1U</td>
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</tr>
<tr>
<td>252-0057-00L</td>
<td>Theoretical Computer Science</td>
<td>W</td>
<td>8 credits</td>
<td>4V+2U+1A</td>
<td>J. Hromkovic, E. Welzl</td>
</tr>
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**Practical exercises based on MATLAB**

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Data: 06.02.2019 13:00  Autumn Semester 2015  Page 1020 of 1434
Upon completion of the course, students are able to classify combinatorial problems and to apply adequate techniques to solve them.

More exercises and examples in:
6. A. Aseroth, Ch. Baier: Theoretische Informatik

During the semester, two non-obligatory test exams will be offered.

### Electives

#### Selection: Algebra, Topology, Discrete Mathematics, Logic

<table>
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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>401-3059-00L</td>
<td>Combinatorics II</td>
<td>W</td>
<td>4 credits</td>
<td>2G</td>
<td>N. Hungerbühler</td>
</tr>
</tbody>
</table>

#### Literature

- Introduction to Algorithms by T. H. Cormen, C. E. Leiserson, R. L. Rivest;
- Randomized Algorithms by R. Motwani und P. Raghavan;
- Probabilistic Number Theory

#### Further reading:

#### Prerequisites / notice


Voraussetzung ist die Vorlesung "Axiomatische Mengenlehre" (Fruehlingssemester 2015) bzw. die entsprechenden Kapitel aus meinem Buch.

| 401-3035-00L | Forcing: An Introduction to Independence Proofs | W    | 8 credits | 3V+1U | L. Halbeisen |

#### Prerequisites / notice

Prerequisites: Complex analysis, measure and integral; some probability theory is useful but the main concepts needed will be recalled.

Some knowledge of number theory is useful but the main results will be summarized.

| 401-3109-65L | Probabilistic Number Theory                 | W    | 6 credits | 2V+1U | E. Kowalski |

#### Literature

- H. Iwaniec and E. Kowalski: "Analytic number theory", and additional lecture notes will be prepared.

| 401-3202-09L | Representation Theory of Finite Groups, and in Particular Symmetric Groups | W    | 4 credits | 2V | A. Buryak |

#### Literature


It will be assumed that the listeners know the material from a basic linear algebra course and also basic facts about groups and rings.

#### Notice

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 1021 of 1434
The course is roughly divided in three parts: (1) Supervised learning via (variations of) nearest neighbor methods, (2) the EM algorithm and clustering, handling missing data and graphical models.

Prerequisites / notice
Office hours: Thursday 11:00 - 12:00

401-3057-00L Finite Geometries II

Abstract
Finite geometries combine aspects of geometry, discrete mathematics and the algebra of finite fields. In particular, we will construct models of axioms of incidence and investigate closing theorems. Applications include test design in statistics, block design, and the construction of orthogonal Latin squares.

Objective
Finite geometries I, II: Students will be able to construct and analyse models of finite geometries. They are familiar with the axioms of incidence and are able to design statistical tests by using the theory of finite geometries. They are able to construct orthogonal Latin squares and know the basic elements of the theory of block design.

Content
Finite geometries I, II: finite fields, rings of polynomials, affine planes, axioms of incidence, Euler's thirty-six officers problem, design of statistical tests, orthogonal Latin squares, transformation of finite planes, closing theorems of Desargues and Pappus-Pascal, hierarchy of closing theorems, finite coordinate planes, division rings, finite projective planes, duality principle, finite Möbius planes, error correcting codes, block design

Literature
- Max Jeger, Endliche Geometrien, ETH Skript 1988
- Albrecht Beutelspacher: Einführung in die endliche Geometrie I,II. Bibliographisches Institut 1983
- Margaret Lynn Batten: Combinatorics of Finite Geometries. Cambridge University Press
- Dembowski: Finite Geometries.

[►► Selection: Analysis]

no course offer

[►► Selection: Numerical Analysis]

no course offer

[►► Selection: Probability Theory, Statistics]

Number Title Type ECTS Hours Lecturers
401-3591-65L Introduction to Random Graphs W 4 credits 2V A. Knowles

Abstract
This is an introductory course on random graphs, covering Erdos-Rényi graphs, inhomogeneous graphs, phase transition phenomena, connectivity, and random walks on random graphs.

Prerequisites / notice
A basic undergraduate course on probability.

401-3627-00L High-Dimensional Statistics

Abstract
"High-Dimensional Statistics" deals with modern methods and theory for statistical inference when the number of unknown parameters is of much larger order than sample size. Statistical estimation and algorithms for complex models and aspects of multiple testing will be discussed.

Objective
Knowledge of methods and basic theory for high-dimensional statistical inference

Content
Lasso and Group Lasso for high-dimensional linear and generalized linear models; Additive models and many smooth univariate functions; Non-convex loss functions and 1-regularization; Stability selection, multiple testing and construction of p-values; Undirected graphical modeling

Literature

Prerequisites / notice
Knowledge of basic concepts in probability theory, and intermediate knowledge of statistics (e.g. a course in linear models or computational statistics).

401-4623-00L Time Series Analysis

Abstract
Statistical analysis and modeling of observations in temporal order, which exhibit dependence. Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. Implementations in the software R.

Objective
Understanding of the basic models and techniques used in time series analysis and their implementation in the statistical software R.

Content
This course deals with modeling and analysis of variables which change randomly in time. Their essential feature is the dependence between successive observations. Applications occur in geophysics, engineering, economics and finance. Topics covered: Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. The models and techniques are illustrated using the statistical software R.

Lecture notes
Not available

Literature
A list of references will be distributed during the course.

Prerequisites / notice
Basic knowledge in probability and statistics

401-3611-00L Advanced Topics in Computational Statistics

Abstract
This lecture covers selected advanced topics in computational statistics, including various classification methods, the EM algorithm, clustering, handling missing data, and graphical modelling.

Objective
Students learn the theoretical foundations of the selected methods, as well as practical skills to apply these methods and to interpret their outcomes.

Content
The course is roughly divided in three parts: (1) Supervised learning via (variations of) nearest neighbor methods, (2) the EM algorithm and clustering, (3) handling missing data and graphical models.

Lecture notes
Lecture notes.
This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning “good practice” that can be applied in every student’s own projects and daily work life.

Objective
The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

Content
The course starts with the basics of linear regression modeling, and then proceeds to parameter estimation, tests and confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, categorical input variables, shrinkage and general modeling strategies.

The last third of the course is dedicated to an introduction into generalized linear regression models: this includes logistic regression for binary response variables, Poisson regression for count data, cumulative logit models for ordered, and multinomial regression for categorical response variables.

Lecture notes
A script will be available.

Literature
Faraway (2005): Linear Models with R
Faraway (2006): Extending the Linear Model with R
Draper & Smith (1998): Applied Regression Analysis
Fox (2008): Applied Regression Analysis and GLMs
Montgomery et al. (2006): Introduction to Linear Regression Analysis

Prerequisites / notice
The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L “Applied Statistical Regression” and 401-3622-00L “Regression” are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

401-0625-01L Applied Analysis of Variance and Experimental Design

Abstract
Key concepts of experimental design. Planning and analysis of single factor experiments, block designs, full factorial and fractional designs, split-plot and strip-plot designs. Random effects and mixed effects models.

Objective
Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R.

Content

Lecture notes
see website

Literature

Selection: Financial and Insurance Mathematics

In the Bachelor's programme in Mathematics 401-3913-01L Mathematical Foundations for Finance is eligible as an elective course, but only if 401-3888-00L Introduction to Mathematical Finance isn't recognised for credits (neither in the Bachelor's nor in the Master's programme). For the category assignment take contact with the Study Administration Office (www.math.ethz.ch/studiensekretariat) after having received the credits.

Number Title Type ECTS Hours Lecturers
401-4905-60L Interest Rate Theory W 8 credits 3V+1U not available

Abstract
We introduce and discuss the most important models for interest rate markets. Emphasis will be placed both on theoretical foundations and on numerical implementation and calibration.

Objective
- Gain overview of interest rate markets and the corresponding financial products.
- Understand the various modeling approaches used (short-rate models, Heath-Jarrow-Morton models, LIBOR market models).
- Get a firm grasp of the underlying theory, and practice numerical implementation of concrete examples.
- Learn about extensions that have recently become increasingly important: default risk, multiple yield curves, etc.

Content
- Gain overview of interest rate markets and the corresponding financial products.
- Understand the various modeling approaches used (short-rate models, Heath-Jarrow-Morton models, LIBOR market models).
- Get a firm grasp of the underlying theory, and practice numerical implementation of concrete examples.
- Learn about extensions that have recently become increasingly important: default risk, multiple yield curves, etc.

Literature

Prerequisites / notice
- Option pricing and hedging for equity markets as covered, e.g., in "Mathematical Foundations for Finance".
- Itô calculus.

401-3953-00L Interest Rate Modeling in Discrete Time

Abstract
This course gives an introduction to stochastic interest rate modeling in discrete time. Starting from cash flow valuation with state price deflators, we derive the equivalent martingale measures for pricing financial instruments and derivatives of primary assets. The lecture is supplemented by several examples such as the Vasicek model where we also study model calibration.

Objective
The students are familiar with the basic terminology of stochastic interest rate modeling and he is able to transfer his (financial) mathematical knowledge to real world pricing of cash flows and financial instruments.
The lecture aims at providing a basis in non-life insurance mathematics which forms a core subject of actuarial sciences. It discusses

The following topics are covered:
1) stochastic discounting with state price deflators
2) equivalent martingale measures
3) pricing of cash flows and primary assets
4) pricing of derivatives, e.g. European put options
5) (multi-factor) Vasicek state price deflator model
6) Heath-Jarrow-Morton interest rate modeling framework

For further reading:

The exams ONLY take place during the official ETH examination period.

Prerequisites: knowledge of probability theory and applied stochastic processes.
Objective

Basic understanding of general relativity, its mathematical foundations, and some of the interesting phenomena it predicts.

Suggested textbooks:

C. Misner, K. Thorne and J. Wheeler: Gravitation
S. Carroll - Spacetime and Geometry: An Introduction to General Relativity
R. Wald - General Relativity
S. Weinberg - Gravitation and Cosmology
N. Straumann - General Relativity with applications to Astrophysics

Selection: Math. Optimization, Discrete Mathematics, Computer Science

Objective

The goal is to make students familiar with fundamental concepts, techniques and results in combinatorial and computational geometry, so as to enable them to model, analyze, and solve theoretical and practical problems in the area and in various application domains.

Several copies of both books are available in the Computer Science library.

Audience: Although this is a Computer Science course, we encourage the participation from all students who are interested in this topic.

This course discusses algorithmic aspects of game-theoretic models, with a focus on recent algorithmic and mathematical developments. Rather than giving an overview of such developments, the course aims to study selected important topics in depth.

Outline:

- Introduction to classical game theoretic concepts.
- Existence of stable solutions (equilibria), algorithms for computing equilibria, computational complexity.
- The cost difference between an optimum under central control and an equilibrium under selfish agents, known as the "price of anarchy".
- Auction-like mechanisms and algorithms that "direct" the actions of selfish agents into a certain desired equilibrium situation.
- Selected current research topics of Algorithmic Game Theory, such as Web-Searched Based Keyword Auctions, or Information Cascading in Social Networks

Selection: Math. Optimization, Discrete Mathematics, Computer Science

Objective

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Several copies of both books are available in the Computer Science library.
Randomized Algorithms are algorithms that "flip coins" to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.

Lecture notes
Yes.

Literature

252-4050-00L

<table>
<thead>
<tr>
<th>Complexity Theory</th>
<th>W</th>
<th>6 credits</th>
<th>3V+2U</th>
<th>T. Holenstein</th>
</tr>
</thead>
</table>

Abstract
Complexity Theory classifies problems according to the resources required in order to solve them. In this course, we give an introduction to modern complexity theory. We introduce basic complexity classes (such as L, P, BPP, PH, NP, AM, PH, PSPACE, IP, EXP), and study circuit complexity.

Objective
The student learns the fundamentals of Complexity Theory, as well as some of the more recent techniques. He not only understands the basic results and techniques used to prove them, but also has insight in some of the technically more advanced theorems.

Content
Complexity Theory classifies problems according to the difficulty of solving them. In this course, we give an introduction to modern complexity theory. We introduce basic complexity classes (such as L, P, BPP, PHSPACE, IP, EXP), and study the known relationship to uniform complexity. We study circuit complexity, and its relationship to uniform complexity. We also will study some circuit lower bounds for constant depth circuits, as well as results which explain why it is difficult to improve these results.

▶▶ Selection: Further Realms

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3502-65L</td>
<td>Reading Course</td>
<td>W</td>
<td>2</td>
<td>4A</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract
For this Reading Course proactive students make an individual agreement with a lecturer to acquire knowledge through independent literature study.

<table>
<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>401-3503-65L</td>
<td>Reading Course</td>
<td>W</td>
<td>3</td>
<td>6A</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract
For this Reading Course proactive students make an individual agreement with a lecturer to acquire knowledge through independent literature study.

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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3504-65L</td>
<td>Reading Course</td>
<td>W</td>
<td>4</td>
<td>9A</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract
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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0445-00L</td>
<td>Advanced Mathematical Signal Processing</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>H. G. Feichtinger</td>
</tr>
</tbody>
</table>

Abstract
Usually Fourier Analysis and Systems Theory emphasize the analogy between the different settings (continuous&discrete, periodic&non-periodic). The author proposes a simple approach to generalized functions, based on a Banach space of test functions. The course provides the foundations to Banach Gelfand triples, but also concrete applications in signal processing (time-variant systems, sampling).
Objective
Deeper mathematical understanding of the foundations of signal processing and system theory. The setting of Banach Gelfand Triples allows to provide a framework that allows among others to discuss the relations between different settings (e.g. the generalized Fourier transform of functions on the Euclidean space and corresponding FFT-based routines).

Content
Time-Frequency Analysis and its discretized version, namely Gabor Analysis have required to develop a family of function spaces (the so-called modulation spaces, introduced by Feichtinger in the 80th) which is different from the usual Lebesgue spaces. There is a smallest space (called $S_0$) and a largest space (namely the dual space), which is a suitable reservoir of generalized functions relevant for the rigorous establishment of basic results in signal processing (sampling theorem, Poisson formula, Fourier inversion, etc.). The course will be centered about the basic properties of the Banach Gelfand triple $(S_0,L^2,S_0')$ (also called rigged Hilbert space), its use for signal processing and systems theory applications. In addition to classical questions we will also discuss the fundamental results of time-frequency analysis (Short-time Fourier transform, Gabor frames, Gabor multipliers, best approximation of operators by Gabor multipliers, identification of slowly varying channels using pilot tones, etc.).

Lecture notes
There will a script related to the course. In fact, material for a book project on the subject is developed while the course is given.

Prerequisites / notice
In principle a good understanding of concepts from linear algebra is sufficient. Of course, basic knowledge about functional analysis (Banach and Hilbert spaces, linear operators and linear functionals) is helpful. We will, however, explain all these concepts as we go along. We will need background on Lebesgue integration or topological vector spaces (as usually required for the treatment of distributions).

Core Courses and Electives (Mathematics Master)

Core Courses (Mathematics Master)

Electives (Mathematics Master)

Minor Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-1511-00L</td>
<td>Geometry</td>
<td>W</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>L. Halbeisen</td>
</tr>
<tr>
<td>Abstract</td>
<td>Im Mittelpunkt dieser Vorlesung steht die euklidische und die projektive Geometrie.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>Robin Hartshorne: &quot;Geometry: Euclid and beyond&quot;, Springer Verlag</td>
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</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0351-00L</td>
<td>Astronomy</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>H. M. Schmid, W. Schmutz</td>
</tr>
<tr>
<td>Abstract</td>
<td>An overview on the important topics in modern astronomy: planets, sun, stars, milky way, galaxies, and cosmology</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>This lecture gives a general introduction to main topics in modern astronomy. The lecture provide a basis for the more advanced lectures in astrophysics.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>Planeten, Sonne, Sterne, Milchstrasse, Galaxien und Kosmologie.</td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>Kopien der Prasentationen werde zur Verfuegung gestellt.</td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>Astronomie, Harry Nussbaumer, Hans Martin Schmid</td>
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</tr>
<tr>
<td>Literature</td>
<td>vdf Vorlesungsskripte (8. Auflage)</td>
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</tr>
</tbody>
</table>

Seminars

Early enrolments for seminars in myStudies are encouraged, so that we will recognize need for additional seminars in a timely manner. Some seminars have waiting lists. Nevertheless, register for at most two mathematics seminars. In this case, you express a stronger preference for the seminar for which you register earlier.

<table>
<thead>
<tr>
<th>Number</th>
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</tr>
</thead>
<tbody>
<tr>
<td>401-3050-65L</td>
<td>Student Seminar in Combinatorics: Linear Complementarity</td>
<td>W</td>
<td>4 credits</td>
<td>2S</td>
<td>K. Fukuda</td>
</tr>
<tr>
<td>Number of participants limited to 18.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>We study the combinatorics and the complexity of various subclasses of the linear complementarity problem.</td>
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<tr>
<td>Content</td>
<td>The Linear Complementarity Problem (LCP) was introduced in mid 1960's (1965-67) by Lemke and Cottle-Dantzig as a common generalization of linear programming, bimatrix games and convex quadratic programming. The problem is NP-hard in general, but there are many subclasses of LCP that are in P (polynomially solvable) or suspected to be in P. The reason for the possible polynomially solvability is that these studied subclasses (e.g. P-matrix LCPs and positive-definite LCPs) can be formulated as a problem which admits a solution that has a succinct certificate for its correctness. Moreover, there are elegant combinatorial abstractions of these subclasses.</td>
<td></td>
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</tr>
<tr>
<td>Literature</td>
<td>In this seminar, we study the most important papers/books, both old and new, in the theory of LCP, and aim at understanding what is crucial lack of knowledge in proving or disproving existing conjectures.</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Literature</td>
<td>To be posted here before the first class on September 15.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literature</td>
<td>The seminar schedule and a list of articles: <a href="http://www.inf.ethz.ch/personal/fukudak/lect/icsemi/icseminar2015_ref.pdf">http://www.inf.ethz.ch/personal/fukudak/lect/icsemi/icseminar2015_ref.pdf</a> (Version October 7, 2015). Please check the version date, as it gets updated frequently.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accepted Reports</td>
<td><a href="http://www.inf.ethz.ch/personal/fukudak/lect/icsemi/reports">http://www.inf.ethz.ch/personal/fukudak/lect/icsemi/reports</a></td>
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<tr>
<td>Prerequisites / notice</td>
<td>Basic knowledge of linear programming.</td>
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</table>

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<tr>
<th>Number</th>
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</tr>
</thead>
<tbody>
<tr>
<td>401-3320-65L</td>
<td>Algebraic Groups and Actions</td>
<td>W</td>
<td>4 credits</td>
<td>2S</td>
<td>B. R. Doran</td>
</tr>
<tr>
<td>The seminar is for more advanced students. Registration is officially closed, but if Prof. Doran agrees, further</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 1027 of 1434
B. Gärtner

Monstrous Moonshine

2S

A list of papers for presentations will be distributed at the beginning of the seminar. The aim of this seminar is to review new and fundamental mathematical introduction to scientific writing for students with focus on publication standards and ethical issues, especially in the case of citations.

E. Welzl

J. Teichmann

Type

To understand the equation \(196884 = 196883 + 1\).

We study Monstrous Moonshine, the surprising connection between modular forms and the Monster group.

Scientific Works in Mathematics

2S

Number of participants limited to 15 up to 20.

Abstract

The seminar introduces and discusses main theorems around Martin Hairer’s regularity structures following the article “Introduction to regularity structures” (Braz Jour Prob Stat 29).

Prerequisites / notice

The seminar is suitable for Bachelor and Master students. Some knowledge in linear functional analysis and algebra is required.

201-3600-65L

Regularity Structures

W 4 credits 2S J. Teichmann

Number of participants 15 up to 20.

Abstract

The seminar introduces and discusses main theorems around Martin Hairer’s regularity structures following the article “Introduction to regularity structures” (Braz Jour Prob Stat 29).

Prerequisites / notice

The seminar is suitable for Bachelor and Master students. Some knowledge in linear functional analysis and algebra is required.

201-3650-65L

Numerical Analysis Seminar: Mathematics for Nanophotonics

W 4 credits 2S H. Ammari

Limited number of participants.

Abstract

The aim of this seminar is to review new and fundamental mathematical tools, computational approaches, and inversion and optimal design methods to address challenging problems in nanophotonics. An emphasis will be put on analyzing plasmon resonant nanoparticles.

Prerequisites / notice

Algebra I and II. Some familiarity with modular forms and Lie algebras is helpful, but not crucial: all necessary concepts will be introduced in the early talks.

201-3110-65L

Monstrous Moonshine

W 4 credits 2S C. A. Keller

Number of participants limited to 16.

Abstract

We study Monstrous Moonshine, the surprising connection between modular forms and the Monster group.

Objective

To understand the equation \(196884 = 196883 + 1\).

Content

see https://www2.math.ethz.ch/education/bachelor/seminars/hs2015/monstrous-moonshine/monshine_overview

Prerequisites / notice

Algebra I and II. Some familiarity with modular forms and Lie algebras is helpful, but not crucial: all necessary concepts will be introduced in the early talks.

263-4200-00L

Seminar SAT

W 2 credits 2S E. Welzl

Study and presentation of research papers from the literature on “Boolean Satisfiability-Combinatorics and Algorithms”.

Objective

Goal of this seminar is to study and present, in continuation of the course “Boolean Satisfiability-Combinatorics and Algorithms”, research papers from the literature.

Prerequisites / notice

Limited number of participants.

Literature

A list of papers for presentations will be distributed at the beginning of the seminar.

263-4203-00L

Geometry: Combinatorics and Algorithms

W 2 credits 2S B. Gärtner, E. Welzl

Does not take place this semester.

Abstract

This seminar is held once a year and complements the courses Computational Geometry and Geometric Graphs: Combinatorics & Algorithms. Students of the seminar will present original research papers, some classic and some of them very recent. The seminar is a good preparation for a master, diploma, or semester thesis in the area.

Objective

Each student is expected to read, understand, and elaborate on a selected research paper. To this end, (s)he should give a 45-min. presentation about the paper. The process includes:

* getting an overview of the related literature;
* understanding and working out the background/motivation: why and where are the questions addressed relevant?
* understanding the contents of the paper in all details;
* selecting parts suitable for the presentation;
* presenting the selected parts in such a way that an audience with some basic background in geometry and graph theory can easily understand and appreciate it.

Prerequisites / notice

To attend the seminar, some basic knowledge in (discrete and computational) geometry and graphs and algorithms is required. Thus, previous participation in some of the courses “Graphs and Algorithms”, “Computational Geometry”, “Geometric Graphs: Combinatorics & Algorithms”, or similar courses is strongly encouraged. It is also possible to take this seminar in parallel to the lecture “Computational Geometry”.

Bachelor Thesis

Bachelor Thesis (Mathematics Master)

Number

401-2000-00L

Scientific Works in Mathematics

Type

O

ECTS

0

Hours

Lecturers

E. Kowalski

Target audience:

Third year Bachelor students; Master students who cannot document to have received an adequate training in working scientifically.

Mandatory for all Bachelor and Master students with matriculation in the autumn semester 2014 or later. Optional for Bachelor and Master students with matriculation until or before the spring semester 2014.

Example: You matriculated in the autumn semester 2013 into the first semester of the Bachelor programme, are now in the third year and plan to matriculate in the autumn semester 2016 into the first semester of the Master programme. In this case, you don't need “Scientific Works in Mathematics” in order to complete the Bachelor degree, but for the Master degree you will need it. In this case, we recommend that you register for “Scientific Works in Mathematics” in the autumn semester 2015 or spring semester 2016.

Directive


Abstract

Number of participants limited to 16.

Introduction to scientific writing for students with focus on publication standards and ethical issues, especially in the case of citations (references to works of others.)

Objective

Learn the basic standards of scientific works in mathematics.
Content
- Types of mathematical works
- Publication standards in pure and applied mathematics
- Data handling
- Ethical issues
- Citation guidelines

Lecture notes
Moodle of the Mathematics Library: https://moodle-app2.let.ethz.ch/course/view.php?id=519

Prerequisites / notice
This course is completed by the optional course "Recherchieren in der Mathematik" (held in German) by the Mathematics Library. For more details see: http://www.math.ethz.ch/library/services/schulungen

401-3990-10L Bachelor's Thesis
No direct enrolment to this course unit in myStudies. Please fill in the online application form. Requirements and application form under www.math.ethz.ch/intranet/students/study-administration/theses.html (Afterwards the enrolment will be done by the Study Administration)

Abstract
The purpose of the BSc thesis is to deepen knowledge in a certain subject chosen by the student. In their BSc thesis, students should demonstrate their ability to carry out independent work in mathematics and to organize results in a written report.

Compulsory Electives in Humanities, Social and Political Sciences
Recommended GESS compulsory elective courses (Type B) for D-MATH:
see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability
see GESS Compulsory Electives: Language Courses

Additional Courses

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-5000-00L</td>
<td>Zurich Colloquium in Mathematics</td>
<td>E-</td>
<td>0</td>
<td></td>
<td>W. Werner, P. L. Bühlmann, M. Burger, S. Mishra, R. Pandharipande, University lecturers</td>
</tr>
<tr>
<td>401-5990-00L</td>
<td>Zurich Graduate Colloquium</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>A. Iozzi, University lecturers</td>
</tr>
<tr>
<td>Abstract</td>
<td>The Graduate Colloquium is an informal seminar aimed at graduate students and postdocs whose purpose is to provide a forum for communicating one's interests and thoughts in mathematics.</td>
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<tr>
<td>401-5960-00L</td>
<td>Colloquium on Mathematics, Computer Science, and Education</td>
<td>E-</td>
<td>0</td>
<td></td>
<td>N. Hungerbühler, M. Akveld, J. Kronkov, H. Klemenz</td>
</tr>
<tr>
<td>Abstract</td>
<td>Didactics colloquium</td>
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<tr>
<td>Abstract</td>
<td>Research colloquium</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Occasionally, talks may be delivered in German.</td>
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<tr>
<td>Abstract</td>
<td>The Zurich Theoretical Physics Colloquium is jointly organized by the University of Zurich and ETH Zurich. Its mission is to bring both students and faculty with diverse interests in theoretical physics together. Leading experts explain the basic questions in their field of research and communicate the fascination for their work.</td>
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<tr>
<td>Objective</td>
<td>Invited talks, covering the entire scope of computer science. External Listeners are welcome at no charge. A detailed schedule is published at the beginning of each semester.</td>
<td></td>
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<tr>
<td>251-0100-00L</td>
<td>Computer Science Colloquium</td>
<td>E-</td>
<td>0</td>
<td>2K</td>
<td>Lecturers</td>
</tr>
<tr>
<td>Abstract</td>
<td>Top international computer scientists take the floor at the distinguished computer science colloquium. Our guest speakers present impacting topics across various areas of the discipline. The colloquium series is held every semester and also includes inaugural and farewell lectures of the department's professors. The colloquium is a noteworthy event for all graduate students. Outside attendance is equally welcome.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
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</tbody>
</table>
Das Ziel dieser Vorlesung ist die Vermittlung der grundlegenden Konzepte und Begriffe der Mathematik. Dazu gehören die Sprache der Mathematik (d.h. Aussagenlogik und Prädikatenlogik), Modelle von Axiomensystemen (inkl. Gödel'scher Vollständigkeitssatz), Beweismethoden, der Aufbau der Zahlen von den natürlichen Zahlen bis zu den reellen Zahlen, sowie die Axiome der Mengenlehre.

Als ergänzende Literatur zur Vorlesung kann ich folgende beiden Bücher empfehlen:
### Mathematics TC

Detailed information on the programme at: www.didaktischeausbildung.ethz.ch

### Educational Science

General course offerings in the category Educational Science are listed under “Programme: Educational Science for Teaching Diploma and TC”.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0242-06L</td>
<td>Cognitively Activating Instructions in MINT Subjects</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>R. Schumacher</td>
</tr>
</tbody>
</table>

Number of participants limited to 30.

This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.

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<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0242-07L</td>
<td>Human Intelligence</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner, B. Rütsche</td>
</tr>
</tbody>
</table>

Number of participants limited to 30.

The focus will be on the book “Intelligenz: Grosse Unterschiede und ihre Folgen” by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.

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<tr>
<th>Number</th>
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<th>ECTS</th>
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<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler</td>
</tr>
</tbody>
</table>

Number of participants limited to 30.

The focus will be on the book “Intelligenz: Grosse Unterschiede und ihre Folgen” by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.

### Subject Didactics and Professional Training

Important: You can only enrol in the courses of this category if you have not more than 12 CP left for possible additional requirements.

**Enrolment in either Mathematics Didactics I or Mathematics Didactics II (spring semester) is compulsory.**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3971-11L</td>
<td>Mathematics Didactics I</td>
<td>W</td>
<td>4</td>
<td>2G</td>
<td>K. Barro</td>
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</tbody>
</table>

Students learn about and learn to use findings from empirical research into mathematical didactics and best practice, as well as theoretical approaches to teaching various topics in mathematics. Methodological suggestions are compared and draft tuition concepts discussed.

<table>
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<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-9987-00L</td>
<td>Teaching Internship Including Examination Lessons</td>
<td>O</td>
<td>4</td>
<td>9P</td>
<td>N. Hungerbühlcr</td>
</tr>
</tbody>
</table>

Mathematics Teaching Diploma Mathematics as Minor Subject.

Repetition of the Teaching Internship is excluded even if Examination Lessons are to be repeated.

Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as assessed as Examination Lessons.
Vertiefung und Ausbau des Stoffes Mathematik I/II für die Anwendung in der Systemanalyse.

Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird

4A
M. Akveld

Contents of the lectures Combinatorics I and II: congruence transformation of the plane, symmetry groups of geometric figures, Euler's

Finite geometries I, II: Students will be able to construct models of axioms of incidence and investigate closing theorems. Applications include test design in statistics, block design, and the construction of orthogonal Latin squares.

Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

Lecture notes
Literature

- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Mentored Work Subject Didactics in Mathematics for TC, Teaching Diploma and Teaching Diploma Mathematics as Minor Subject.

401-9983-00L
Mentored Work Subject Didactics Mathematics A ■ O

Abstract
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

Objective
The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Dokument: schriftliche Vorbereitung für Prüfungslektionen.

Vertiefung der mehrdimensionalen Analysis mit Schwerpunkt in der Anwendung der partiellen Differentialgleichungen, Vertiefung der Linearen Algebra und Einführung in die Systemanalyse.

401-2923-00L
Mathematics III

Abstract
Vertiefung der mehrdimensionalen Analysis mit Schwerpunkt in der Anwendung der partiellen Differentialgleichungen, Vertiefung der Linearen Algebra und Einführung in die Systemanalyse.

Objective

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3057-00L</td>
<td>Finite Geometries II</td>
<td>W</td>
<td>4</td>
<td>2G</td>
<td>N. Hungerbühler</td>
</tr>
</tbody>
</table>

Abstract

Fine geometries I, II: Finite geometries combine aspects of geometry, discrete mathematics and the algebra of finite fields. In particular, we will construct models of axioms of incidence and investigate closing theorems. Applications include test design in statistics, block design, and the construction of orthogonal Latin squares.

Objective

Fine geometries I, II: Students will be able to construct and analyse models of finite geometries. They are familiar with closing theorems of the axioms of incidence and are able to design statistical tests by using the theory of finite geometries. They are able to construct orthogonal Latin squares and know the basic elements of the theory of block design.

Content

Finite geometries I, II: finite fields, rings of polynomials, finite affine planes, axioms of incidence, Euler's thirty-six officers problem, design of statistical tests, orthogonal Latin squares, transformation of finite planes, closing theorems of Desargues and Pappus-Pascal, hierarchy of closing theorems, finite coordinate planes, division rings, finite projective planes, duality principle, finite M"obius planes, error correcting codes, block design

Literature

- Max Jeger, Endliche Geometrien, ETH Skript 1988
- Albrecht Beutelspacher: Einführung in die endliche Geometrie I,II. Bibliographisches Institut 1983
- Margaret Lynn Batten: Combinatorics of Finite Geometries. Cambridge University Press
- Dembowski: Finite Geometries.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-3059-00L</td>
<td>Combinatorics II</td>
<td>W</td>
<td>4</td>
<td>2G</td>
<td>N. Hungerbühler</td>
</tr>
</tbody>
</table>

Abstract

The course Combinatorics I and II is an introduction into the field of enumerative combinatorics.

Objective

Upon completion of the course, students are able to classify combinatorial problems and to apply adequate techniques to solve them.

Content

Contents of the lectures Combinatorics I and II: congruence transformation of the plane, symmetry groups of geometric figures, Euler's function, Cayley graphs, formal power series, permutation groups, cycles, Bunsell's lemma, cycle index, Polya's theorems, applications to graph theory and isomers.

Literature

- Dembowski: Finite Geometries.

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 1032 of 1434

Als ergänzende Literatur zur Vorlesung kann ich folgende beiden Bücher empfehlen:


Die Studierenden kennen die wesentlichen Elemente der mathematischen Modellierung. Sie sind in der Lage, Modelle zu erstellen und mathematisch zu diskutieren. Sie können selbständig Unterrichtsssequenzen zur Modellierung entwickeln.

### Literature


### Prerequisites

**Vorlesungen Mathematik I/II**

### Content

**Mathematics III (Supplement)**

- Modellbildung
- Lineare Modelle:
- Vektorräume, Normalformen,
- Lösungsräume linearer DGL-Systeme
- Qualitative Aussagen, Nichtlineare Modelle:
  - Stabilität für eine DGL 1. Ordnung, für allgemeine DGL-Systeme
  - Modelle in Raum und Zeit:
    - Partielle DGL,
    - Fourier-Reihe, -Transformation,
    - Laplace-Operator

**Simultaneous enrolment in "Mathematics III" (401-0293-00L) is compulsory.**

### Abstract


### Objective

Die Studierenden kennen die wesentlichen Elemente der mathematischen Modellierung. Sie sind in der Lage, Modelle zu erstellen und mathematisch zu diskutieren. Sie können selbständig Unterrichtsssequenzen zur Modellierung entwickeln.

### Content

- Modellbildung
- Lineare Modelle:
- Vektorräume, Normalformen,
- Lösungsräume linearer DGL-Systeme
- Qualitative Aussagen, Nichtlineare Modelle:
  - Stabilität für eine DGL 1. Ordnung, für allgemeine DGL-Systeme
  - Modelle in Raum und Zeit:
    - Partielle DGL,
    - Fourier-Reihe, -Transformation,
    - Laplace-Operator

### Literature


### Prerequisites

**Grundvorlesungen zur Analysis**

### Content

**Foundations of Mathematics**

- Modellbildung
- Lineare Modelle:
- Vektorräume, Normalformen,
- Lösungsräume linearer DGL-Systeme
- Qualitative Aussagen, Nichtlineare Modelle:
  - Stabilität für eine DGL 1. Ordnung, für allgemeine DGL-Systeme
  - Modelle in Raum und Zeit:
    - Partielle DGL,
    - Fourier-Reihe, -Transformation,
    - Laplace-Operator

### Literature


### Prerequisites

**Grundvorlesungen zur Analysis**

### Content

**Mentored Work Specialised Courses in the Respective Subject with an Educational Focus Mathematics A**

In the mentored work on their subject specialisation, students link high-school and university aspects of the subject, thus strengthening their teaching competence with regard to curriculum decisions and the future development of the tuition. They compile texts under supervision that are directly comprehensible to the targeted readers - generally specialist-subject teachers at high-school level.

The aim is for the students

- to familiarise themselves with a new topic by obtaining material and studying the sources, so that they can selectively extend their specialist competence in this way.
- to independently develop a text on the topic, with special focus on its mathematical comprehensibility in respect of the level of knowledge of the targeted readers.
- to try out different options for specialist further training in their profession.

**Thematic Schwerpunkte:**


Lernformen:


### Prerequisites

**Grundvorolesungen zur Analysis**
Eine Anleitung zur mentorierten Arbeit in FV wird zur Verfügung gestellt.

Die Literatur ist themenspezifisch. Sie muss je nach Situation selber beschafft werden oder wird zur Verfügung gestellt.

Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

**Lecture notes**

**Literature**

**Prerequisites / notice**

**Colloquia**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-5960-00L</td>
<td>Colloquium on Mathematics, Computer Science, and Education</td>
<td></td>
<td>0 credits</td>
<td></td>
<td>N. Hungerbühler, M. Akveld, J. Hromkovic, H. Klemenz</td>
</tr>
<tr>
<td></td>
<td>Subject didactics for mathematics and computer science teachers.</td>
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</tbody>
</table>

**Abstract**

Didactics colloquium

**Mathematics TC - Key for Type**

<table>
<thead>
<tr>
<th>Key</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

**Key for Hours**

<table>
<thead>
<tr>
<th>Key</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td></td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td></td>
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<tr>
<td>S</td>
<td>seminar</td>
<td></td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
<td></td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</tr>
</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Understanding of research methods used in the empirical human sciences

S. Edelsbrunner

Literature from the learning sciences is critically discussed with a focus on research methods. The course is targeted at advanced students who have taken an interest in gathering practical research experience in the field of Learning and Instruction.

Course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

<table>
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<tbody>
<tr>
<td>851-0242-06L</td>
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<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>R. Schumacher</td>
</tr>
<tr>
<td></td>
<td>Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
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<tr>
<td></td>
<td>Number of participants limited to 30.</td>
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<tr>
<td></td>
<td>This course unit can only be enrolled after successful participation in, or during enrollment in the course &quot;Human Learning (EW 1)&quot;.</td>
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<tr>
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<td>Abstract</td>
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<td>Objective</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Get to know cognitively activating instructions in MINT subjects</td>
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<tr>
<td></td>
<td>- Get information about recent literature on learning and instruction</td>
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<td></td>
<td>Prerequisites / notice</td>
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<tr>
<td></td>
<td>Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.</td>
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</tr>
<tr>
<td>851-0242-07L</td>
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<td>W</td>
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<tr>
<td></td>
<td>- Understanding of research methods used in the empirical human sciences</td>
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<td></td>
<td>- Getting to know intelligence tests</td>
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<tr>
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<td></td>
<td>Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and two further meetings will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.</td>
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<td></td>
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<tr>
<td></td>
<td>- Understand research methods used in the empirical educational sciences</td>
<td></td>
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<tr>
<td></td>
<td>- Understand and critically examine information from scientific journals and media</td>
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<tr>
<td></td>
<td>- Understand pedagogically relevant findings from the empirical educational sciences</td>
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<tr>
<td></td>
<td>Number of participants limited to 20.</td>
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<tr>
<td></td>
<td>The successful completion of both course no. 851-0240-00L &quot;Menschliches Lernen (EW 1)&quot; and course no. 851-0238-01L &quot;Unterstützung und Diagnose von Wissenserwerbsprozessen (EW 3)&quot; is a necessary prerequisite for this course.</td>
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<tr>
<td></td>
<td>Abstract</td>
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<tr>
<td></td>
<td>In teams of two, participants in this seminar conduct their own research project. Each team is advised by one of the researchers serving as lecturers in this course. Basic conceptual and methodological issues are the topic of a series of plenary meetings; however, the major part of the work is done in small-group meetings with the advising researcher, and in self-directed research projects.</td>
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<tr>
<td></td>
<td>Objective</td>
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<tr>
<td></td>
<td>The course is targeted at advanced students who have taken an interest in gathering practical research experience in the field of Learning &amp; Instruction. In teams of two, students conduct their own research projects (planning, conducting, analyzing, interpreting, and presenting research); thus, the course requires a high amount of self-directed working. Students are personally advised, and supported in their research project, by one of the researchers serving as lecturers in this course. During the first half the semester, relevant methodological knowledge and skills are practiced during plenary meetings and in students’ independent reading (e.g. generating and testing research questions, designing experiments, and analyzing data in the field of Learning and Instruction)</td>
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<tr>
<td></td>
<td>Learning goals include:</td>
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<tr>
<td></td>
<td>- Participants can illustrate and explain basic methods and concepts for research in the fields of Learning and Instruction, e.g. with the help of practical examples.</td>
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<tr>
<td></td>
<td>- Participants can generate testable research questions for a topic relevant in the fields of Learning and Instruction.</td>
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<tr>
<td></td>
<td>- Participants can design and conduct a study that is relevant for answering their research question</td>
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<tr>
<td></td>
<td>- Participants can summarize and evaluate the main results from a study in the field of learning and Instruction, with regard to the research question being asked.</td>
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</tbody>
</table>
Subject Didactics in Mathematics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-3971-11L</td>
<td>Mathematics Didactics I</td>
<td>O</td>
<td>4 credits</td>
<td>2G</td>
<td>K. Barro</td>
</tr>
<tr>
<td></td>
<td><em>Enrolment only possible with matriculation in Mathematics</em></td>
<td></td>
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</tr>
<tr>
<td></td>
<td><em>Teaching Diploma or Mathematics TC at ETH or in Mathematics Teaching Diploma at LÜZ.</em></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Abstract</td>
<td>Students learn about and learn to use findings from empirical research into mathematical didactics and best practice, as well as theoretical approaches to teaching various topics in mathematics. Methodological suggestions are compared and draft tuition concepts discussed.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>On the basis of their understanding of mathematics, of the knowledge acquired from research into teaching/learning and subject teaching, and also of best practice, students who have completed this course will be in a position to draft motivating teaching arrangements, with cognitive appeal, which trigger and maintain learning processes. The aim here is to implement a corresponding teaching plan, so that the mathematics tuition that is given has a general-education value, on the one hand, and ensures that pupils acquire the fundamental knowledge necessary for studying at university, on the other hand.</td>
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</table>

Mentored Work Subject Didactics Mathematics A

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-9983-00L</td>
<td>Mentored Work Subject Didactics Mathematics A</td>
<td>O</td>
<td>2 credits</td>
<td>4A</td>
<td>M. Akveld, K. Barro, L. Halbeisen, M. Huber, N. Hungerbühler</td>
</tr>
<tr>
<td></td>
<td><em>Mentored Work Subject Didactics in Mathematics for TC, Teaching Diploma and Teaching Diploma Mathematics as Minor Subject.</em></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Abstract</td>
<td>In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>The objective is for the students:</td>
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<tr>
<td></td>
<td>- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.</td>
<td></td>
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<tr>
<td></td>
<td>- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.</td>
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<td></td>
</tr>
<tr>
<td>Content</td>
<td>Thematische Schwerpunkte</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Lernformen</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literature</td>
<td>Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.</td>
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</tbody>
</table>

Mentored Work Subject Didactics Mathematics B

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-9984-00L</td>
<td>Mentored Work Subject Didactics Mathematics B</td>
<td>O</td>
<td>2 credits</td>
<td>4A</td>
<td>M. Akveld, K. Barro, L. Halbeisen, M. Huber, N. Hungerbühler</td>
</tr>
<tr>
<td></td>
<td><em>Mentored Work Subject Didactics in Mathematics for TC, Teaching Diploma and Teaching Diploma Mathematics as Minor Subject and for students upgrading TC to Teaching Diploma.</em></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.</td>
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<tr>
<td>Objective</td>
<td>The objective is for the students:</td>
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<tr>
<td></td>
<td>- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.</td>
<td></td>
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<tr>
<td></td>
<td>- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.</td>
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</tr>
<tr>
<td>Content</td>
<td>Thematische Schwerpunkte</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.</td>
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<tr>
<td></td>
<td>Lernformen</td>
<td></td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt.</td>
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</tr>
<tr>
<td>Literature</td>
<td>Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.</td>
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</table>

Professional Training in Mathematics

Professional Training (First Subject)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-9970-00L</td>
<td>Introductory Internship Mathematics</td>
<td>O</td>
<td>3 credits</td>
<td>6P</td>
<td>N. Hungerbühler</td>
</tr>
<tr>
<td></td>
<td><em>Enrolment only possible with matriculation in Mathematics</em></td>
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<tr>
<td></td>
<td><em>Teaching Diploma or Mathematics TC at ETH.</em></td>
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<tr>
<td></td>
<td><em>It is advisable to enrol in this course not prior to the first Mathematics Didactics course and not after the second Mathematics Didactics course.</em></td>
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<tr>
<td>Abstract</td>
<td>During the introductory teaching practice, the students sit in on five lessons given by the teacher responsible for their teaching practice, and teach five lessons themselves. The students are given observation and reflection assignments by the teacher responsible for their teaching practice.</td>
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</tbody>
</table>
Right at the start of their training, students acquire initial experience with the observation of teaching, the establishment of concepts for teaching and the implementation of teaching. This early confrontation with the complexity of everything that teaching involves helps students decide whether they wish to and, indeed, ought to, continue with the training. It forms a basis for the subsequent pedagogical and subject-didactics training.

The teaching practice takes in 50 lessons: 30 are taught by the students, and the students sit in on 20 lessons. The teaching practice lasts 4-6 weeks. It gives students the opportunity to implement the contents of their specialist-subject, educational science and subject-didactics training in the classroom. Students also conduct work assignments in parallel to their teaching practice.

- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics in their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They acquire the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.

Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.


This course is to be chosen jointly with 401-3972-00L.

This is a supplement to the Teaching Internship required to obtain a Master of Advanced Studies in Secondary and Higher Education in the corresponding subject. It is aimed at enlarging the already acquired teaching experience. Students observe 10 lessons and teach 15 lessons independently.

The Didaktiken können die Bedeutung von Unterrichtsthemen in ihrem Fach unter verschiedenen Blickwinkeln einschätzen. Sie kennen und beherrschen das unterrichtliche Handwerk. Sie können ein gegebenes Unterrichtsthema für eine Gruppe von Lernenden fachlich und didaktisch korrekt strukturieren und in eine adäquate Lernumgebung umsetzen. Es gelingt ihnen, die Balance zwischen Anleitung und Offenheit zu finden, sodass sie die Lernenden sowohl über den nötigen Freiraum wie über ausreichend Orientierung verfügen, um aktiv und effektiv fachdidaktisch zu arbeiten.


The candidates show that they are in a position to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

The candidates learn about and use findings from empirical research into mathematical didactics and best practice, as well as theoretical approaches to teaching mathematics. Methodological suggestions are compared and draft tuition concepts discussed.

This course is to be chosen jointly with 401-3972-00L.

This course is to be chosen jointly with 401-3972-00L.

This is a supplement to the Teaching Internship required to obtain a Master of Advanced Studies in Secondary and Higher Education in the corresponding subject. It is aimed at enlarging the already acquired teaching experience. Students observe 10 lessons and teach 15 lessons independently.


The Didaktiken können die Bedeutung von Unterrichtsthemen in ihrem Fach unter verschiedenen Blickwinkeln einschätzen. Sie kennen und beherrschen das unterrichtliche Handwerk. Sie können ein gegebenes Unterrichtsthema für eine Gruppe von Lernenden fachlich und didaktisch korrekt strukturieren und in eine adäquate Lernumgebung umsetzen. Es gelingt ihnen, die Balance zwischen Anleitung und Offenheit zu finden, sodass sie die Lernenden sowohl über den nötigen Freiraum wie über ausreichend Orientierung verfügen, um aktiv und effektiv fachdidaktisch zu arbeiten.


The candidates show that they are in a position to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

The candidates learn about and use findings from empirical research into mathematical didactics and best practice, as well as theoretical approaches to teaching mathematics. Methodological suggestions are compared and draft tuition concepts discussed.

Die gehaltene Lektion wird kriteriumsbasiert beurteilt. Die Beurteilung umfasst auch die schriftliche Vorbereitung und eine mündliche Reflexion des Kandidaten/ der Kandidatin über die gehaltene Lektion im Rahmen eines kurzen Kolloquiums.

### Professional Training (Two Subjects in One-Step Procedure)

The programme "Teaching Diploma, Two Subjects in One-Step Procedure" will not be offered anymore since Autumn Semester 2010. Therefore new matriculations are no longer possible. The courses offered below are valid only for students who have registered before.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-9970-00L</td>
<td>Introductory Internship Mathematics</td>
<td>O</td>
<td>3 credits</td>
<td>6P</td>
<td>N. Hungerbühler</td>
</tr>
<tr>
<td></td>
<td>Enrolment only possible with matriculation in Mathematics</td>
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<tr>
<td></td>
<td>Teaching Diploma or Mathematics TC at ETH.</td>
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<tr>
<td></td>
<td>It is advisable to enrol in this course prior to the first Mathematics Didactics course and not after the second Mathematics Didactics course.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>During the introductory teaching practice, the students sit in on five lessons given by the teacher responsible for their teaching practice, and teach five lessons themselves. The students are given observation and reflection assignments by the teacher responsible for their teaching practice.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>Right at the start of their training, students acquire initial experience with the observation of teaching, the establishment of concepts for teaching and the implementation of teaching. This early confrontation with the complexity of everything that teaching involves helps students decide whether they wish to and, indeed, ought to, continue with the training. It forms a basis for the subsequent pedagogical and subject-didactics training.</td>
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</tr>
<tr>
<td>Literature</td>
<td>Wird von der Praktikumslehrperson bestimmt.</td>
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<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-9990-00L</td>
<td>Teaching Internship Mathematics</td>
<td>O</td>
<td>6 credits</td>
<td>13P</td>
<td>N. Hungerbühler</td>
</tr>
<tr>
<td></td>
<td>Teaching Internship Mathematics for Teaching Diploma in 2 Subjects in One-Step Procedure and Mathematics as Major Subject</td>
<td></td>
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</tr>
<tr>
<td>Abstract</td>
<td>In the final phase of their training, students have to apply and test the insights, abilities and skills they have acquired. They spend 3-5 weeks in an educational institution, during which time they observe 10 lessons and teach 30 lessons independently. The Teaching Internship is complemented by 10 further observed lessons, which are integrated into the Mentored Work in Subject Didactics.</td>
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</tr>
<tr>
<td>Objective</td>
<td>Die Studierenden können die Bedeutung von Unterrichtsthemen unter verschiedenen Blickwinkeln einschätzen. Sie kennen und beherrschen das unterrichtliche Handwerk. Sie können ein gegebenes Unterrichtsthema für eine Gruppe von Lernenden fachlich und didaktisch korrekt strukturieren und in eine adäquate Lernumgebung umsetzen. Es gelingt ihnen, die Balance zwischen Anleitung und Offenheit zu halten, sodass die Lernenden sowohl über den nötigen Freiraum wie über ausreichend Orientierung verfügen, um aktiv und effektiv flexibel nutzbares (Fach-)Wissen zu erwerben.</td>
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<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-9991-01L</td>
<td>Examination Lesson I Mathematics</td>
<td>O</td>
<td>1 credit</td>
<td>2P</td>
<td>N. Hungerbühler</td>
</tr>
<tr>
<td></td>
<td>Simultaneous enrolment in &quot;Examination Lesson Mathematics&quot; (401-9991-01L) is compulsory.</td>
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</tr>
<tr>
<td>Abstract</td>
<td>In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Objective</td>
<td>On the basis of a specified topic, the candidate shows that they are in a position to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.</td>
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</tbody>
</table>

**Notice**

Prerequisites / notice


# Lecture notes

**401-9991-02L**

Examination Lesson II Mathematics

Simultaneous enrolment in “Examination Lesson I Mathematics” (401-9991-01L) is compulsory.

**Abstract**

In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.

**Objective**

On the basis of a specified topic, the candidate shows that they are in a position to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

**Content**


**Notice**

Prerequisites / notice

The course Combinatorics I and II is an introduction into the field of enumerative combinatorics.

**Lecturers**

- N. Hungerbühler


**Finite Geometries II**

Die Studierenden kennen die wesentlichen Elemente der mathematischen Modellierung. Sie sind in der Lage, Modelle zu erstellen und

On the basis of a specified topic, the candidate shows that they are in a position

**Finite geometries I, II: finite fields, rings of polynomials, finite affine planes, axioms of incidence, Euler's thirty-six officers problem, design of

Combinatorics II


- to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle

- to analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

**Content**

Die Studierenden erfahren das Lektionsthema in der Regel 10 Tage vor dem Prüfungstermin. Von der zuständigen Lehrperson erhalten sie Informationen über den Wissensstand der zu unterrichtenden Klasse und können sie vor dem Prüfungstermin besuchen.

Die gehaltene Lektion wird kriteriernbasiert beurteilt. Die Beurteilung umfasst auch die schriftliche Vorbereitung und eine mündliche Refleksion des Kandidat/ der Kandidatin über die gehaltene Lektion im Rahmen eines kurzen Kolloquiums.

Lecture notes

Dokument: Schriftliche Vorbereitung für Prüfungskriterien.

Prerequisites / notice

Nach Abschluss der übrigen Ausbildung.

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*Teaching Diploma in 2 Subjects in One-Step Procedure: no courses from this category have to be completed.*

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3059-00L</td>
<td>Combinatorics II</td>
<td>W</td>
<td>4 credits</td>
<td>2G</td>
<td>N. Hungerbühler</td>
</tr>
<tr>
<td>401-3057-00L</td>
<td>Finite Geometries II</td>
<td>W</td>
<td>4 credits</td>
<td>2G</td>
<td>N. Hungerbühler</td>
</tr>
<tr>
<td>401-0293-00L</td>
<td>Mathematics III</td>
<td>W</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>E. W. Farkas</td>
</tr>
<tr>
<td>401-0293-99L</td>
<td>Mathematics III (Supplement)</td>
<td>W</td>
<td>1 credit</td>
<td>1A</td>
<td>N. Hungerbühler</td>
</tr>
</tbody>
</table>

---
Upon completion of the course, students are able to classify combinatorial problems and to apply adequate techniques to solve them.

Mentored Work Specialised Courses in the Respective Subject with an Educational Focus Mathematics A

Title: Mentored Work Specialised Courses in the Respective Subject with an Educational Focus Mathematics for TC and Teaching Diploma.

Objective: The aim is for the students - to familiarise themselves with a new topic by obtaining material and studying the sources, so that they can selectively extend their specialist competence in this way.

Content: The work should be completed before the internship begins. The mentored research that is directly comprehensible to the targeted readers - generally specialist-subject teachers at high-school level.

Further course offerings from the category Educational Science are listed under “Programme: Educational Science for Teaching Diploma and TC”. Teaching Diploma in 2 Subjects in One-Step Procedure:

a) courses from the category Compulsory Elective Courses of the Minor Subject may also be selected;
b) courses from the category Specialized Courses in the Respective Subject, either of the Major or the Minor Subject, may also be selected.

Compulsory Elective Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3059-00L</td>
<td>Combinatorics II</td>
<td>W</td>
<td>4 credits</td>
<td>2G</td>
<td>N. Hungerbühler</td>
</tr>
</tbody>
</table>

Objective: Upon completion of the course, students are able to classify combinatorial problems and to apply adequate techniques to solve them.
Contents of the lectures Combinatorics I and II: congruence transformation of the plane, symmetry groups of geometric figures, Euler's function, Cayley graphs, formal power series, permutation groups, cycles, Bunday's lemma, cycle index, Polya's theorems, applications to graph theory and isomers.

**401-3057-00L** Finite Geometries II

*Does not take place this semester.*

**Abstract**

Finite geometries I, II: Finite geometries combine aspects of geometry, discrete mathematics and the algebra of finite fields. In particular, we will construct models of axioms of incidence and investigate closing theorems. Applications include test design in statistics, block design, and the construction of orthogonal Latin squares.

**Objective**

Finite geometries I, II: Students will be able to construct and analyse models of finite geometries. They are familiar with closing theorems of the axioms of incidence and are able to design statistical tests by using the theory of finite geometries. They are able to construct orthogonal Latin squares and know the basic elements of the theory of block design.

**Content**

Finite geometries I, II: finite fields, rings of polynomials, finite affine planes, axioms of incidence, Euler's thirty-six officers problem, design of statistical tests, orthogonal Latin squares, transformation of finite planes, closing theorems of Desargues and Pappus-Pascal, hierarchy of closing theorems, finite coordinate planes, division rings, finite projective planes, duality principle, finite Moebius planes, error correcting codes, block design

**Literature**

- Max Jeger, Endliche Geometrien, ETH Skript 1988
- Albrecht Beutelspacher: Einführung in die endliche Geometrie I,II, Bibliographisches Institut 1983
- Margaret Lynn Batten: Combinatorics of Finite Geometries. Cambridge University Press
- Dembowski: Finite Geometries.

**401-9951-58L** Didactics of Mathematics at the College Level I

*(University of Zurich)*

*Enrolment only possible with matriculation in Teaching Diploma or TC at ETH or in Teaching Diploma at UZH.*

**Course code**: 2V+1A

**Abstract**

Students are familiarised with the subjects taught at high-school level I (the first three years of the full-length high school, or the first year of the reduced-length high school). The central contents of geometry, arithmetic and algebra, and also written mathematical problems are explained.

**Objective**

In the teaching given at high-school level I (the first three years of the full-length high school or the first year of the reduced-length high school), central concepts and approaches adopted in mathematics are introduced and observed in greater depth. These include variables, function, proof. This calls for a careful didactic analysis on the part of the teacher, requiring them to study and reflect on the prerequisites for the pupils and the requirements in terms of mathematics and cognitive psychology.

**Content**

Beispiele von Schülerarbeiten geben in diesem Seminar einen Einblick in die mathematische Denkwelt der Schülerinnen und Schüler. Vielfältige Aufgaben zum Einsatz im Unterricht werden vorgestellt, selber gelöst und diskutiert.

- Arithmetik und Algebra: Zahlbereiche, Form und Inhalt in der Algebra
- Geometrie: Konstruieren-Berechnen-Beweisen, dynamische Geometrie (Geogebra).
- Sachrechnen: Funktionsbegriff, mathematische Modellierung.
- Aktuelle mathematikdidaktische Aspekte wie Lernprozesse, Grundvorstellungen, Kompetenzen, offene Aufgaben.

**Lecture notes**

Seminar mit Übungen

**Prerequisites / notice**

Zahlreiche begleitende Unterlagen werden abgegeben.

**401-9931-00L** Foundations of Mathematics

**W** 4 credits

**Objective**

Das Ziel dieser Vorlesung ist die Vermittlung der grundlegenden Konzepte und Begriffe der Mathematik. Dazu gehören die Sprache der Mathematik (d.h. Aussagenlogik und Prädikatenlogik), Modelle von Axiomensystemen (inkl. Gödel'scher Vollständigkeitssatz), Beweismethoden, der Aufbau der Zahlen von den natürlichen Zahlen bis zu den reellen Zahlen sowie die Axiome der Mengenlehre.

**Literature**

Als ergänzende Literatur zur Vorlesung kann ich folgende beiden Bücher empfehlen:

**401-9935-00L** Computer Science in Secondary School Mathematics

**W** 4 credits

**Abstract**

The unit "Computer Science in Secondary School Mathematics" addresses key contributions of computer science to general education, the tight relations between the algorithmic and the mathematical way of thinking, and the thoughtful choice of computer science topics for high school mathematics classes.
Objective

The general goal of the course consists in presenting ways to teach fundamentals of computer science, which are closely related to contents and methods of mathematics. After attending the course unit, a mathematics teacher is able to teach selected fundamentals of computer science in mathematics classes.

The students understand the fundamental concepts of computer science in the context of a broad and deep knowledge. Through this understanding, they manage to prepare teaching materials for a successful knowledge transfer and to pass their passion for the subject on to their pupils.

The students know various teaching methods as well as their advantages and disadvantages. They can handle inhomogeneous prior knowledge of the learners inside a class. Besides holding classes, the students do care about the individual pupil support.

They encourage the autonomy of the learners, manage to work with diverse target groups and to establish a positive learning environment.

The students are able to express themselves using a comprehensible and refined professional language, both in a spoken and a written way, and they master the basic terminology of computer science. Besides the English terms, they are familiar with the corresponding German expressions. The students are able to produce detailed, matured, linguistically correct and design-wise appealing teaching materials.

Content

The main topics of the course unit "Computer Science in Secondary School Mathematics" represent a scientific and didactic added value for mathematics classes.

The course covers the didactics of logic, of cryptography, of finite state automata, of computability and of the introduction to programming. The students develop the understanding of fundamental scientific concepts such as algorithm, program, complexity, determinism, computation, automata, verification, testing, security of a cryptosystem and secure communication. They reflect on ways to embed them into a scientifically sound and didactically sustainable mathematics course.

In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester.

Lecture notes

Liturature wird angegeben. Zusätzliche Unterlagen und Folien werden zur Verfügung gestellt.

Literature


see Compulsory Elective Courses Teaching Diploma

Mathematics as Second Subject

Subject Didactics in Mathematics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3971-11L</td>
<td>Mathematics Didactics I: Enrolment only possible with matriculation in Mathematics Teaching Diploma or Mathematics TC at ETH or in Mathematics Teaching Diploma at UZH.</td>
<td>O</td>
<td>4</td>
<td>2G</td>
<td>K. Barro</td>
</tr>
</tbody>
</table>

Objective

On the basis of their understanding of mathematics, of the knowledge acquired from research into teaching/learning and subject teaching, and also of best practice, students who have completed this course will be in a position to draft motivating learning arrangements, with cognitive appeal, which trigger and maintain learning processes. The aim here is to implement a corresponding teaching plan, so that the mathematics tuition that is given has a general-education value, on the one hand, and ensures that pupils acquire the fundamental knowledge necessary for studying at university, on the other hand.

Content

The students develop the understanding of fundamental scientific concepts such as algorithm, program, complexity, determinism, computation, automata, verification, testing, security of a cryptosystem and secure communication. They reflect on ways to embed them into a scientifically sound and didactically sustainable mathematics course.

In a semester exercise, the students develop and document an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester.

Lecture notes

Liturature wird angegeben. Zusätzliche Unterlagen und Folien werden zur Verfügung gestellt.

Literature


see Compulsory Elective Courses Teaching Diploma

Mathematics as Second Subject

Subject Didactics in Mathematics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-9983-00L</td>
<td>Mentored Work Subject Didactics Mathematics A: Teaching Diploma and Teaching Diploma Mathematics as Minor Subject.</td>
<td>O</td>
<td>2</td>
<td>4A</td>
<td>M. Akveld, K. Barro, L. Halbeisen, M. Huber, N. Hungerbühler</td>
</tr>
</tbody>
</table>

Objective

The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Content

Thematische Schwerpunkte
Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

Lernformen

Lecture notes

Eine kurze Anleitung zur mentorierten Arbeit in Fachdidaktik wird zur Verfügung gestellt.

Literature

Die Literatur ist themenspezifisch. Die Studierenden beschaffen sie sich in der Regel selber (siehe Lernziele). In besonderen Fällen wird sie vom Betreuer zur Verfügung gestellt.

Prerequisites / notice

Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.
The objective is for the students:
- to be able to familiarize themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Content
Thematic Schwerpunkte
Die Gegenstände der mentorierten Arbeit in Fachdidaktik stammen in der Regel aus dem gymnasialen Unterricht.

Prerequisites / notice
Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

Professional Training in Mathematics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-9987-00L</td>
<td>Teaching Internship Including Examination Lessons Mathematics</td>
<td>O</td>
<td>4</td>
<td>9P</td>
<td>N. Hungerbühler</td>
</tr>
<tr>
<td></td>
<td>Teaching Internship Mathematics for TC and Teaching Diploma Mathematics as Minor Subject. Repetition of the Teaching Internship is excluded even if Examination Lessons are to be repeated.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Abstract
Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as assessed as Examination Lessons.

Objective
- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils’ work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Content

Lecture notes
Dokument: schriftliche Vorbereitung für Prüfungslektionen.

Literature
Vorlesung: Didactics colloquium

Colloquia

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-5960-00L</td>
<td>Colloquium on Mathematics, Computer Science, and Education</td>
<td>E-</td>
<td>0</td>
<td></td>
<td>N. Hungerbühler, M. Akveid, J. Hronkovic, H. Klemenz</td>
</tr>
<tr>
<td></td>
<td>Subject didactics for mathematics and computer science teachers.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mathematics Teaching Diploma - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>W+</th>
<th>W</th>
<th>O</th>
<th>E-</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eligible for credits and recommended</td>
<td></td>
<td>Compulsory</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Eligible for credits</td>
<td></td>
<td></td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td></td>
<td>Courses outside the curriculum</td>
<td></td>
<td></td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>P</th>
<th>practical/laboratory course</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**ECTS**

- European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
Mathematics Master

► Core Courses

For the Master's degree in Applied Mathematics the following additional condition (not manifest in myStudies) must be obeyed: At least 15 of the required 28 credits from core courses and electives must be acquired in areas of applied mathematics and further application-oriented fields.

►► Core Courses: Pure Mathematics

(both Bachelor) core courses

([www.vvz.ethz.ch/Vorlesungsverzeichnis/sucheLehrangebot.do?seite=1&semkez=2015W&abschnittId=63461&lang=en&ansicht=1]) are eligible under certain conditions.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3225-00L</td>
<td>Introduction to Lie Groups</td>
<td>W</td>
<td>8 credits</td>
<td>4G</td>
<td>M. Einsiedler</td>
</tr>
<tr>
<td>Abstract</td>
<td>Topological groups and Haar measure. Definition of Lie groups, examples of local fields and examples of discrete subgroups; basic properties; Lie subgroups, Lie algebras and relation with Lie groups; exponential map, adjoint representation. Semisimplicity, nilpotency, solvability, compactness: Killing form, Lie's and Engel's theorems. Definition of algebraic groups and relation with Lie groups.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>The goal is to have a broad though foundational knowledge of the theory of Lie groups and their associated Lie algebras with an emphasis on the algebraic and topological aspects of it.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Literature | A. Knapp: "Lie groups beyond an Introduction" (Birkhaeuser) 
A. Sagle & R. Walde: "Introduction to Lie groups and Lie algebras" (Academic Press, '73) 
F. Warner: "Foundations of differentiable manifolds and Lie groups" (Springer) 
H. Samelson: "Notes on Lie algebras" (Springer, '90) 
S. Helgason: "Differential geometry, Lie groups and symmetric spaces" (Academic Press, '78) 
| Prerequisites / notice | Topology and basic notions of measure theory. A basic understanding of the concepts of manifold, tangent space and vector field is useful, but could also be achieved throughout the semester. |
| Course webpage: | http://www.math.ethz.ch/education/bachelor/lectures/hs2014/math/introlg |

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3118-09L</td>
<td>Modular Forms</td>
<td>W</td>
<td>8 credits</td>
<td>3V+1U</td>
<td>Ö. Imamoglu</td>
</tr>
<tr>
<td>Abstract</td>
<td>This is an introductory course on automorphic forms covering its basic properties with emphasis on connections with number theory.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>The aim of the course is to cover the classical theory of modular forms.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Literature | J.P. Serre, A Course in Arithmetic; 
N. Koblitz, Introduction to Elliptic Curves and Modular Forms; 
D. Zagier, The 1-2-3 of Modular Forms; 
H. Iwaniec, Topics in Classical Automorphic Forms. |

►► Core Courses: Applied Mathematics and Further Appl.-Oriented Fields

(both Bachelor) core courses

([www.vvz.ethz.ch/Vorlesungsverzeichnis/sucheLehrangebot.do?seite=1&semkez=2015W&abschnittId=63462&lang=en&ansicht=1]) are eligible under certain conditions.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3651-00L</td>
<td>Numerical Methods for Elliptic and Parabolic Partial Differential Equations</td>
<td>W</td>
<td>10 credits</td>
<td>4V+1U</td>
<td>C. Schwab</td>
</tr>
</tbody>
</table>
| Abstract | Course audience at ETH: 3rd year ETH BSc Mathematics and MSc Mathematics and MSc Applied Mathematics students. Other ETH students are advised to attend the course. 
"Numerical Methods for Partial Differential Equations" (401-0674-00L) in the CSE curriculum during the spring semester. |
| Objective | This course gives a comprehensive introduction into the numerical treatment of linear and non-linear elliptic boundary value problems, related eigenvalue problems and linear, parabolic evolution problems. Emphasis is on theory and the foundations of numerical methods. 
Practical exercises include MATLAB implementations of finite element methods. |
| Content | Participants of the course should become familiar with 
* concepts underlying the discretization of elliptic and parabolic boundary value problems 
* analytical techniques for investigating the convergence of numerical methods for the approximate solution of boundary value problems 
* methods for the efficient solution of discrete boundary value problems 
* implementational aspects of the finite element method. |
| Lecture notes | Course slides will be made available to the audience. |
| Literature | n.a. |
| Prerequisites / notice | Practical exercises based on MATLAB |

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3621-00L</td>
<td>Fundamentals of Mathematical Statistics</td>
<td>W</td>
<td>10 credits</td>
<td>4V+1U</td>
<td>S. van de Geer</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course covers the basics of inferential statistics.</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 1045 of 1434
**Mathematical Optimization**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3901-00L</td>
<td>Mathematical Optimization</td>
<td>W</td>
<td>11 credits</td>
<td>4V + 2U</td>
<td>R. Weismantel</td>
</tr>
</tbody>
</table>

**Abstract**

Mathematical treatment of diverse optimization techniques.

**Objective**

1. Linear optimization: The geometry of linear programming, the simplex method for solving linear programming problems, Farkas' Lemma and infeasibility certificates, duality theory of linear programming.


3. Integer optimization: Ties between linear and integer optimization, total unimodularity, complexity theory, cutting plane theory.

4. Combinatorial optimization: Network flow problems, structural results and algorithms for matroids, matchings and, more generally, independence systems.

**(also Bachelor) Core Courses: Pure Mathematics**

401-3531-00L Differential Geometry I can only be recognised for the Master Programme if 401-3532-00L Differential Geometry II has not been recognised for the Bachelor Programme.

Analogously for:

401-3461-00L Functional Analysis I - 401-3462-00L Functional Analysis II
401-3001-61L Algebraic Topology I - 401-3002-12L Algebraic Topology II
401-3132-00L Commutative Algebra - 401-3146-12L Algebraic Geometry
401-3371-00L Dynamical Systems I - 401-3372-00L Dynamical Systems II

For the category assignment take contact with the Study Administration Office (www.math.ethz.ch/studiensekretariat) after having received the credits.

---

### Differential Geometry I

**Abstract**

This course is an introduction to differential and Riemannian geometry.

**Objective**

The aim is to lead students from a reasonable knowledge of advanced calculus, basic knowledge of general topology and solid knowledge of linear algebra to fundamental knowledge of differentiable manifolds and their basic tools. Riemannian geometry, some basic Lie theory, and de Rham cohomology will be developed as applications.

**Literature**

- W. Boothby: "An introduction to differentiable manifolds and Riemannian geometry"
- J.M. Lee: "Introduction to smooth manifolds"
- M. P. Do Carmo: "Riemannian Geometry"

---

### Functional Analysis I

**Abstract**

Baire category; Banach and Hilbert spaces, bounded linear operators; Three Fundamental Principles: Uniform Boundedness, Open Mapping/Closed Graph, Hahn-Banach; Convexity; Dual Spaces: weak and weak* topologies, Banach-Alaoglu, reflexive spaces; Ergodic Theorem; compact operators and Fredholm theory, Closed Image Theorem; Spectral theory, self-adjoint operators.

**Lecture notes**

Lecture Notes on "Functional Analysis" by D. A. Salamon

---

### Algebraic Topology I

**Abstract**

This is an introductory course in algebraic topology. The course will cover the following main topics: introduction to homotopy theory, homology and cohomology of spaces.

**Literature**


Book can be downloaded for free at:

http://www.math.cornell.edu/~hatcher/AT/ATpage.html

See also:

http://www.math.cornell.edu/~hatcher/#anchor1772800

3. E. Spanier, "Algebraic topology", Springer-Verlag

General topology, linear algebra.

Some knowledge of differential geometry and differential topology is useful but not absolutely necessary.

---

### Commutative Algebra

**Abstract**

This course is meant to provide an introduction to commutative algebra that equips the student to start studying the basics of algebraic geometry.

**Objective**

About the course: We shall closely follow the text "Introduction to Commutative Algebra" by M. F. Atiyah and I. G. Macdonald. Wherever possible, there will be extra focus on exercises that lead towards the basics of Algebraic Geometry. Topics include

- Basics about rings, ideals and modules
- Localization
- Primary decomposition
- Integral dependence and valuations
- Noetherian rings
- Completions
- Basic dimension theory

**Literature**

- "Introduction to Commutative Algebra" by M. F. Atiyah and I. G. Macdonald (Addison-Wesley Publ., 1969)
- "Commutative algebra. With a view towards algebraic geometry" by D. Eisenbud (GTM 150, Springer Verlag, 1995)

Prerequisites / notice

Some knowledge of differential geometry and commutative algebra is useful but not absolutely necessary.

---

### Dynamical Systems I

**Abstract**

This course is a Part I of a broad introduction to dynamical systems. Topic covered include topological dynamics, symbolic dynamics, ergodic theory, hyperbolic dynamics. In Part II (FS 2016), we will cover low-dimensional dynamics, complex dynamics, measure-theoretic entropy and Hamiltonian dynamics.

**Objective**

Mastery of the basic methods and principal themes of dynamical systems.
The course introduces the principal themes of modern dynamical systems. Topics covered include:

1. Topological dynamics
   (transitivity, attractors, chaos, structural stability)

2. Symbolic dynamics
   (Perron-Frobenius theorem, zeta functions)

3. Ergodic theory
   (Poincare recurrence theorem, Birkhoff ergodic theorem, existence of invariant measures)

4. Hyperbolic dynamics
   (Groban-Hartman theorem, Shadowing lemma, Closing lemma and applications)

The course presents some aspects of probabilistic number theory, including distribution properties of the number of prime divisors of integers, probabilistic properties of the zeta function and statistical distribution of exponential sums.

A more advanced textbook which covers everything in both Dynamical Systems I and II (and much more!) is

Introduction to Dynamical Systems, Brin and Stuck, CUP, 2002.

Another excellent book (which will be relevant also for Dynamical Systems II) is

Lectures on Dynamical Systems, Zehnder, EMS 2010.

The material of the basic courses of the first two years of the program at ETH is assumed. Some basic differential geometry and functional analysis would be useful but not essential.

**Electives: Pure Mathematics**

**Selection: Algebra, Topology, Discrete Mathematics, Logic**

The course presents some aspects of probabilistic number theory, including distribution properties of the number of prime divisors of integers, probabilistic properties of the zeta function and statistical distribution of exponential sums.

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 1047 of 1434
We will first study the properties of elliptic curves. We prove that an elliptic curve can be described as the quotient of the complex numbers.

H. Iwaniec and E. Kowalski: "Analytic number theory", and additional lecture notes will be prepared.

Prerequisites / notice

Some knowledge of number theory is useful but the main results will be summarized.

Elliptic Curves

Abstract

We will study elliptic curves from different point of view: as varieties, as equations, as quotients. We will then study some properties of algebraic points on an elliptic curve. We will finally describe special subset of the rational points of curves that are embedded in products of elliptic curves.

Objective

The aim of this course is to get used to geometric objects and algebraic tools, such as elliptic curves, curves, heights and degree.

Content

We will first study the properties of elliptic curves. We prove that an elliptic curve can be described as the quotient of the complex numbers by a lattice and equivalently as the zero set of an equation of degree 3. We will introduce the notion of height and degree of algebraic points and describe subsets of algebraic points of bounded height and degree.

Finally, We will study some properties of algebraic points on curves embedded in products of elliptic curves.

Literature

J. Silverman "The arithmetic of Elliptic Curves"
J. Silverman " Advanced Topics in the arithmetic of Elliptic Curves"
E. Bombieri & W. Gubler " Heights in Diophantine Geometry"

Prerequisites / notice

Algebra and Linear Algebra, Topology, Geometry, some basic Algebraic Geometry.

Combinatorics II

Abstract

The course Combinatorics I and II is an introduction into the field of enumerative combinatorics. Upon completion of the course, students are able to classify combinatorial problems and to apply adequate techniques to solve them.

Content

Contents of the lectures Combinatorics I and II: congruence transformation of the plane, symmetry groups of geometric figures, Euler's function, Cayley graphs, formal power series, permutation groups, cycles, Bunsdie's lemma, cycle index, Polya's theorems, applications to graph theory and isomers.

Representation Theory of Finite Groups, and in Particular Symmetric Groups

Abstract

The first part of the course will be devoted to the general theory of linear representations of finite groups. In the second part we will discuss in details the representation theory of the symmetric groups and some of its applications.

Literature

J. P. Serre. Linear Representations of Finite Groups.

Prerequisites / notice

It will be assumed that the listeners know the material from a basic linear algebra course and also basic facts about groups and rings.

Combinatorics II

Reading Course: Geometric Invariant Theory

Abstract

Geometric Invariant Theory (GIT) is concerned with the problem of defining quotients of algebraic varieties by group actions, a crucial step in the construction of moduli spaces. Although some of the ideas go back to Hilbert, it was developed in its present form by Mumford in the 60s.

Objective

The goal of this reading course is to give an introduction to GIT, with emphasis on examples rather than the most general statements.

After a couple of introductory sessions, participants will contribute with talks.

Content

We will cover topics as:
- existence of affine and projective quotients
- the Hilbert-Mumford criterion
- construction of the moduli space of elliptic curves
- toric varieties as GIT quotients
- semistable vector bundles on curves

Literature


Basic knowledge of algebraic geometry will be assumed.

Equidecomposability of Polytopes

Abstract

A polygon in the plane can be decomposed into finitely many (convex) pieces and reassembled to form another polygon if and only if they have the same area. Hilbert's third problem asks if the analogous is also true for two polyhedra in space. Whether or not it is possible to define volume without the use of approximation arguments depends on the answer to this question.

Objective

The course will cover classical results on equidecomposability including the Dehn-Sydler theorem, i.e. the solution to Hilbert's third problem. We will then describe the connection between equidecomposability and valuation theory. Finally, we will discuss some recent classification results of valuations that are invariant under certain groups of motions.

Prerequisites / notice

Office hours: Thursday 11:00 - 12:00

Surfaces and 3-Manifolds

Abstract

This course is an introduction and invitation to the theory of manifolds of dimension 2 and 3, with focus on the connections between the two dimensions.
Finite geometries I, II: Finite geometries combine aspects of geometry, discrete mathematics and the algebra of finite fields. In particular, finite fields, rings of polynomials, finite affine planes, axioms of incidence, Euler's thirty-six officers problem, design of statistical tests, orthogonal Latin squares, transformation of finite planes, closing theorems of Desargues and Pappus-Pascal, hierarchy of closing theorems, finite coordinate planes, division rings, finite projective planes, duality principle, finite Moebius planes, error correcting codes, block design.

Prerequisites / notice
The prerequisite is essentially just knowing the definition of manifold. It could help but it's not strictly necessary to know basic covering theory and Riemannian geometry.

Objective
The goal is to give an overview of hyperbolic surfaces, Mapping Class Groups, construction of 3-manifolds, and the geometrisation theorem. The starting point will be the statement of the geometrisation theorem in dimension 2 and the goal the statement of the geometrisation theorem in dimension 3.

Content
Finite geometries I, II: Students will be able to construct and analyse models of finite geometries. They are familiar with closing theorems of the axioms of incidence and are able to design statistical tests by using the theory of finite geometries. They are able to construct orthogonal Latin squares and know the basic elements of the theory of block design.

Literature
- Max Jeger, Endliche Geometrien, ETH Skript 1988
- Albrecht Beutelspacher: Einführung in die endliche Geometrie I,II. Bibliographisches Institut 1983
- Margaret Lynn Batten: Combinatorics of Finite Geometries. Cambridge University Press
- Dembowski: Finite Geometries.

The exam will consist in presenting a result from the course whose proof has been skipped during the course.

401-3507-00L Finite Geometries II
Does not take place this semester.

Abstract
Finite geometries I, II: Finite geometries combine aspects of geometry, discrete mathematics and the algebra of finite fields. In particular, we will construct models of axioms of incidence and investigate closing theorems. Applications include test design in statistics, block design, and the construction of orthogonal Latin squares.

Objective
Finite geometries I, II: Students will be able to construct and analyse models of finite geometries. They are familiar with closing theorems of the axioms of incidence and are able to design statistical tests by using the theory of finite geometries. They are able to construct orthogonal Latin squares and know the basic elements of the theory of block design.

Content
Finite geometries I, II: finite fields, rings of polynomials, finite affine planes, axioms of incidence, Euler’s thirty-six officers problem, design of statistical tests, orthogonal Latin squares, transformation of finite planes, closing theorems of Desargues and Pappus-Pascal, hierarchy of closing theorems, finite coordinate planes, division rings, finite projective planes, duality principle, finite Moebius planes, error correcting codes, block design.

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- Margaret Lynn Batten: Combinatorics of Finite Geometries. Cambridge University Press
- Dembowski: Finite Geometries.

The exam will consist in presenting a result from the course whose proof has been skipped during the course.
6) the name and first name of the supervisor of the Reading Course.

Abstract

For this Reading Course proactive students make an individual agreement with a lecturer to acquire knowledge through independent literature study.

**401-3504-65L Reading Course**

**THE ENROLMENT IS DONE BY THE STUDY ADMINISTRATION.**

Please send an email to Studiensekretariat D-MATH <studiensekretariat@math.ethz.ch> including the following pieces of information:

1) which Reading Course (60, 90, 120 hours of work, corresponding to 2, 3, 4 ECTS credits) you wish to register;
2) in which semester;
3) for which degree programme;
4) your name and first name;
5) your student number;
6) the name and first name of the supervisor of the Reading Course.

Abstract

For this Reading Course proactive students make an individual agreement with a lecturer to acquire knowledge through independent literature study.

**Electives: Applied Mathematics and Further Application-Oriented Fields**

**Selection: Numerical Analysis**

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
---|---|---|---|---|---
401-4657-00L | Numerical Analysis of Stochastic Ordinary Differential Equations | W | 6 credits | 3V+1U | A. Jentzen

Abstract

Course on numerical approximations of stochastic ordinary differential equations driven by Wiener processes. These equations have several applications, for example in financial option valuation. This course also contains an introduction to random number generation and Monte Carlo methods for random variables.

Objective

The aim of this course is to enable the students to carry out simulations and their mathematical convergence analysis for stochastic models originating from applications such as mathematical finance. For this course the teacher teaches a decent knowledge of the different numerical methods, their underlying ideas, convergence properties and implementation issues.

Content

- Generation of random numbers
- Monte Carlo methods for the numerical integration of random variables
- Stochastic processes and Brownian motion
- Stochastic ordinary differential equations (SODEs)
- Numerical approximations of SODEs
- Multilevel Monte Carlo methods for SODEs
- Applications to computational finance: Option valuation

Lecture notes

Lecture Notes will be available.

Literature


Prerequisites / notice

- Mandatory: Probability and measure theory, basic numerical analysis and basics of MATLAB programming.
  - a) mandatory courses: Elementary Probability, Probability Theory I.
  - b) recommended courses: Stochastic Processes.

401-4655-64L Numerical Analysis of High-Dimensional Problems for Uncertainty Quantification

Abstract

In many applications of mathematics, efficient numerical methods for PDEs on high dimensional state and/or parameter spaces is required. This course provides succinct surveys of recently developed numerical methods, their computer implementation for model problems, and elements of their mathematical analysis for the efficient approximation of high- and infinite-dimensional PDE problems.
Content

1. Infinite-Dimensional Analysis
   Probability spaces and measures,
   Tensor Products,
   Measures on function spaces,
   Covariance operators,
   PCA and KL-expansions,
   (generalized) polynomial chaos expansions,
   Kolmogoroff N-widths

2. Examples.
   Parametric Approximation Problems.
   Parametric ODEs (biochemical reaction pathways).
   Parametric PDEs (diffusion problems with random coefficients).
   PDEs in Parametric Domains (Scattering from random obstacles).


4. Stochastic Galerkin Methods

5. Stochastic Collocation Methods
   Smolyak's algorithm and its generalizations;
   sparse, adaptive interpolation algorithms

6. Reduced Basis Methods

7. Monte Carlo Methods

8. Quasi-Monte Carlo Methods

   Bayesian Inverse Problems
   Shape Sensitivity Analysis of PDEs.
   Optimal Control of parametric ODEs and PDEs.
   Optimization of Parametric ODEs and PDEs.

Literature

Books and Surveys:


2. F. Y. Kuo and Ch. Schwab and I. H. Sloan
   Quasi-Monte Carlo methods for high dimensional integration -
   the standard (weighted Hilbert space) setting and beyond,

3. A. Stuart: Bayesian Inverse Problems,

4. Ch. Schwab and C. J. Gittelson
   Sparse tensor discretizations of
   high-dimensional parametric and stochastic PDEs,

Prerequisites / notice

- ETH BSc Math or equivalent
- Num. elliptic and Parabolic PDE
- Num. hyperbolic PDE
- ETH Doctoral Studies in applied mathematics or CSE.

Programming:
- MATLAB (for MSc MATH)
- Python and C/C++/MPI programming (MSc CSE).

Selection: Probability Theory, Statistics

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>401-3591-65L</td>
<td>Introduction to Random Graphs</td>
<td>W</td>
<td>4 credits</td>
<td>2V</td>
<td>A. Knowles</td>
</tr>
<tr>
<td>Abstract</td>
<td>This is an introductory course on random graphs, covering Erdos-Renyi graphs, inhomogeneous graphs, phase transition phenomena, connectivity, and random walks on random graphs.</td>
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| 401-4607-59L | Percolation Theory | W    | 4 credits | 2V   | P. Nolin |
| Objective | The objective is to gain familiarity with the methods of the percolation theory and to learn some of its important results. |
| Content   | Definition of percolation, FKG and BK inequalities, Harris-Kesten Theorem, Menshikov's Theorem, uniqueness of the infinite cluster and possibly Smirnov's Theorem on the conformal invariance of the critical percolation. |
The course is roughly divided into three parts: (1) Supervised learning via (variations of) nearest neighbor methods, (2) the EM algorithm and related procedures, and (3) handling missing data and graphical models.

Objective
Knowledge of methods and basic theory for high-dimensional statistical inference.

Content
Lasso and Group Lasso for high-dimensional linear and generalized linear models; Additive models and many smooth univariate functions; Non-convex loss functions and ℓ¹-regularization; Stability selection, multiple testing and construction of p-values; Undirected graphical modeling.

Literature

Prerequisites / notice
Knowledge of basic concepts in probability theory, and intermediate knowledge of statistics (e.g. a course in linear models or computational statistics).

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401-4623-00L Time Series Analysis

Abstract
Statistical analysis and modeling of observations in temporal order, which exhibit dependence. Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analyses, ARIMA-, GARCH- and state space models. Implementations in the software R.

Objective
Understanding of the basic models and techniques used in time series analysis and their implementation in the statistical software R.

Content
This course deals with modeling and analysis of variables which change randomly in time. Their essential feature is the dependence between successive observations. Applications occur in geophysics, engineering, economics and finance. Topics covered: Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analyses, ARIMA-, GARCH- and state space models. The models and techniques are illustrated using the statistical software R.

Lecture notes
Not available

Literature
A list of references will be distributed during the course.

Prerequisites / notice
Basic knowledge in probability and statistics.

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401-3611-00L Advanced Topics in Computational Statistics

Abstract
This course covers selected advanced topics in computational statistics, including various classification methods, the EM algorithm, clustering, handling missing data, and graphical modeling.

Objective
Students learn the theoretical foundations of the selected methods, as well as practical skills to apply these methods and to interpret their outcomes.

Content
The course is roughly divided into three parts: (1) Supervised learning via (variations of) nearest neighbor methods, (2) the EM algorithm and clustering, and (3) handling missing data and graphical models.

Lecture notes
Lecture notes

Prerequisites / notice
We assume a solid background in mathematics, an introductory lecture in probability and statistics, and at least one more advanced course in statistics.

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401-0649-00L Applied Statistical Regression

Abstract
This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning "good practice" that can be applied in every student's own projects and daily work life.

Objective
The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

Content
The course starts with the basics of linear regression modeling, and then proceeds to parameter estimation, tests and confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, categorical input variables, shrinkage and general modeling strategies.

The last third of the course is dedicated to an introduction into generalized linear regression models: this includes logistic regression for binary response variables, Poisson regression for count data, cumulative logit models for ordered, and multinomial regression for categorical response variables.

Lecture notes
A script will be available

Literature
Faraway (2005): Linear Models with R
Faraway (2006): Extending the Linear Model with R
Draper & Smith (1998): Applied Regression Analysis
Fox (2008): Applied Regression Analysis and GLMs
Montgomery et al. (2008): Introduction to Linear Regression Analysis

Prerequisites / notice
The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

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401-0625-01L Applied Analysis of Variance and Experimental Design

Abstract
Key concepts of experimental design. Planning and analysis of single factor experiments, block designs, full factorial and fractional designs, split-plot and strip-plot designs. Random effects and mixed effects models.

Objective
Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R.

Content

Lecture notes
see website
The following topics are covered:

- Schramm-Loewner Evolution and Gaussian Free Field
- This block course taking place in January 2016 will be an introduction to the Schramm-Loewner Evolutions, which are random curves arising in a number of random planar systems.

Objective
- Topics covered in this class will include:
  - Definition of Loewner chains and their properties
  - Definition and basic properties of Schramm-Loewner Evolutions
  - Relation between SLE(4) and the Gaussian Free Field
  - Survey of properties of some other SLE curves.

Prerequisites / notice
- Students of the 2015-2016 Swissmap Master class program are welcome to attend.

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
401-4889-00L | Mathematical Finance | W | 12 credits | 4V+2U | M. Soner

Abstract
- Advanced introduction to mathematical finance:
  - absence of arbitrage and martingale measures
  - option pricing and hedging
  - optimal investment problems
  - additional topics

Objective
- Advanced level introduction to mathematical finance, presupposing knowledge in probability theory and stochastic processes

Content
- This is an advanced level introduction to mathematical finance for students with a good background in probability. We want to give an overview of main concepts, questions and approaches, and we do this in both discrete- and continuous-time models. Topics include absence of arbitrage and martingale measures, option pricing and hedging, optimal investment problems, and probably others.

Prerequisites are probability theory and stochastic processes (for which lecture notes are available).

Lecture notes
- None available

Literature
- Details will be announced in the course.

Prerequisites / notice
- Prerequisites are probability theory and stochastic processes (for which lecture notes are available).

401-4905-60L | Interest Rate Theory | W | 8 credits | 3V+1U | not available

Abstract
- We introduce and discuss the most important models for interest rate markets. Emphasis will be placed both on theoretical foundations and on numerical implementation and calibration.

Objective
- Gain overview of interest rate markets and the corresponding financial products.
  - Understand the various modeling approaches used (short-rate models, Heath-Jarrow-Morton models, LIBOR market models).
  - Get a firm grasp of the underlying theory, and practice numerical implementation of concrete examples.
  - Learn about extensions that have recently become increasingly important: default risk, multiple yield curves, etc.

Content
- Gain overview of interest rate markets and the corresponding financial products.
  - Understand the various modeling approaches used (short-rate models, Heath-Jarrow-Morton models, LIBOR market models).
  - Get a firm grasp of the underlying theory, and practice numerical implementation of concrete examples.

Prerequisites / notice
- Option pricing and hedging for equity markets as covered, e.g., in "Mathematical Foundations for Finance".
  - Itô calculus.

401-3953-00L | Interest Rate Modeling in Discrete Time | W | 4 credits | 2V | M. V. Wüthrich

Abstract
- This course gives an introduction to stochastic interest rate modeling in discrete time. Starting from cash flow valuation with state price deflators, we derive the equivalent martingale measures for pricing financial instruments and derivatives of primary assets. The lecture is supplemented by several examples such as the Vasicek model where we also study model calibration.

Objective
- The students are familiar with the basic terminology of stochastic interest rate modeling and he is able to transfer his (financial) mathematical knowledge to real world pricing of cash flows and financial instruments.

Content
- The following topics are covered:
  1) stochastic discounting with state price deflators
  2) equivalent martingale measures
  3) pricing of cash flows and primary assets
  4) pricing of derivatives, e.g. European put options
  5) (multi-factor) Vasicek state price deflator model
  6) Heath-Jarrow-Morton interest rate modeling framework

Lecture notes
- Part I of:

Literature
- For further reading:
The student is familiar with the basics in non-life insurance mathematics and statistics. This includes the basic mathematical models for insurance liability modeling, pricing concepts, stochastic claims reserving models and ruin and solvency considerations.

<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
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<tr>
<th>401-3925-00L</th>
<th>Non-Life Insurance: Mathematics and Statistics</th>
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<tbody>
<tr>
<td>Abstract</td>
<td>The lecture aims at providing a basis in non-life insurance mathematics which forms a core subject of actuarial sciences. It discusses collective risk modeling, individual claim size modeling, approximations for compound distributions, ruin theory, premium calculation principles, tariffication with generalized linear models, credibility theory, claims reserving and solvency.</td>
</tr>
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<td>Objective</td>
<td>The student is familiar with the basics in non-life insurance mathematics and statistics. This includes the basic mathematical models for insurance liability modeling, pricing concepts, stochastic claims reserving models and ruin and solvency considerations.</td>
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<tr>
<td>Content</td>
<td>The following topics are treated: Collective Risk Modeling, Individual Claim Size Modeling, Approximations for Compound Distributions, Ruin Theory in Discrete Time, Premium Calculation Principles, Tariffication and Generalized Linear Models, Bayesian Models and Credibility Theory, Claims Reserving, Solvency Considerations.</td>
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<tr>
<th>Lecture notes</th>
<th>M. V. Wüthrich, Non-Life Insurance: Mathematics &amp; Statistics</th>
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This course will be held in English and counts towards the diploma of "Aktuar SAV". For the latter, see details under www.actuaries.ch.

<table>
<thead>
<tr>
<th>401-3922-00L</th>
<th>Life Insurance Mathematics</th>
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<tr>
<td>Abstract</td>
<td>The classical life insurance model is presented together with the important insurance types (insurance on one and two lives, term and endowment insurance and disability). Besides that the most important terms such as mathematical reserves are introduced and calculated. The profit and loss account and the balance sheet of a life insurance company is explained and illustrated.</td>
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<tr>
<th>Lecture notes</th>
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<tbody>
<tr>
<td>Prerequisites / notice</td>
<td>Brownian Motion and Stochastic Calculus, Introduction to Mathematical Finance or Mathematical Foundations for Finance</td>
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<td>Abstract</td>
<td>We present an introduction into stochastic portfolio theory following the recent work of Bob Fernholz and Ioannis Karatzas. Stochastic Portfolio theory is based on diffusion models which allow for certain forms of arbitrage related to econometric facts on (ranked) capital distribution curves.</td>
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Note: The former (spring semester 2013) course title of the course unit 401-4926-13L was Filter Theory -- Theory and Applications.

<table>
<thead>
<tr>
<th>401-4926-13L</th>
<th>Stochastic Filtering - Theory and Applications</th>
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<tr>
<td>Content</td>
<td>Filtering is the task of recovering unobserved state variables from noisy observations. This course covers the theoretical foundations of filtering in various levels of generality, as well as numerics and applications in statistics and finance.</td>
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<th>401-3833-65L</th>
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<td>Abstract</td>
<td>One might have, more provocatively, entitled the course: How does time end (in, Einstein's general relativity)? In a word, badly. Not in a whimper, nor in a crunch, but in something much more exotic.</td>
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Content
One might have, more provocatively, entitled the course: How does time end (in, Einstein's general relativity)? In a word, badly. Not in a whimper, nor in a crunch, but in something much more exotic.

More, technically, what does a generic singular point, restricting time, in solutions to the Einstein gravitational field equations look like?

Special cosmological solutions, such as Freedman’s, do have singularities.

In 1963, Lifshitz and Khalatnikov 'constructed a class' of singular solutions and concluded that ‘... the presence of a singularity in time is NOT a necessary property of cosmological models of the general theory of relativity, and that the general case of an arbitrary distribution of matter and gravitational field does not lead to the appearance of a singularity.'

In 1965 Penrose and Hawking formulated and proved 'incompleteness' theorems that convinced even Lifshitz and Khalatnikov that singularities in time ARE a necessary property of cosmological models of the general theory of relativity. Penrose and Hawking proved that, under very general, physically reasonable conditions, a spacetime (that is, a solution to the Einstein equations) has a light ray (null geodesic) that suddenly ends ('incompleteness') sufficiently far in the past. They adroitly sidestep the problem of defining what a singularity actually is, by saying it is the 'place' where their light rays end. The proofs of incompleteness theorems are not hard. That's good. Unfortunately, they are by their very nature completely non constructive and provide no quantitative information at all about what a 'singularity' really looks like.

In 1970, Belinski, Khalatnikov and Lifshitz revisited the work of 1963 and found that Khalatnikov and Lifshitz had missed something and that ‘... we shall show that there exists a solution which exhibits a physical singularity with respect to time.' In 1982 they revised the 1970 proposal. Their work culminates in a series of fascinating, but very, very heuristic, statements about the possible existence of a class of singular solutions to the field equations. These heuristic statements are referred to as the 'BKL Conjectures'.

Next semester, we will rigorously formulate and prove the 'BKL Conjectures' for homogeneous spacetimes. That is, we will construct a set of initial data with positive measure which evolve into homogeneous, chaotically singular spacetimes that exhibit all of the BKL phenomenology. Most importantly, there are chaotic oscillations, growing in magnitude, whose distribution is governed by the continued fraction expansion of a parameter appearing in the initial data.

The lectures will be completely self contained. One doesn't need to know anything about general relativity; the Einstein field equations will be introduced from scratch. We will classify real, three dimensional Lie algebras, introduce tensor analysis and discuss the geometry of homogeneous spacetimes. We will also derive the basic properties of continued fractions and the Gauss map $x \mapsto \begin{cases} x & \text{if } x \notin \mathbb{Q} \\ \frac{1}{x} - \left\lfloor \frac{1}{x} \right\rfloor & \text{if } x \in \mathbb{Q} \end{cases}$ from $(0,1) \smallsetminus \mathbb{Q}$ to itself.

Lecture notes
There will be lecture notes.

Prerequisites / notice
First year analysis and linear algebra are the only prerequisites.

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<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Prerequisites</th>
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<tr>
<td>402-0843-00L</td>
<td>Quantum Field Theory I</td>
<td>10</td>
<td>W</td>
<td>4V+2U, G. Isidori</td>
</tr>
<tr>
<td>402-0861-00L</td>
<td>Statistical Physics</td>
<td>10</td>
<td>W</td>
<td>4V+2U, M. Sigrist</td>
</tr>
<tr>
<td>402-0830-00L</td>
<td>General Relativity</td>
<td>10</td>
<td>W</td>
<td>4V+2U, M. Gaberdiel</td>
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</table>

Abstract
This course discusses the quantisation of fields in order to introduce a coherent formalism for the combination of quantum mechanics and special relativity. Topics include:
- Relativistic quantum mechanics
- Quantisation of bosonic and fermionic fields
- Interactions in perturbation theory
- Scattering processes and decays
- Radiative corrections

Objective
The goal of this course is to provide a solid introduction to the formalism, the techniques, and important physical applications of quantum field theory. Furthermore it prepares students for the advanced course in quantum field theory (Quantum Field Theory II), and for work on research projects in theoretical physics, particle physics, and condensed-matter physics.

Abstract
This lecture covers the concepts of classical and quantum statistical physics, and some aspects of kinetic gas theory. In a more advanced part Bose-Einstein condensation, general mean field theory and critical phenomena will be addressed. Finally also various aspects of linear response theory will be discussed.

Objective
This lecture gives an introduction in the basic concepts and applications of statistical physics for the general use in physics and, in particular, as a preparation for the theoretical solid state physics education.

Content
Basics of phenomenological thermodynamics, three laws of thermodynamics.
Classical statistical physics: microcanonical ensembles, canonical ensembles and grandcanonical ensembles, applications to simple systems.
Quantum statistical physics: single particle, ideal quantum gases, fermions and bosons.
Bose-Einstein condensation: Bogolyubov theory, superfluidity.
Critical phenomena: mean field, series expansions, scaling behavior, universality.
Renormalization group: fixed points, simple models.
Linear response theory: general formulation, response in mean field, sum rules, collective modes, fluctuation dissipation theorem.

Literature
Lecture notes will be provided.

Abstract
Manifold, Riemannian metric, connection, curvature; Special Relativity; Lorentzian metric; Equivalence principle; Tidal force and spacetime curvature; Energy-momentum tensor, field equations, Newtonian limit; Post-Newtonian approximation; Schwarzschild solution; Mercury's perihelion precession, light deflection.

Objective
Basic understanding of general relativity, its mathematical foundations, and some of the interesting phenomena it predicts.

Suggested textbooks:
- C. Misner, K. Thorne and J. Wheeler: Gravitation
- S. Carroll - Spacetime and Geometry: An Introduction to General Relativity
- R. Wald - General Relativity
- S. Weinberg - Gravitation and Cosmology
- N. Straumann - General Relativity with applications to Astrophysics

Abstract
In this course we cover several fundamental equations of quantum physics: the Schrödinger equation, which lies at the foundation of Quantum Mechanics, the Gross-Pitaevskii, Landau-Lifshitz and Hartree and Hartree-Fock equations playing an important role in condensed matter physics, the Ginzburg-Landau equations of superconductivity, and the Yang-Mills equations of particle physics.

Data: 06.02.2019 13:00
Autumn Semester 2015
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### Selection: Math. Optimization, Discrete Mathematics, Computer Science

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<td>Geometry: Combinatorics and Algorithms</td>
<td>W</td>
<td>6 credits</td>
<td>2V+2U+1A</td>
<td>B. Gärtner, M. Hoffmann, E. Welzl</td>
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<td></td>
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<td>Geometric structures are useful in many areas, and there is a need to understand their structural properties, and to work with them algorithmically. The lecture addresses theoretical foundations concerning geometric structures. Central objects of interest are triangulations. We study combinatorial (does a certain object exist?) and algorithmic questions (Can we find a certain object efficiently?)</td>
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<td>The goal is to make students familiar with fundamental concepts, techniques and results in combinatorial and computational geometry, so as to enable them to model, analyze, and solve theoretical and practical problems in the area and in various application domains. In particular, we want to prepare students for conducting independent research, for instance, within the scope of a thesis project.</td>
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<td>Planar and geometric graphs, embeddings and their representation (Whitney's Theorem, canonical orderings, DCEL), polygon triangulations and the art gallery theorem, convexity in R^d, planar convex hull algorithms (Jarvis Wrap, Graham Scan, Chazan's Algorithm), point set triangulations, Delaunay triangulations (Lawson flips, lifting map, randomized incremental construction), Voronoi diagrams, the Crossing Lemma and incidence bounds, line arrangements (duality, Zone Theorem, ham-sandwich cuts), 3-SUM hardness, counting planar triangulations.</td>
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<td>Prerequisites: The course assumes basic knowledge of discrete mathematics and algorithms, as supplied in the first semesters of Bachelor Studies at ETH.</td>
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<td>Outlook: In the following spring semester there is a seminar &quot;Geometry: Combinatorics and Algorithms&quot; that builds on this course. There are ample possibilities for Semester-, Bachelor- and Master Thesis projects in the area.</td>
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<td>252-1407-00L</td>
<td>Algorithmic Game Theory</td>
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<td>7 credits</td>
<td>3V+2U+1A</td>
<td>P. Widmayer</td>
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<td>Game theory provides a formal model to study the behavior and interaction of self-interested users and programs in large-scale distributed computer systems without central control. The course discusses algorithmic aspects of game theory.</td>
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<td>Learning the basic concepts of game theory and mechanism design, acquiring the computational paradigm of self-interested agents, and using these concepts in the computational and algorithmic setting.</td>
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<td>The Internet is a typical example of a large-scale distributed computer system without central control, with users that are typically only interested in their own good. For instance, they are interested in getting high bandwidth for themselves, but don't care about others, and the same is true for computational load or download rates. Game theory provides a particularly well-suited model for the behaviour and interaction of such selfish users and programs. Classical game theory dates back to the 1930s and typically does not consider algorithmic aspects at all. Only a few years back, algorithms and game theory have been considered together, in an attempt to reconcile selfish behavior of independent agents with the common good.</td>
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<td>- Introduction to classical game theoretic concepts.</td>
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<td>- Existence of stable solutions (equilibria), algorithms for computing equilibria, computational complexity.</td>
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<td>- The cost difference between an optimum under central control and an equilibrium under selfish agents, known as the &quot;price of anarchy&quot;.</td>
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<td>- Augmented games and algorithms that &quot;direct&quot; the actions of selfish agents into a certain desired equilibrium situation.</td>
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<td>- Selected current research topics of Algorithmic Game Theory, such as Web-Search Based Keyword Auctions, or Information Cascading in Social Networks</td>
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<tr>
<td></td>
<td>&quot;Game Theory and Strategy&quot;, Philip D. Straffin, The Mathematical Association of America, 5th printing, 2004</td>
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<td>252-0417-00L</td>
<td>Randomized Algorithms and Probabilistic Methods</td>
<td>W</td>
<td>7 credits</td>
<td>3V+2U+1A</td>
<td>A. Steger, E. Welzl</td>
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<td>Abstract</td>
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<td>Las Vegas &amp; Monte Carlo algorithms; inequalities of Markov, Chebyshev, Chernoff; negative correlation; Markov chains: convergence, rapidly mixing; generating functions; Examples include: min cut, median, balls and bins, routing in hypercubes, 3SAT, card shuffling, random walks.</td>
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<td>After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.</td>
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<td>Randomized Algorithms are algorithms that &quot;flip coins&quot; to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.</td>
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<td>Lecture notes</td>
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<td>252-4050-00L</td>
<td>Complexity Theory</td>
<td>W</td>
<td>6 credits</td>
<td>3V+2U</td>
<td>T. Holenstein</td>
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<td></td>
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<td>Complexity Theory classifies problems according to the resources required in order to solve them. In this course, we give an introduction to modern complexity theory. We introduce basic complexity classes (such as L, P, BPP, PH, NP, AM, PH, PSPACE, IP, EXP), and study circuit complexity.</td>
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<td>The student learns the fundamentals of Complexity Theory, as well as some of the more recent techniques. He not only understands the basic results and techniques used to prove them, but also has insight in some of the technically more advanced theorems.</td>
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<td>Complexity Theory classifies problems according to the difficulty of solving them. In this course, we give an introduction to modern complexity theory. We introduce basic complexity classes (such as L, P, BPP, PH, PSPACE, IP, EXP), and study the known relationship to uniform complexity. We study circuit complexity, and its relationship to uniform complexity. We also will study some circuit lower bounds for constant depth circuits, as well as results which explain why it is difficult to improve these results.</td>
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### Selection: Further Realms

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<tr>
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<td>Reading Course</td>
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<td>2</td>
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<td>Please send an email to Studiensekretariat D-MATH <a href="mailto:studiensekretariat@math.ethz.ch">studiensekretariat@math.ethz.ch</a> including the following pieces of information:</td>
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<td>4) your name and first name;</td>
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<td>6) the name and first name of the supervisor of the Reading Course.</td>
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Abstract
For this Reading Course proactive students make an individual agreement with a lecturer to acquire knowledge through independent literature study.

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Abstract
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Abstract
Usually Fourier Analysis and Systems Theory emphasize the analogy between the different settings (continuous, discrete, periodic, non-periodic). The author proposes a simple approach to generalized functions, based on a Banach space of test functions. The course provides the foundations to Banach Gelfand triples, but also concrete applications in signal processing (time-variant systems, sampling).

Objective
Deeper mathematical understanding of the foundations of signal processing and system theory. The setting of Banach Gelfand Triples allows to provide a framework that allows among others to discuss the relations between different settings (e.g. the generalized Fourier transform of functions on the Euclidean space and corresponding FFT-based routines).

Content
Time-Frequency Analysis and its discretized version, namely Gabor Analysis have required to develop a family of function spaces (the so-called modulation spaces, introduced by Feichtinger in the 80th) which is different from the usual Lebesgue spaces. There is a smallest space (called $S_0$) and a largest space (nearly the dual space), which is a suitable reservoir of generalized functions relevant for the rigorous establishment of basic results in signal processing (sampling theorem, Poisson formula, Fourier inversion, etc.). The course will be centered on the basic properties of the Banach Gelfand triple ($S_0,L_2,S_0'$) (also called rigged Hilbert space), its use for signal processing and systems theory applications. In addition to classical questions we will also discuss the fundamental results of time-frequency analysis (Short-time Fourier transform, Gabor frames, Gabor multipliers, best approximation of operators by Gabor multipliers, identification of slowly varying channels using pilot tones, etc.).

Lecture notes
There will be a script related to the course. In fact, material for a book project on the subject is developed while the course is given.

Prerequisites / notice
In principle a good understanding of concepts from linear algebra is sufficient. Of course, basic knowledge about functional analysis (Banach and Hilbert spaces, linear operators and linear functionals) is helpful. We will, however, explain all these concepts as we go along. We will not need background on Lebesgue integration or topological vector spaces (as usually required for the treatment of distributions).

Application Area
Only necessary and eligible for the Master degree in Applied Mathematics.

One of the application areas specified must be selected for the category Application Area for the Master degree in Applied Mathematics. At least 8
Atmospherical Physics

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>651-4911-00L</td>
<td>Climate and the Global Circulation of the Atmosphere</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>T. Schneider</td>
</tr>
</tbody>
</table>

Abstract
Key features of the surface climate (e.g., the wind and temperature distribution) can be understood by considering how basic physical balances such as the angular momentum and energy balance constrain global atmospheric circulations. This course gives an overview of the physical balances involved and explores some of their implications for maintaining the surface climate.

Objective
Understanding of the basic physical processes involved in maintaining the global circulation of the atmosphere and the surface climate (winds, temperature, precipitation, etc.). Ability to reason how climate may change on long timescales.

Content
Introduction to the physical balances and dynamical mechanisms governing global atmospheric circulations and the surface climate: angular momentum balance and its role in controlling winds; energy balance and its role in controlling temperatures; the hydrologic cycle and its role in controlling humidity and aridity; tracer transport and connections to the surface. The relative importance of mean circulations, transient eddies, and stationary eddies in these balances will be discussed, as will be the dynamics of their generation and maintenance.

The course gives an overview of the dominant processes that govern the surface climate, with a focus on phenomenology and order-of-magnitude physics that is applicable to climates generally, including those of Earth's distant past and of other planets.

Lecture notes
Available at http://climate-dynamics.org/courses/651-4911-00-climate-and-the-global-circulation-of-the-atmosphere/

Biology

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<tr>
<td>551-0015-00L</td>
<td>Biology I</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>R. Glockshuber, E. Hafen</td>
</tr>
</tbody>
</table>

Abstract
The lecture Biology I, together with the lecture Biology II in the following summer semester, is a basic, introductory course into Biology for Students of Materials Sciences and other students with biology as subsidiary subject.

Objective
The goal of this course is to give the students a basic understanding of the molecules that build a cell and make it function, and the basic principles of metabolism and molecular genetics.

Content
Die folgenden Kapitelnummern beziehen sich auf das der Vorlesung zugrundeliegende Lehrbuch "Biology" (Campbell & Rees, 7th edition, 2005)
Kapitel 1-4 des Lehrbuchs werden als Grundwissen vorausgesetzt
1. Aufbau der Zelle
   Kapitel 5: Struktur und Funktion biologischer Makromoleküle
   Kapitel 6: Eine Tour durch die Zelle
   Kapitel 7: Membranstruktur und-funktion
   Kapitel 8: Einführung in den Stoffwechsel
   Kapitel 9: Zelluläre Atmung und Speicherung chemischer Energie
   Kapitel 10: Photosynthese
   Kapitel 12: Der Zellzyklus
   Kapitel 17: Vom Gen zum Protein
2. Allgemeine Genetik
   Kapitel 13: Meiose und Reproduktionszyklen
   Kapitel 14: Mendelsche Genetik
   Kapitel 15: Die chromosomale Basis der Vererbung
   Kapitel 16: Die molekulare Grundlage der Vererbung
   Kapitel 18: Genetik von Bakterien und Viren
   Kapitel 46: Tierische Reproduktion

Grundlagen des Stoffwechsels und eines Überblicks über molekulare Genetik
Der Vorlesungsstoff ist sehr nahe am Lehrbuch gehalten, Skripte werden ggf. durch die Dozenten zur Verfügung gestellt.
Das folgende Lehrbuch ist Grundlage für die Vorlesungen Biologie I und II:


Molekulare Evolution, Phylogenetics and Phylodynamics

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<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>636-0017-00L</td>
<td>Molecular Evolution, Phylogenetics and Phylodynamics</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>T. Stadler</td>
</tr>
</tbody>
</table>

Abstract
The aim of the course is to provide up-to-date knowledge on how we can obtain an understanding of the evolution and population dynamics of organisms based on their genetic sequencing data, employing key concepts from molecular evolution, phylogenetics and phylodynamics. Throughout the course, we tie the models and methods closely with applications, mainly in the field of epidemiology and evolution.
Objective

Attendees will learn what information is contained in genetic sequencing data and how this information is extracted from the sequencing data. The main concepts introduced are:

- models in molecular evolution
- phylogenetic & phylodynamic inference
- maximum likelihood and Bayesian statistics
- stochastic processes

Attendees will apply these concepts to a number of applications yielding biological insight into:

- epidemiology
- pathogen evolution
- macroevolution of species

Content

The course consists of three parts. We first introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Second, we employ these evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades.

Lecture notes

Slides of the lecture will be available online.

Literature

The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:

- Drummond, A. & Bouckert, R. 2015. Bayesian evolutionary analysis with BEAST.

Prerequisites / notice

Basic knowledge in linear algebra, analysis, and statistics.

701-1415-00L Population Biology W 3 credits 2V

Does not take place this semester.

Abstract

This course provides an understanding of the basic concepts of population biology. It presents models regarding the dynamics and evolution of populations and experimental designs for investigating population biology hypotheses (e.g., population growth, species interactions, epidemiology, metapopulations, life history evolution, local adaptation, evolution of sex, and coevolution).

Objective

Students are able

- to describe and apply population biology models (e.g. growth, species interactions)
- to describe and apply epidemiological models
- to substantiate evolutionary concepts (e.g. life history evolution, coevolution, evolution of sex) using population biology arguments and provide examples
- to propose population biology experiments

Content

Population growth, population regulation, predator-prey interactions, host-pathogen interactions, competition, metapopulations, life history evolution, local adaptation, mating systems, sexual selection, coevolution.

Lecture notes

Handouts of lectures

Literature

Recommended:


Computational Electromagnetics

Number Title Type ECTS Hours Lecturers
227-0707-00L Optimization Methods for Engineers W 3 credits 2G C. Hafner, P. Leuchtmann

Abstract

First half of the semester: Introduction to the main methods of numerical optimization with focus on stochastic methods such as genetic algorithms, evolutionary strategies, etc.
Second half of the semester: Each participant implements a selected optimizer and applies it on a problem of practical interest.

Objective

Numerical optimization is an increasing importance for the development of devices and for the design of numerical methods. The students shall learn to select, improve, and combine appropriate procedures for efficiently solving practical problems.

Content

Typical optimization problems and their difficulties are outlined. Well-known deterministic search strategies, combinatorial minimization, and evolutionary algorithms are presented and compared. In engineering, optimization problems are often very complex. Therefore, new techniques based on the generalization and combination of known methods are discussed. To illustrate the procedure, various problems of practical interest are presented and solved with differen optimization codes.

Lecture notes

PDF file see http://alphard.ethz.ch/hafner/Vorles/lect.htm

Prerequisites / notice

Lecture in the first half of the semester, exercises in form of small projects in the second half, presentation of the results in the last week of the semester.

227-2037-00L Physical Modelling and Simulation W 5 credits 4G C. Hafner, J. Leuthold, J. Smajic

Abstract

Physical modelling plays an important role in the design and analysis of new structures, especially for micro and nano devices where fabrication and measurement are difficult. After the fundamentals of electromagnetics, mechanics, and thermodynamics, an introduction to the main concepts and most widely used codes for physical modelling is given and commercial codes are applied.

Objective

Basic knowledge of the fundamental equations and effects of electromagnetics, mechanics, and thermodynamics. Knowledge of the main concepts of numerical methods for physical modelling and simulation. Ability 1) to select appropriate software, 2) to apply it for solving given problems, 3) to validate the results, 4) to interactively improve the models until sufficiently accurate results are obtained.

Content

Since the fabrication and characterization of micro- and nanostructures is difficult, expensive, and time-consuming, numerical modelling drastically reduced the design process. Although many commercial software packages are available, it is important to know the drawbacks and difficulties of the numerical methods behind them and to be able to validate the results obtained with such packages.
First, an introduction to the fundamental equations and effects of electromagnetics, mechanics, and thermodynamics is given. This is important for understanding the problems to be analyzed and for validating results obtained from software packages. After this, the main concepts of numerical methods and of the most widely used codes for physical modelling are outlined and compared, which is essential for the adequate selection of software for solving given problems. After this, prominent commercial software packages are applied to various types of problems, ranging from electrodynamics to multiphysics. For becoming able to select appropriate software and to validate the results obtained, different commercial software packages will be used and compared during the exercises in form of small projects.

Control and Automation

Number Title Type ECTS Hours Lecturers
151-0563-01L Dynamic Programming and Optimal Control W 4 credits 3G R. D’Andrea

Abstract

Introduction to Dynamic Programming and Optimal Control.

Objective

Covers the fundamental concepts of Dynamic Programming & Optimal Control.
Dynamic Programming Algorithm; Deterministic Systems and Shortest Path Problems; Infinite Horizon Problems, Bellman Equation; Deterministic Continuous-Time Optimal Control.


Requirements: Knowledge of advanced calculus, introductory probability theory, and matrix-vector algebra.

### Economics

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<tr>
<td>363-0537-00L</td>
<td>Resource and Environmental Economics</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>L. Bretschger, A. Brausmann</td>
</tr>
</tbody>
</table>

**Abstract**

Relationship between economy and environment, market failure, external effects and public goods, contingent valuation, internalisation of externalities; economics of non-renewable resources, economics of renewable resources, cost-benefit analysis, sustainability, and international aspects of resource and environmental economics.

**Objective**

Understanding of the basic issues and methods in resource and environmental economics; ability to solve typical problems in the field using the appropriate tools, which are concise verbal explanations, diagrams or mathematical expressions.

Topics are:

- Introduction to resource and environmental economics
- Importance of resource and environmental economics
- Main issues of resource and environmental economics
- Normative basis
- Utilitarianism
- Fairness according to Rawls
- Economic growth and environment
- Externalities in the environmental sphere
- Governmental internalisation of externalities
- Private internalisation of externalities: the Coase theorem
- Free rider problem and public goods
- Types of public policy
- Efficient level of pollution
- Tax vs. permits
- Command and Control Instruments
- Empirical data on non-renewable natural resources
- Optimal price development: the Hotelling-rule
- Effects of exploration and Backstop-technology
- Effects of different types of markets.
- Biological growth function
- Optimal depletion of renewable resources
- Social inefficiency as result of over-use of open-access resources
- Cost-benefit analysis and the environment
- Measuring environmental benefit
- Measuring costs
- Concept of sustainability
- Technological feasibility
- Conflicts sustainability / optimality
- Indicators of sustainability
- Problem of climate change
- Cost and benefit of climate change
- Climate change as international ecological externality
- International climate policy: Kyoto protocol
- Implementation of the Kyoto protocol in Switzerland

**Content**

Economy and natural environment, welfare concepts and market failure, external effects and public goods, measuring externalities and contingent valuation, internalising external effects and environmental policy, economics of non-renewable resources, renewable resources, cost-benefit-analysis, sustainability issues, international aspects of resource and environmental problems, selected examples and case studies.

**Lecture notes**

Learning material and script can be found here: [https://moodle-app2.let.ethz.ch/course/view.php?id=328](https://moodle-app2.let.ethz.ch/course/view.php?id=328)

**Literature**


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<tr>
<td>363-0503-00L</td>
<td>Principles of Microeconomics</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>M. Filippini</td>
</tr>
</tbody>
</table>

**Abstract**

The course introduces basic principles, problems and approaches of microeconomics.

The course includes the following main topics:

- Basic principles of demand and supply, market and state in a modern economy, externalities, cost analysis, consumer behaviour, economies of scale and economies of scope, perfect competition, monopoly, oligopoly, monopolistic competition, mathematical treatment of some basic concepts.

**Lecture notes**

Lecture notes, exercises and reference material can be downloaded from Moodle.

**Literature**

N. Gregory Mankiw and Mark P. Taylor (2014), "Economics", 3rd edition, South-Western Cengage Learning. The book can also be used for the course "Principles of Macroeconomics" (Sturm)

For students taking only the course 'Principles of Microeconomics' there is a shorter version of the same book:


Complementary:


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<th>Number</th>
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<tbody>
<tr>
<td>363-0565-00L</td>
<td>Principles of Macroeconomics</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>J.E. Sturm</td>
</tr>
</tbody>
</table>

**Abstract**

This course examines the behaviour of macroeconomic variables, such as gross domestic product, unemployment and inflation rates. It tries to answer questions like: How can we explain fluctuations of national economic activity? What can economic policy do against unemployment and inflation. What significance do international economic relations have for Switzerland?

**Objective**

This lecture will introduce the fundamentals of macroeconomic theory and explain their relevance to every-day economic problems.
Content

This course helps you understand the world in which you live. There are many questions about the macroeconomy that might spark your curiosity. Why are living standards so meagre in many African countries? Why do some countries have high rates of inflation while others have stable prices? Why have some European countries adopted a common currency? These are just a few of the questions that this course will help you answer.

Furthermore, this course will give you a better understanding of the potential and limits of economic policy. As a voter, you help choose the policies that guide the allocation of society's resources. When deciding which policies to support, you may find yourself asking various questions about economics. What are the burdens associated with alternative forms of taxation? What are the effects of free trade with other countries? What is the best way to protect the environment? How does the government budget deficit affect the economy? These and similar questions are always on the minds of policy makers.

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Lecture notes

The course webpage (to be found at http://www.kof.ethz.ch/en/events/teaching/) contains announcements, course information and lecture slides.

Literature

The set-up of the course will closely follow the book of


We advise you to also buy access to Aplia. This internet platform will support you in learning for this course. To save money, you should buy the book together with Aplia. This is sold as a bundle (ISBN: 9781473715998).

Besides this textbook, the slides and lecture notes will cover the content of the lecture and the exam questions.

Environmental Science

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<tr>
<td>701-0535-00L</td>
<td>Environmental Soil Physics/Vadose Zone Hydrology</td>
<td>W</td>
<td>3</td>
<td>2G+2U</td>
<td>D. Or</td>
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</table>

Abstract

The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.

Objective

Students are able to

- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media.
- quantify driving forces and resulting fluxes of water, solute, and heat in soils.
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges

Content

Weeks 1 to 3: Physical Properties of Soils and Other Porous Media

Units and dimensions, definitions and basic mass-volume relationships between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay behavior

Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics)

- The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity

Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing

Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:

Part 1 - Laminar flow in tubes (Poiseuille's Law); Darcy's Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement.

Lab #1: Measurement of saturated hydraulic conductivity in uniform and layered soil columns using the constant head method.

Part 2 - Unsaturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.

Midterm exam

Lab #2: Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip's approximations; infiltration rates and wetting front propagation.

Part 3 - Use of Hydrus model for simulation of unsaturated flow

Weeks 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface evaporation.

Week 12 to 13: Solute Transport in Soils

Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion eq.; solutions for pulse and step solute application; parameter estimation; salt balance.

Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

Additional topics:

Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.

Biological Processes in the Vadose Zone

This course helps you understand the world in which you live. There are many questions about the macroeconomy that might spark your curiosity. Why are living standards so meagre in many African countries? Why do some countries have high rates of inflation while others have stable prices? Why have some European countries adopted a common currency? These are just a few of the questions that this course will help you answer.

Furthermore, this course will give you a better understanding of the potential and limits of economic policy. As a voter, you help choose the policies that guide the allocation of society's resources. When deciding which policies to support, you may find yourself asking various questions about economics. What are the burdens associated with alternative forms of taxation? What are the effects of free trade with other countries? What is the best way to protect the environment? How does the government budget deficit affect the economy? These and similar questions are always on the minds of policy makers.

Lecture notes

Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller (available at the beginning of the semester)

http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology

Literature

Supplemental textbook (not mandatory) - Environmental Soil Physics, by: D. Hillel

Finance
### Financial Engineering (University of Zurich)

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>401-8905-00L</td>
<td>Financial Engineering (University of Zurich)</td>
<td>W</td>
<td>4.5 credits</td>
<td>3G</td>
<td>University lecturers</td>
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<td>corresponding module directly at UZH.</td>
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<td>UZH Module Code: MFOEC103</td>
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**Abstract**
This lecture is intended for students who would like to learn more on equity derivatives modelling and pricing.

**Objective**
Quantitative models for European option pricing (including stochastic volatility and jump models), volatility and variance derivatives, American and exotic options.

**Content**
After introducing fundamental concepts of mathematical finance including no-arbitrage, portfolio replication and risk-neutral measure, we will present the main models that can be used for pricing and hedging European options e.g. Black–Scholes model, stochastic and jump-diffusion models, and highlight their assumptions and limitations. We will cover several types of derivatives such as European and American options, Barrier options and Variance-Swaps. Basic knowledge in probability theory and stochastic calculus is required. Besides attending class, we strongly encourage students to stay informed on financial matters, especially by reading daily financial newspapers such as the Financial Times or the Wall Street Journal.

**Lecture notes**
Script.

**Prerequisites / notice**
Basic knowledge of probability theory and stochastic calculus. Asset Pricing.

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### Advanced Corporate Finance I (University of Zurich)

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<tr>
<td>401-8913-00L</td>
<td>Advanced Corporate Finance I (University of Zurich)</td>
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<td>3 credits</td>
<td>2V</td>
<td>University lecturers</td>
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<td>No enrolment to this course at ETH Zurich. Book the</td>
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<td>corresponding module directly at UZH.</td>
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<td>UZH Module Code: MEOC0288</td>
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**Abstract**
The course applies the basic concepts of corporate finance learnt in earlier courses to a variety of problems in corporate finance. Examples are valuation, takeovers, the measurement of value created, mergers, capital structure, project finance, and foreign direct investment. These are studied in the context of real cases.

---

### Image Processing and Computer Vision

### Information and Communication Technology
The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications: discrete- 
time linear filters, equalization, DFT, discrete-time stochastic processes, elements of detection theory and estimation theory, LMMSE 
estimation and LMMSE filtering, LMS algorithm, Viterbi algorithm.

Objectives

The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications. The two 
main themes are "linearity" and "probability". In the first part of the course, we deepen our understanding of discrete-time linear filters. In the 
second part of the course, we review the basics of probability theory and discrete-time stochastic processes. We then discuss some 
basic concepts of detection theory and estimation theory, as well as some practical methods including LMMSE estimation 
and LMMSE filtering, the LMS algorithm, and the Viterbi algorithm.

Content

Discrete-time linear systems and the z-transform. 
Discrete time and continuous time: forth and back. 
Digital filters. 
DFT. 
Elements of probability theory. 
Discrete-time stochastic processes. 
Elements of detection theory and estimation theory. 
Linear estimation and filtering. 
Wiener filter. 
LMS algorithm. 
Viterbi algorithm.

Material Modelling and Simulation

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<th>Number</th>
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<tbody>
<tr>
<td>227-0101-00L</td>
<td>Discrete-Time and Statistical Signal Processing</td>
<td>W</td>
<td>6 credits</td>
<td>4G</td>
<td>H.A. Loeliger</td>
</tr>
</tbody>
</table>

Abstract

The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications: discrete- 
time linear filters, equalization, DFT, discrete-time stochastic processes, elements of detection theory and estimation theory, LMMSE 
estimation and LMMSE filtering, LMS algorithm, Viterbi algorithm.

Objective

The course introduces some fundamental topics of digital signal processing with a bias towards applications in communications. The two 
main themes are "linearity" and "probability". In the first part of the course, we deepen our understanding of discrete-time linear filters. In the 
second part of the course, we review the basics of probability theory and discrete-time stochastic processes. We then discuss some 
basic concepts of detection theory and estimation theory, as well as some practical methods including LMMSE estimation 
and LMMSE filtering, the LMS algorithm, and the Viterbi algorithm.

Content

Discrete-time linear systems and the z-transform. 
Discrete time and continuous time: forth and back. 
Digital filters. 
DFT. 
Elements of probability theory. 
Discrete-time stochastic processes. 
Elements of detection theory and estimation theory. 
Linear estimation and filtering. 
Wiener filter. 
LMS algorithm. 
Viterbi algorithm.

Quantum Chemistry

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>529-0003-00L</td>
<td>Advanced Quantum Chemistry</td>
<td>W</td>
<td>7 credits</td>
<td>3G</td>
<td>M. Reiher, S. Knecht</td>
</tr>
</tbody>
</table>

Abstract

Advanced, but fundamental topics central to the understanding of theory in chemistry and for solving actual chemical problems with a 
computer.

Examples are:

* Operators derived from principles of relativistic quantum mechanics
* Relativistic effects + methods of relativistic quantum chemistry
* Open-shell molecules + spin-density functional theory
* New electron-correlation theories

Prerequisites / notice

Complex numbers, Vector analysis (integrability; Gauss' divergence theorem), Laplace and Fourier transforms. Ordinary differential 
equations (basic ideas), Linear algebra (matrices; functions of matrices; eigenvectors and eigenvalues; eigenfunctions). Probability theory 
(Gaussian distributions; Poisson distributions; averages; moments; variances; random variables). Numerical mathematics (integration), 
Equilibrium thermodynamics (Gibbs' fundamental equation; thermodynamic potentials; Legendre transforms). Maxwell equations. 
Programming and simulation techniques (Matlab, Monte Carlo simulations).
The aim of the course is to provide an in-depth knowledge of theory and method development in theoretical chemistry. It will be shown that standard non-relativistic quantum chemistry shall be analyzed and understood, too. Examples are the Born-Oppenheimer approximation and the expansion of the electronic wave function in a set of pre-defined many-electron basis functions (Slater determinants). Overcoming these concepts, which are so natural to the theory of chemistry, will provide deeper insights into many-particle quantum mechanics. Also revisiting the workhorse of quantum chemistry, namely density functional theory, with an emphasis on open-shell electronic structures (radicals, transition-metal complexes) will contribute to this endeavor. It will be shown how these insights allow us to make more accurate predictions in chemistry in practice - at the frontier of research in theoretical chemistry.

The objective of the course is to provide an in-depth knowledge of theory and method development in theoretical chemistry. A successful participant of the course is able to:

1. Explain the physical principles of modern semiconductor devices and the foundations of their modeling and numerical simulation.
2. Understand how basic knowledge on quantum-mechanics, semiconductor physics, and device physics is provided. Computer simulations of the most important devices and of interesting physical effects supplement the lectures.
3. Gain an understanding of the principle physics of modern semiconductor devices, of the foundations in the physical modeling of transport and its numerical simulation. The course also basic knowledge on quantum-mechanics, semiconductor physics, and device physics is provided.
4. Analyze the stability of nonlinear dynamical systems and apply this to macroeconomic dynamics.
5. Identify feedback cycles and reasons for unintended systems behavior.
6. Set up and run systems dynamics models by means of the Vensim software.
7. Implementing solutions: project management, critical path method, quality control feedback loop.
8. Use the Vensim software, feedback cycles, control parameters, instabilities, chaos, oscillations and cycles, supply and demand, production functions, investment and consumption.

Prerequisites

- Standard non-relativistic quantum chemistry shall be analyzed and understood, too. Examples are the Born-Oppenheimer approximation and the expansion of the electronic wave function in a set of pre-defined many-electron basis functions (Slater determinants).
- Overcoming these concepts, which are so natural to the theory of chemistry, will provide deeper insights into many-particle quantum mechanics.
- Also revisiting the workhorse of quantum chemistry, namely density functional theory, with an emphasis on open-shell electronic structures (radicals, transition-metal complexes) will contribute to this endeavor.
- It will be shown how these insights allow us to make more accurate predictions in chemistry in practice - at the frontier of research in theoretical chemistry.

Simulation of Semiconductor Devices

- Number: 227-0157-00L
- Title: Semiconductor Devices: Physical Bases and Simulation
- Type: W
- ECTS: 4 credits
- Hours: 3G
- Lecturer: A. Schenk

Objective

The course addresses the physical principles of modern semiconductor devices and the foundations of their modeling and numerical simulation. Necessary basic knowledge on quantum-mechanics, semiconductor physics and device physics is provided. Computer simulations of the most important devices and of interesting physical effects supplement the lectures.

Content

- 1) Introductory lecture: basics of quantum mechanics and quantum chemistry
- 2) Einstein's special theory of relativity and the (classical) electromagnetic interaction of two charged particles
- 3) Klein-Gordon and Dirac equation; the Dirac hydrogen atom
- 4) Numerical methods based on the Dirac-Fock-Coulomb Hamiltonian, two-component and scalar relativistic Hamiltonians
- 5) Response theory and molecular properties, derivation of property operators, Breit-Pauli-Hamiltonian
- 6) Relativistic effects in chemistry and the emergence of spin
- 7) Spin in density functional theory
- 8) New electron-correlation theories: Tensor network and matrix product states, the density matrix renormalization group
- 9) Quantum chemistry without the Born-Oppenheimer approximation

Lecture notes

A set of detailed lecture notes will be provided, which will cover the whole course.

Literature

2. F. Schwabl: Quantenmechanik für Fortgeschrittene (QM II), Springer-Verlag, 1997

Note also the standard textbooks:

- A) I. N. Levine, Quantum Chemistry, Pearson
- B) I. N. Levine, Quantum Chemistry, Pearson

Prerequisites

Strongly recommended (preparatory) courses are: quantum mechanics and quantum chemistry
Content
Why are problems not simple? Why do some systems behave in an unintended way? How can we model and control their dynamics? The course provides answers to these questions by using a broad range of methods encompassing systems oriented management, classical systems dynamics, nonlinear dynamics and macroeconomic modeling.

The course is structured along three main tasks:
1. Finding solutions
2. Implementing solutions
3. Controlling solutions

PART 1 introduces complexity as a system immanent property that cannot be simplified. It introduces the problem solving cycle, used in systems oriented management, as an approach to structure problems and to find solutions.

PART 2 discusses selected problems of project management when implementing solutions. Methods for identifying the critical path of subtasks in a project and for calculating the allocation of resources are provided. The role of quality control as an additional feedback loop and the consequences of small changes are discussed.

PART 3, by far the largest part of the course, provides more insight into the dynamics of existing systems. Examples come from biology (population dynamics), management (inventory modeling, technology adoption, production systems) and economics (supply and demand, investment and consumption). For systems dynamics models, the software program VENSIM is used to evaluate the dynamics. For economic models analytical approaches, also used in nonlinear dynamics and control theory, are applied. These together provide a systematic understanding of the role of feedback loops and instabilities in the dynamics of systems. Emphasis is on oscillating phenomena, such as business cycles and other life cycles.

Lecture notes
Weekly self-study tasks are used to apply the concepts introduced in the lectures and to come to grips with the software program VENSIM.

The lecture slides are provided as handouts - including notes and literature sources - to registered students only. All material is to be found on the Moodle platform. More details during the first lecture.

Prerequisites / notice
Self-study tasks (discussion exercises, Vensim exercises), are provided as home work. Weekly exercise sessions (45 min) are used to discuss selected solutions. Regular participation in the exercises is an efficient way to understand the concepts relevant for the final exam.

Theoretical Physics
In the Master's programme in Applied Mathematics 402-0205-00L Quantum Mechanics I is eligible as a course unit in the application area Theoretical Physics. But only if 402-0204-00L Theoretical Physics wasn't or isn't recognised for credits (neither in the Bachelor's nor in the Master's programme).

For the category assignment take contact with the Study Administration Office (www.math.ethz.ch/studiensekretariat) after having received the credits.

Number Title Type ECTS Hours Lecturers
402-0809-00L Introduction to Computational Physics W 8 credits 2V+2U H. J. Herrmann
402-2203-01L Classical Mechanics W 7 credits 4V+2U C. Anastasiou
402-0861-00L Statistical Physics W 10 credits 4V+2U M. Sigrist
402-0843-00L Quantum Field Theory I W 10 credits 4V+2U G. Isidori
402-0830-00L General Relativity W 10 credits 4V+2U M. Gaberdiel
Transportation Science

<table>
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<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>101-0417-00L</td>
<td>Transport Planning Methods</td>
<td>W</td>
<td>6 credits</td>
<td>4G</td>
<td>K. W. Axhausen</td>
</tr>
</tbody>
</table>

Abstract
The course provides the necessary knowledge to develop models supporting the solution of given planning problems. This is done by dividing the forecasting problem into sub-problems.

Objective
- Knowledge of methods and algorithms commonly used in transport planning
- Ability to independently develop a transport model able to solve / answer the given problem / questions
- Understanding of algorithms and their implementations commonly used in transport planning

Content
The course provides the necessary knowledge to develop models supporting the solution of given planning problems. Examples of such planning problems are the estimation of traffic volumes, prediction of estimated utilization of new public transport lines, and evaluation of effects (e.g. change in emissions of a city) triggered by building new infrastructure and changes to operational regulations.

To cope with the forecasting problem it is first divided into sub-problems. Then, these are solved using various algorithms like iterative proportional fitting, shortest path algorithms and the method of successive averages.

The course is composed of a lecture part, providing the theoretical knowledge, and a applied part, in which students create their own models. This part takes place in form of a tutorial and consists in the development of a computer program. The programming part is closely guided and particularly suitable for students with little programming experience.

Student Seminar in Combinatorics: Linear Complementarity

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<tr>
<th>Number</th>
<th>Title</th>
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<tbody>
<tr>
<td>401-3050-65L</td>
<td>Student Seminar in Combinatorics: Linear Complementarity</td>
<td>W</td>
<td>4 credits</td>
<td>2S</td>
<td>K. Fukuda</td>
</tr>
</tbody>
</table>

Abstract
We study the combinatorics and the complexity of various subclasses of the linear complementarity problem.

Objective
- To understand the importance of linear complementarity as a common generalization of linear programming, bimatrix games and convex quadratic programming.

Content
The Linear Complementarity Problem (LCP) was introduced in mid 1960's (1965-67) by Lemke and Cottle-Dantzig as a common generalization of linear programming, bimatrix game and convex quadratic programming.

The problem is NP-hard in general, but there are many subclasses of LCP that are in P (polynomially solvable) or suspected to be in P. The reason for the possible polynomial solvability is that these studied subclasses (e.g. P-matrix LCPs and positive-definite LCPs) can be formulated as a problem which admits a solution that has a succinct certificate for its correctness. Moreover, there are elegant combinatorial abstractions of these subclasses.

In this seminar, we study the most important papers/books, both old and new, in the theory of LCP, and aim at understanding what is crucial lack of knowledge in proving or disproving existing conjectures.

Literature
The slides of the overview (Revised on September 22, 2015):

Prerequisites / notice
Basic knowledge of linear programming.

Monstrous Moonshine

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>401-3110-65L</td>
<td>Monstrous Moonshine</td>
<td>W</td>
<td>4 credits</td>
<td>2S</td>
<td>C. A. Keller</td>
</tr>
</tbody>
</table>

Abstract
We study Monstrous Moonshine, the surprising connection between modular forms and the Monster group.

Objective
To understand the equation 196884 = 196883 + 1.

Content
see https://www2.math.ethz.ch/education/bachelor/seminars/hs2015/monstrous-moonshine/monshine_overview

Prerequisites / notice
Algebra I and II. Some familiarity with modular forms and Lie algebras is helpful, but not crucial: all necessary concepts will be introduced in the early talks.

Algebraic Groups and Actions

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<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-3320-65L</td>
<td>Algebraic Groups and Actions</td>
<td>W</td>
<td>4 credits</td>
<td>2S</td>
<td>B. R. Doran</td>
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</table>
The seminar is for more advanced students. Registration is officially closed, but if Prof. Doran agrees, further registrations (via the Study Administration) might be possible.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-4460-62L</td>
<td>Functional Analysis III</td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>M. Einsiedler</td>
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<td><strong>Abstract</strong></td>
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<td></td>
<td>We will discuss various additional topics in Functional Analysis: unitary representations of abelian and non-abelian groups, Choquet's theorem on extremal points, distributions, amenability and property (T). Prequisites: Functional Analysis I and II</td>
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<tr>
<td>401-4600-65L</td>
<td>Student Seminar in Probability: Gaussian Processes on Trees</td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>A.S. Sznitman, J. Bertoin, A. Knowles, P. Nolin, W. Werner</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>The seminar will discuss results concerning branching Brownian motion.</td>
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<tr>
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<td>Registration to the seminar will only be effective once confirmed by email from the organizers.</td>
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<tr>
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<td><strong>Content</strong></td>
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<td></td>
<td>The seminar is centered around a topic in probability theory which changes each semester.</td>
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<td>The student seminar in probability is held at times at the undergraduate level (typically during the spring term) and at times at the graduate level (typically during the autumn term). The themes vary each semester.</td>
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<tr>
<td>401-3600-65L</td>
<td>Regularity Structures</td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>J. Teichmann</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>The seminar introduces and discusses main theorems around Martin Hairer's regularity structures following the article &quot;Introduction to regularity structures&quot; (Braz Jour Prob Stat 29).</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td>The seminar is suited for Bachelor and Master students. Some knowledge in linear functional analysis and algebra is required.</td>
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<tr>
<td>401-3650-65L</td>
<td>Numerical Analysis Seminar: Mathematics for Nanophotonics</td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>H. Ammari</td>
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<td><strong>Abstract</strong></td>
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<td>The aim of this seminar is to review new and fundamental mathematical tools, computational approaches, and inversion and optimal design methods to address challenging problems in nanophotonics. An emphasis will be put on analyzing plasmon resonant nanoparticles.</td>
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<tr>
<td>401-4660-65L</td>
<td>Mathematics of Computerized Tomography</td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>R. Aliafari</td>
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<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>This seminar should provide an overview of the mathematical principles and fundamental concepts behind computerized tomography. The main topics are the Radon transform and its properties, inversion formulas, ill-posedness and reconstruction techniques.</td>
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<tr>
<td>263-4200-00L</td>
<td>Seminar SAT</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>E. Welzl</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>Study and presentation of research papers from the literature on &quot;Boolean Satisfiability-Combinatorics and Algorithms&quot;. Goal of this seminar is to study and present, in continuation of the course &quot;Boolean Satisfiability-Combinatorics and Algorithms&quot;, research papers from the literature.</td>
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<tr>
<td></td>
<td><strong>Literature</strong></td>
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<td>A list of papers for presentations will be distributed at the beginning of the seminar.</td>
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<td>263-4203-00L</td>
<td>Geometry: Combinatorics and Algorithms</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>B. Gärtner, E. Welzl</td>
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<tr>
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<td><strong>Abstract</strong></td>
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<td>This seminar is held once a year and complements the courses Computational Geometry and Geometric Graphs: Combinatorics &amp; Algorithms. Students of the seminar will present original research papers, some classic and some of them very recent. The seminar is a good preparation for a master, diploma, or semester thesis in the area.</td>
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<td><strong>Objective</strong></td>
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<td>Each student is expected to read, understand, and elaborate on a selected research paper. To this end, (s)he should give a 45-min. presentation about the paper. The process includes</td>
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<td>* getting an overview of the related literature;</td>
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<td>* understanding and working out the background/motivation: why and where are the questions addressed relevant?</td>
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<td>* understanding the contents of the paper in all details;</td>
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<td>* selecting parts suitable for the presentation;</td>
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<td>* presenting the selected parts in such a way that an audience with some basic background in geometry and graph theory can easily understand and appreciate it.</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td>To attend the seminar, some basic knowledge in (discrete and computational) geometry and graphs and algorithms is required. Thus, previous participation in some of the courses &quot;Graphs and Algorithms&quot;, &quot;Computational Geometry&quot;, &quot;Geometric Graphs: Combinatorics &amp; Algorithms&quot;, or similar courses is strongly encouraged. It is also possible to take this seminar in parallel to the lecture &quot;Computational Geometry&quot;.</td>
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**Semester Papers**

There are several course units "Semester Paper" that are all equivalent. If, during your studies, you write several semester papers, choose among the different numbers in order to be able to obtain credits again.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>401-3750-01L</td>
<td>Semester Paper m</td>
<td>W</td>
<td>8</td>
<td>11A</td>
<td>Professors</td>
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<td></td>
<td>No direct enrolment to this course unit in myStudies. Please fill in the online application form. Requirements and application form under <a href="http://www.math.ethz.ch/intranet/students/study-administration/theses.html">www.math.ethz.ch/intranet/students/study-administration/theses.html</a> (Afterwards the enrolment will be done by the Study Administration.)</td>
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</table>
Abstract
Semester Papers help to deepen the students' knowledge of a specific subject area. Students are offered a selection of topics. These papers serve to develop the students' ability for independent mathematical work as well as to enhance skills in presenting mathematical results in writing.

Prerequisites / notice
There are several course units "Semester Paper" that are all equivalent. If, during your studies, you write several semester papers, choose among the different numbers in order to be able to obtain credits again.

401-3750-02L  Semester Paper  W  8 credits  11A  Professors

Abstract
Semester Papers help to deepen the students' knowledge of a specific subject area. Students are offered a selection of topics. These papers serve to develop the students' ability for independent mathematical work as well as to enhance skills in presenting mathematical results in writing.

Prerequisites / notice
There are several course units "Semester Paper" that are all equivalent. If, during your studies, you write several semester papers, choose among the different numbers in order to be able to obtain credits again.

401-3750-03L  Semester Paper  W  8 credits  11A  Professors

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-MATH.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Master Thesis

Number  Title  Type  ECTS  Hours  Lecturers
401-2000-00L  Scientific Works in Mathematics  O  0 credits  E. Kowalski

Objective
Learn the basic standards of scientific works in mathematics.

Content
- Types of mathematical works
- Publication standards in pure and applied mathematics
- Data handling
- Ethical issues
- Citation guidelines

Lecture notes
Moodle of the Mathematics Library: https://moodle-app2.let.ethz.ch/course/view.php?id=519

Prerequisites / notice
This course is completed by the optional course "Recherchieren in der Mathematik" (held in German) by the Mathematics Library. For more details see: http://www.math.ethz.ch/library/services/schulungen

401-4990-00L  Master's Thesis  O  30 credits  57D  Professors

Only students who fulfil the following criteria are allowed to begin with their master's thesis:
- a. successful completion of the bachelor programme;
- b. fulfilling of any additional requirements necessary to
gain admission to the master programme.

No direct enrolment to this course unit in myStudies. Please fill in the online application form. Requirements and application form under www.math.ethz.ch/intranet/students/study-administration/theses.html (Afterwards the enrolment will be done by the Study Administration.)

Abstract

The master's thesis concludes the study programme. Writing up the master's thesis allows students to independently produce a major piece of work on a mathematical topic. It generally involves consulting the literature, solving any ensuing problems, and putting together the results in writing.

### Additional Courses

<table>
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<tr>
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<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-5000-00L</td>
<td>Zurich Colloquium in Mathematics</td>
<td>E-</td>
<td>0 credits</td>
<td></td>
<td>W. Werner, P. L. Bühlmann, M. Burger, S. Mishra, R. Pandharipande, University lecturers</td>
</tr>
<tr>
<td>401-5990-00L</td>
<td>Zurich Graduate Colloquium</td>
<td>E-</td>
<td>0 credits</td>
<td>1K</td>
<td>A. Iozzi, University lecturers</td>
</tr>
<tr>
<td>401-5110-00L</td>
<td>Number Theory Seminar</td>
<td>E-</td>
<td>0 credits</td>
<td>1K</td>
<td>Ö. Imamoglu, P. S. Jossen, E. Kowalski, P. D. Nelson, R. Pink</td>
</tr>
<tr>
<td>401-5350-00L</td>
<td>Analysis Seminar</td>
<td>E-</td>
<td>0 credits</td>
<td>1K</td>
<td>M. Struwe, D. Christodoulou, F. Da Lio, N. Hungerbühler, T. Kappeler, T. Rivière, D. A. Salamon</td>
</tr>
<tr>
<td>401-5530-00L</td>
<td>Geometry Seminar</td>
<td>E-</td>
<td>0 credits</td>
<td>1K</td>
<td>M. Burger, M. Einsiedler, A. Iozzi, U. Lang, V. Schroeder, A. Sisto</td>
</tr>
<tr>
<td>401-5580-00L</td>
<td>Symplectic Geometry Seminar</td>
<td>E-</td>
<td>0 credits</td>
<td>2K</td>
<td>D. A. Salamon, P. Biran, A. Cannas da Silva</td>
</tr>
<tr>
<td>401-5330-00L</td>
<td>Talks in Mathematical Physics</td>
<td>E-</td>
<td>0 credits</td>
<td>1K</td>
<td>A. Cattaneo, G. Felder, M. Gabrerdil, G. M. Graf, H. Knörer, T. H. Willwacher, University lecturers</td>
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<tr>
<td>401-5600-00L</td>
<td>Seminar on Stochastic Processes</td>
<td>E-</td>
<td>0 credits</td>
<td>1K</td>
<td>J. Bertoin, A. Knowles, A. Nikeghbali, P. Nolin, B. D. Schlein, A.S. Sznitman, W. Werner</td>
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<tr>
<td>401-5910-00L</td>
<td>Talks in Financial and Insurance Mathematics</td>
<td>E-</td>
<td>0 credits</td>
<td>1K</td>
<td>P. Embrechts, M. Schweizer, M. Soner, J. Teichmann, M. V. Wüthrich</td>
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<tr>
<td>401-5900-00L</td>
<td>Optimization Seminar</td>
<td>E-</td>
<td>0 credits</td>
<td>1K</td>
<td>R. Weismantel, R. Zenklusen</td>
</tr>
</tbody>
</table>
Colloquium on Mathematics, Computer Science, and Education

Subject didactics for mathematics and computer science teachers.

E- Didactics colloquium

N. Hungerbühler, M. Akveld, J. Hromkovic, H. Klemenz

Abstract

The Zurich Physics Colloquium

E- 0 credits


Abstract

Research colloquium

Prerequisites / notice

Occasionally, talks may be delivered in German.

The Zurich Theoretical Physics Colloquium

E- 0 credits


Abstract

Research colloquium

Objective

The Zurich Theoretical Physics Colloquium is jointly organized by the University of Zurich and ETH Zurich. Its mission is to bring both students and faculty with diverse interests in theoretical physics together. Leading experts explain the basic questions in their field of research and communicate the fascination for their work.

Computer Science Colloquium

E- 0 credits

Lecturers

Invited talks, covering the entire scope of computer science. External Listeners are welcome at no charge. A detailed schedule is published at the beginning of each semester.

Objective

Top international computer scientists take the floor at the distinguished computer science colloquium. Our guest speakers present impacting topics across various areas of the discipline. The colloquium series is held every semester and also includes inaugural and farewell lectures of the department's professors. The colloquium is a noteworthy event for all graduate students. Outside attendance is equally welcome.

Content

Eingeladene Vorträge aus dem gesamten Bereich der Informatik, zu denen auch Auswärtige kostenlos eingeladen sind. Zu Semesterbeginn erscheint jeweils ein ausführliches Programm.

Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>406-2004-AAL</td>
<td>Algebra II</td>
<td>E-</td>
<td>5</td>
<td>11R</td>
<td>E. Kowalski</td>
</tr>
</tbody>
</table>

Abstract

Galois theory and Representations of finite groups, algebras.

The precise content changes with the examiner. Candidates must therefore contact the examiner in person before studying the material.

Objective

Introduction to fundamentals of Galois theory, and representation theory of finite groups and algebras

Content

Fundamentals of Galois theory

Representation theory of finite groups and algebras

Literature

S. Lang, Algebra, Springer Verlag
B.L. van der Waerden: Algebra I und II, Springer Verlag
I.R. Shafarevich, Basic notions of algebra, Springer verlag
G. Mislin: Algebra I, vdf Hochschulverlag
U. Stammbach: Algebra, in der Polybuchhandlung erhältlich
G. Wüstholz, Algebra, vieweg-Verlag, 2004
J-P. Serre, Linear representations of finite groups, Springer Verlag

Prerequisites / notice

Algebra I

406-2005-AAL | Algebra I and II             | E-    | 12   | 26R   | E. Kowalski |

Abstract

Introduction and development of some basic algebraic structures - groups, rings, fields including Galois theory, representations of finite groups, algebras.

The precise content changes with the examiner. Candidates must therefore contact the examiner in person before studying the material.
Content

Basic notions and examples of groups:
Subgroups, Quotient groups and Homomorphisms,
Group actions and applications

Basic notions and examples of rings:
Ring Homomorphisms,
ideals, and quotient rings, rings of fractions
Euclidean domains, Principal ideal domains, Unique factorization domains

Basic notions and examples of fields:
Field extensions, Algebraic extensions, Classical straight edge and compass constructions

Fundamentals of Galois theory
Representation theory of finite groups and algebras

Literature
S. Lang, Algebra, Springer Verlag
B.L. van der Waerden: Algebra I und II, Springer Verlag
I.R. Shafarevich, Basic notions of algebra, Springer verlag
G. Mislin: Algebra I, vdf Hochschulverlag
U. Stammbach: Algebra, in der Polybuchhandlung erhältlich
G. Wüstholz, Algebra, vieweg-Verlag, 2004
J.-P. Serre, Linear representations of finite groups, Springer Verlag

406-2303-AAL
Complex Analysis
Enrolment only for MSc students who need this course as additional admission requirement.

Abstract
Complex functions of one variable, Cauchy-Riemann equations, Cauchy theorem and integral formula, singularities, residue theorem, index of closed curves, analytic continuation, conformal mappings, Riemann mapping theorem.

Literature

B. Paikka: "An introduction to complex function theory."

R. Remmert: Theory of Complex Functions. Springer Verlag

E. Hille: Analytic Function Theory. AMS Chelsea Publication

406-2284-AAL
Measure and Integration
Enrolment only for MSc students who need this course as additional admission requirement.

Abstract
Introduction to the abstract measure theory and integration, including the following topics: Lebesgue measure and Lebesgue integral, Lp-spaces, convergence theorems, differentiation of measures, product measures (Fubini’s theorem), abstract measures, Radon-Nikodym theorem, probabilistic language.

Objective
Basic acquaintance with the theory of measure and integration, in particular, Lebesgue's measure and integral.

Literature
1. Lecture notes by Professor Michael Struwe (http://www.math.ethz.ch/~struwe/Skripten/AnalysisIII-SS2007-18-4-08.pdf)
2. L. Evans and R.F. Gariepy "Measure theory and fine properties of functions"
3. Walter Rudin "Real and complex analysis"
4. R. Bartle The elements of Integration and Lebesgue Measure
http://www.mat.uniroma2.it/~cannarsa/cam_0607.pdf

406-2554-AAL
Topology
Enrolment only for MSc students who need this course as additional admission requirement.

Abstract
Topological spaces, continuous maps, connectedness, compactness, separation axioms, metric spaces, quotient spaces, homotopy, fundamental group and covering spaces, van Kampen Theorem, surfaces and manifolds.

Literature
Klaus Jänich: Topologie (Springer-Verlag)
http://www.springerlink.com/content/978-3-540-21393-2/fulltext/#section=592889&page=1
James Munkres: Topology (Prentice Hall)
William Massey: Algebraic Topology: an Introduction (Springer-Verlag)
Alan Hatcher: Algebraic Topology (Cambridge University Press)
http://www.math.cornell.edu/~hatcher/AT/ATpage.html

Prerequisites / notice
The precise content changes with the examiner. Candidates must therefore contact the examiner in person before studying the material.

406-2604-AAL
Probability and Statistics
Enrolment only for MSc students who need this course as additional admission requirement.

Abstract
Introduction to probability and statistics with many examples, based on chapters from the books "Probability and Random Processes" by G. Grimmett and D. Stirzaker and "Mathematical Statistics and Data Analysis" by J. Rice.

Objective
The goal of this course is to provide an introduction to the basic ideas and concepts from probability theory and mathematical statistics. In addition to a mathematically rigorous treatment, also an intuitive understanding and familiarity with the ideas behind the definitions are emphasized. Measure theory is not used systematically, but it should become clear why and where measure theory is needed.

Content
Probability:
Chapters 1-5 (Probabilities and events, Discrete and continuous random variables, Generating functions) and Sections 7.1-7.5 (Convergence of random variables) from the book "Probability and Random Processes". Most of this material is also covered in Chap. 1-5 of "Mathematical Statistics and Data Analysis", on a slightly easier level.

Statistics:
Sections 8.1 - 8.5 (Estimation of parameters), 9.1 - 9.4 (Testing Hypotheses), 11.1 - 11.3 (Comparing two samples) from "Mathematical Statistics and Data Analysis".

406-2605-AAL
Linear Algebra
Enrolment only for MSc students who need this course as additional admission requirement.

Abstract
Introduction to the theory of linear algebra, including vector spaces, linear maps, determinants, eigenvalues and eigenvectors, and applications.

Objective
To provide a solid foundation in linear algebra, essential for further studies in mathematics and its applications.

Literature
1. J. B. Garnett: "Linear Algebra" (Springer-Verlag)

Prerequisites
A basic understanding of real and complex analysis and linear algebra is required.

Autumn Semester 2015
Functional Analysis I
Enrolment only for MSc students who need this course as additional admission requirement.

Abstract
Baire category; Banach spaces and linear operators; Fundamental theorems: Open Mapping Theorem, Closed Range Theorem, Uniform Boundedness Principle, Hahn-Banach Theorem; Convexity; reflexive spaces; Spectral theory.

Lecture notes
Lecture notes by Professor Michael Struwe (http://www.math.ethz.ch/~struwe/Skripten/FA-I-II-26-8-08.pdf) or Lecture notes by Prof. Einsiedler and Ward (https://dl.dropboxusercontent.com/u/2098511/FAnotes.pdf)

Literature
Numerous texts in English or German

Fundamentals of Mathematical Statistics
Enrolment only for MSc students who need this course as additional requirement.

Abstract
The course covers the basics of inferential statistics.

Mathematics Master - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
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<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

Special students and auditors need special permission from the lecturers.
## Compulsory Courses

### Medicinal and Industrial Pharmaceutical Sciences Master

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-0030-00L</td>
<td>Therapeutic Proteins</td>
<td>O</td>
<td>3</td>
<td>3G</td>
<td>C. Halin Winter, D. Neri</td>
</tr>
</tbody>
</table>

**Abstract**

In this course, various topics related to the development, GMP production and application of therapeutic proteins will be discussed. Furthermore, students will expand their training in pharmaceutical immunology and will be introduced to the basic concepts of pharmaceutical product quality management.

**Objective**

Students know and understand:

- basic mechanisms and regulation of the immune response
- the pathogenic mechanisms of the most important immune-mediated disorders
- the most frequently used expression systems for the production of therapeutic proteins
- the use of protein engineering tools for modifying different features of therapeutic proteins
- the mechanism of action of selected therapeutic proteins and their application
- basic concepts in the GMP production of therapeutic proteins

**Content**

The course consists of two parts:

- In a first part, students will complete their training of pharmaceutical immunology (Chapter 13 - 16 Immunobiology VIII textbook). This part particularly focuses on the pathogenic mechanisms of immune-mediated diseases. Deepened knowledge of immunology will be relevant for understanding the mechanism of action of many therapeutic proteins, as well as for understanding one major concern related to the use of protein-based drugs, namely, immunogenicity.
- The second part focuses on topics related to the development and application of therapeutic proteins, such as protein expression, protein engineering, reducing immunogenicity, and GMP production of therapeutic proteins. Furthermore, selected examples of approved therapeutic proteins will be discussed.

**Lecture notes**

Handouts to the lectures will be available for downloading under [http://www.pharma.ethz.ch/scripts/index](http://www.pharma.ethz.ch/scripts/index).

**Literature**

- Chapters 13-16 of the Immunobiology VIII book (Janeway et al.)
- Lecture Handouts
- Paper References provided in the Scripts
- EMEA Dossier for Humira

<table>
<thead>
<tr>
<th>Number</th>
<th>Pharmacology and Toxicology III</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
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<tbody>
<tr>
<td>535-0041-00L</td>
<td>Pharmacology and Toxicology III</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>M. Detmar, U. Quitterer</td>
</tr>
</tbody>
</table>

**Abstract**

The course advances basic knowledge in pharmacology and toxicology. Special emphasis is placed on the interrelationship between pharmacological, pathophysiological and clinical aspects of drug therapy in the fields of infectious diseases and cancer. The course also provides an overview of the field of pharmacogenomics, with a special focus on the role of genetic polymorphisms in disease susceptibility, drug response and adverse effects.

**Objective**

- Topics include the pharmacology and pharmacotherapy of infectious diseases and cancer. In the field of pharmacogenomics, the course is focused on genetics, genome-wide association studies, genetic disease predisposition, examples of genetic variability of drug metabolism and drug responses, identification of new drug targets, relevance of pharmacogenomics for clinical drug development, and toxicogenomics.
- The course also provides an overview of the field of pharmacogenomics, with a special focus on the role of genetic polymorphisms in disease susceptibility, drug response and adverse effects.

**Content**

- Pharmacogenomics
- Pharmacokinetics
- Pharmacodynamics
- Pharmacological, pathophysiological and clinical aspects of drug therapy

**Lecture notes**

A script is provided for each lecture course. The scripts define important and exam-relevant contents of lectures. Scripts do not replace the lecture.

**Literature**

- Goodman and Gilman’s The Pharmacological Basis of Therapeutics
- Lawrence Brunton, Bruce Chabner, Bjorn Knollman. 12th edition - 1808 pages

**or**

- Allgemeine und spezielle Pharmakologie und Toxikologie. 2013; Urban & Fischer (Elsevier, München)

<table>
<thead>
<tr>
<th>Number</th>
<th>Pharmacoepidemiology and Drug Safety</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>535-0050-00L</td>
<td>Pharmacoepidemiology and Drug Safety</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>S. Russmann</td>
</tr>
</tbody>
</table>

**Abstract**

Introduction of principles of pharmacoepidemiology and epidemiology in addressing drug related questions in the population and of epidemiologic perspectives for health care management. In parallel appropriate tools to critique pharmacoepidemiologic studies in medical literature will be given and applied.

**Objective**

- To familiarize participants with the principles of pharmacoepidemiology and epidemiology in addressing drug related questions with concern to the use, effects and risks of medicinal products in a large population.
- To introduce participants to fundamental statistical, economic and epidemiological concepts and methods.
- To provide the appropriate tools to critique pharmacoepidemiologic studies in the literature and to critically read and understand papers in the medical literature which relate to drug benefits, risks, and costs.
- To address controversial topics in drug use and benefit-risk assessment, and to critically appraise the outcome of drug therapy.
- To equip participants with skills to facilitate further studies in these areas.

**Content**

- The contribution of epidemiology to the study of drug uses, effects and risks:
  - Pharmacoepidemiology study methodologies, concepts and strategies,
  - Detection and identification of unintended drug effects (pharmacovigilance),
  - Quantifying unintended effects and drug interactions,
  - Bias and confounding by indication,
  - Drug utilization

**Lecture notes**

This course will be a combination of formal lectures, group discussions and self-directed project work. Course material will be taught through seminars, case studies and group projects. Reading material and scripts will be given for each week.
Goals: knowledge of the major reactions of biotransformation in drug therapy, prediction of possible metabolites of drugs and xenobiotics.

Drug therapy is nothing less than interference with a highly complex biological system, which is affected by various internal and external factors. A profound understanding of drug effects thus requires a transdisciplinary approach of investigation. The drug seminars provide a platform for the presentation and discussion of these transdisciplinary approaches for the investigation of drug action.

The faculty members of the Institute of Pharmaceutical Sciences offer specific projects from different areas of the pharmaceutical sciences, each of which is elaborated by a small groups of students (4-8). Each group is tutored by a faculty member. The objective of this work is to achieve an in-depth understanding of the problem investigated and to present the results of the work to an audience composed of all students participating in the drug seminar and the faculty of the Institute of Pharmaceutical Sciences. Presentations will take place in the framework of a dedicated mini-symposium, which is part of the external seminar week. The possibility exists to invite external experts from industry or the public health sector to participate in the mini-symposium. Students are strongly encouraged to make use of this option and will again be supported in these efforts by the faculty members.

Literature

Further references will be provided in the course.
1. Introduction into industrial property (patents, trademarks, industrial designs);
2. Prosecution of patent applications (patentability);
3. Patent information (patent publications, databases, searches);
4. Exploitation and enforcement of patents (possibilities of exploitation, licenses, parallel imports, scope of protection, patent infringement);
5. Peculiarities in pharmacists and medicine (supplementary protection certificates, experimental use exemption, therapy and diagnosis, medical indication);
6. Social, political and ethical aspects (patents and prices for medicinal products, traditional knowledge and ethnomedicine, bioprosppecting and biopiracy, human DNA inventions);
7. Trademarks, types of trademarks, grounds for refusal, peculiarities of pharmac-marks.

Lecture notes
A script is available in electronic form during the lecture.

Literature
- Swiss Patents Act: [external link]
- Swiss Trademarks Act: [external link]
- Swiss Industrial-Designs Act: [external link]
- European Patent Convention: [external link]
- Patent Cooperation Treaty: [external link]
- Swiss Federal Institute of Intellectual Property: [external link]
- European Patent Office: [external link]
- World Intellectual Property Organization: [external link]

Compensatory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>535-0310-00L</td>
<td>Glycobiology in Drug Development</td>
<td>W</td>
<td>1</td>
<td>1V</td>
<td>V. I. Otto</td>
</tr>
<tr>
<td>Abstract</td>
<td>Protein-based drugs constitute around 25% of new approvals and most of them are glycoproteins. Using selected examples the course aims at providing insight into our present knowledge on glycosylation-activity relationships and the production and analysis of glycoprotein-based drugs.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>Gaining insight into the glycobiology of therapeutically used glycoproteins. This implies knowing and understanding - the major types of protein-linked glycans and their biosynthesis - the most important expression systems for production of recombinant glycoproteins - methods used to alter or manipulate glycosylation - the most prominent clinically used glycoproteins and how glycosylation influences their therapeutic profile. - Current methods for the qualitative and quantitative characterization of glycoproteins and being able to apply this knowledge in other contexts.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>lecture plan: 1. Proteins wearing a &quot;sugar dress&quot;. Glycans in cell-cell communication and molecular recognition in multicellular organisms 2. Tissue plasminogen activator (t-PA), glucosecerbrosidase and the biosynthesis of N-glycans 3. PSGL-1 and the biosynthesis of O-glycans; P-selectin and other lectins 4. The glycoprotein hormones and the production and analysis of therapeutic glycoproteins 5. Monoclonal antibodies and the modification of their therapeutic profile through glycoengineering 6. EPO &quot;the same but different&quot; 7. Current topics: Biosimilars and the currently marketed &quot;Biopharmaceuticals&quot;</td>
<td></td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>The slides used for the lectures will be provided online</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Requirements: Basic knowledge in molecular biology, protein chemistry and analytics. Basic knowledge in pharmacology.</td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

| 535-0300-00L  | Molecular Mechanisms of Drug Actions and Targets | W    | 1    | 1V    | V. I. Otto  |
| Abstract      | In the last 10 years, an average of one drug per year was withdrawn from the market. Using selected examples of such drug failures, the course aims at analyzing the present explanations of drug actions as well as the design and predictive power of animal models and clinical trials. In addition, the ethical, societal, and economical expectations in new drugs shall be reflected. |
| Objective     | To develop a critical understanding of the relevance and limitations of the current approaches to explaining and anticipating drug effects. To critically appraise the ethical, societal, economical and political expectations in the development of new drugs. |
| Content       | In December 2006, Pfizer stopped a large phase III study on the use of Torcetrapib for the prevention of atherosclerosis and cardiovascular disease. 800 million $ in development costs and 21 billion $ in stocks were annihilated overnight. The failure of Torcetrapib has pinpointed the limitations of an extremely reductionist view of atherosclerosis and it's prevention by drug therapy. It has also highlighted what high expectations we have in a safe and wide applicability of drugs and of their economical success. Torcetrapib is not a single case. In the last 10 years, on average one drug per year was withdrawn from the market due to lack of efficacy, unexpected side effects or toxicity. This clearly shows that the common investigations and the modern understanding of drug actions are often not sufficient to predict the effects a drug will have in large patient populations. These are the topics of the present course. Using three particularly informative examples of drug failures, the problems encountered and the concepts and informative value of preclinical and clinical studies will be analyzed and discussed. Furthermore, the ethical, societal, economical and political expectations in new drugs shall be reflected. |
| Lecture notes | Printouts of the slides used for the lectures and literature for reading and discussions will be available online. |
| Prerequisites / notice | Requirements: basic knowledge in Medicinal Chemistry and Pharmacology. Ability to read and understand scientific publications in English. |

| 535-0022-00L  | Computer-Assisted Drug Design | W    | 1    | 1V    | G. Schneider |
| Abstract      | The lecture series provides an introduction to computer applications in medicinal chemistry. A focus is on molecular representations, property predictions, molecular similarity concepts, virtual screening techniques, and de novo drug design. All theoretical concepts and algorithms presented are illustrated by practical applications and case studies |
| Objective     | The students will learn how computer simulation can be applied to drug design and development, understand the theoretical principles of property prediction and computer-generated compound generation, and understand possibilities and limitations of computer-assisted drug design in pharmaceutical chemistry. As a result, they are prepared for professional assessment of computer-assisted drug design studies in medicinal chemistry projects. |
Successful participation in this course is required for a research project ("Forschungspraktikum") in the CADD group.

<table>
<thead>
<tr>
<th>851-0180-00L</th>
<th>Research Ethics</th>
<th>2 credits</th>
<th>2G</th>
<th>G. Achermann</th>
</tr>
</thead>
</table>

**Abstract**
This course has its focus on the responsible conduct of research (RCR) and the ethical dimensions of the biological and biomedical sciences.

**Objective**
The main goal of this course is to enhance the student's ability to:
- recognize and identify ethical issues and conflicts,
- analyze and develop well-reasoned responses to the kinds of ethical problems a scientist is likely to encounter.

Additionally, students will become familiar with regulations and ethical guidelines relevant for their research field on the international, governmental, institutional and professional level.

To achieve these objectives, teaching methods will include lectures, discussions, case study work (alone and in groups), moral games, paper work and exercises.

**Content**

### I. Ethics & the Process of Ethical Inquiry

- Introduction in Ethics and Research Ethics
  - What is ethics? What ethics is not…;
  - Awareness: what constitutes an ethical question? Distinguishing ethical questions from other kinds of questions; Science & ethics: a comparison;
  - The ethics movement in the biological and health sciences;
  - What is research ethics and why is it important?
  - Values (personal, cultural & ethical) in science & principles for ethical conduct in research;
  - Professional codes of conduct: functions and limitations

- Ethical approaches in the conduct of research (Normative Ethics)
  - Overview over important theories for research ethics: virtue theories, duty-based theories (rights theory, categorical imperative, prima facie duties); consequentialist theories, other theories);
  - The plurality of ethical theories and its consequences;
  - The concept of dignity

- Moral reasoning I: Arguments
  - Why arguments? What is a good argument? The structure of (moral) arguments;
  - Deductive and inductive arguments; Validity and soundness;
  - Assessing moral arguments

- Moral reasoning II: Decision-making
  - How (not) to approach ethical issues…; Is there a correct method for answering moral questions?
  - Models of method in Applied Ethics: a) Top-down approaches; b) the reflective equilibrium; c) a bottom-up approach: casuistry (or reasoning-by-analogy);
  - Is there a right answer?

### II. Research Ethics / Responsible Conduct of Research (RCR)

- Integrity in Research & Research Misconduct
  - What is "integrity" in scientific research? What is research misconduct (falsification, fabrication, plagiarism - FFP) and questionable research practices (QRP)?
  - Factors leading to misconduct; Procedure for responding to allegations of research misconduct;
  - The confidant of ETH Zurich

- Data Management
  - Data collection and recordkeeping; Analysis and selection of data;
  - Ownership of data; retention and sharing of data;
  - Falsification and fabrication of data

- Research involving animals
  - The moral status of animals; Ethical approaches to animal experimentation: Animal welfare (Peter Singer) and Animal rights (Tom Regan);
  - The 3 Rs (replacement, reduction, refinement);
  - Ethical assessment of conflicting issues in animal experimentation;
  - The dignity of animals in the Swiss constitution;

- Research involving human subjects
  - History & guidelines (Nuremberg Code; Declaration of Helsinki; Belmont Report; International Ethical Guidelines for Biomedical Research Involving Human Subjects (CIOMS Guidelines); Convention on Human Rights and Biomedicine (Oviedo Convention);
  - Informed consent; confidentiality and anonymity; research risks and benefits; vulnerable subjects;
  - Clinical trials;
  - Biobanks
  - Ethics Committees / Institutional Review Boards (IRB)

- Authorship & Peer review
  - Criteria for authorship;
  - Plagiarism;
  - Challenges to openness and freedom in scientific publication;
  - Open access
  - Peer review

- Social responsibility
  - What is social responsibility? Social responsibility: whose obligation?
  - Public advocacy by researchers

**Lecture notes**
Course material (handouts, case studies, exercises, surveys and papers) will be available during the lectures and on the course homepage.
Recommended literature:
- "Introduction to the Responsible Conduct of Research" (http://ori.dhhs.gov/education/products/RClintro/)

Detailed literature lists for the different topics of the course will be provided in the script/handout or on the course work space.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
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<td>511-0001-00L</td>
<td>Research Project</td>
<td>O</td>
<td>10 credits</td>
<td>20A</td>
<td>Lecturers</td>
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</table>

Abstract
The Research Project accustoms students to scientific work.

Objective
Students are accustomed to scientific work and they get to know one specific research field.

Content
Students work on a current field of research.

<table>
<thead>
<tr>
<th>Code</th>
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<th>Type</th>
<th>ECTS</th>
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<td>O</td>
<td>30 credits</td>
<td>40D</td>
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</table>

Abstract
In the Master Thesis students prove their ability to independent, structured and scientific working. The Master thesis is usually carried out in a subject area of Pharmaceutical Sciences as chosen by the student.

<table>
<thead>
<tr>
<th>Code</th>
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<th>Type</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td></td>
<td>Compulsory Electives in Humanities, Social and Political Sciences</td>
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</tbody>
</table>

Recommended GESS compulsory elective courses (Type B) for D-CHAB.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses
### Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>406-0603-AAL</td>
<td>Stochastics (Probability and Statistics)</td>
<td>E-</td>
<td>4</td>
<td>9R</td>
<td>M. Kalisch</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>Introduction to basic methods and fundamental concepts of statistics and probability theory for non-mathematicians. The concepts are presented on the basis of some descriptive examples. Learning the statistical program R for applying the acquired concepts will be a central theme.</td>
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<td><strong>Objective</strong></td>
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<td></td>
<td>The objective of this course is to build a solid fundement in probability and statistics. The student should understand some fundamental concepts and be able to apply these concepts to applications in the real world. Furthermore, the student should have a basic knowledge of the statistical programming language &quot;R&quot;.</td>
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<tr>
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<td><strong>Content</strong></td>
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<tr>
<td></td>
<td>From &quot;Statistics for research&quot; (online)</td>
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<tr>
<td></td>
<td>Ch 1: The Role of Statistics</td>
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<td>Ch 2: Populations, Samples, and Probability Distributions</td>
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<td>Ch 3: Binomial Distributions</td>
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<td>Ch 4: Sampling Distribution of Averages</td>
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<td>Ch 7: Normal Distributions</td>
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<td>Ch 8: Student’s t Distribution</td>
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<td>Ch 9: Distributions of Two Variables</td>
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<td></td>
<td>From &quot;Introductory Statistics with R (online)&quot;</td>
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<td></td>
<td>Ch 1: Basics</td>
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<td>Ch 2: The R Environment</td>
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<td>Ch 3: Probability and distributions</td>
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<td>Ch 4: Descriptive statistics and tables</td>
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<td>Ch 5: One- and two-sample tests</td>
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<td>Ch 6: Regression and correlation</td>
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<tr>
<td></td>
<td><strong>Literature</strong></td>
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<tr>
<td></td>
<td>- &quot;Introductory Statistics with R&quot; by Peter Dalgaard; ISBN 978-0-387-79053-4; DOI: 10.1007/978-0-387-79054-1 From within the ETH, this book is freely available online under: <a href="http://www.springerlink.com/content/m17578">http://www.springerlink.com/content/m17578</a></td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>The goal of this course is to provide students with a wide general understanding in cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.</td>
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<td>The goal of this course is to provide students with a wide general understanding cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
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<td>The focus is animal cells and the development of multicellular organisms with a clear emphasis on the molecular basis of cellular structures and phenomena. The topics include biological membranes, the cytoskeleton, protein sorting, energy metabolism, cell cycle and division, viruses, extracellular matrix, cell signaling, embryonic development and cancer research.</td>
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<tr>
<td></td>
<td><strong>Literature</strong></td>
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<tr>
<th>535-0135-AAL</th>
<th>Clinical Chemistry I</th>
<th>E-</th>
<th>1</th>
<th>2R</th>
<th>M. Hersberger</th>
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<td><strong>Abstract</strong></td>
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<td>Introduction into fundamentals of laboratory diagnostics and overview of the laboratory parameters concerning inflammation, lipid metabolism, myocardial infarction, diabetes, kidney function, urinary diagnostics, liver function, blood coagulation, blood count, therapeutic drug monitoring and drugs of abuse screening.</td>
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<tr>
<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>Overview of the possibilities and limitations in clinical laboratory diagnostics. Indications and methods of everyday parameters are known.</td>
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</tbody>
</table>

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Prerequisites / notice: none

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Data: 06.02.2019 13:00  Autumn Semester 2015  Page 1078 of 1434
Introduction to medical laboratory diagnostics: immunochemical methods, diagnostics of inflammation, acute myocardial infarction, lipid metabolism, diabetes, kidney function and urinary diagnostics, blood coagulation, blood count, therapeutic drug monitoring, drugs of abuse screening, common diagnostics of liver diseases, point-of-care diagnostics.

535-0222-AAL Pharmaceutical Analytics E- 4 credits 9R I. A. Werner Kaeslin
Enrolment only for MSc students who need this course as additional admission requirement.

Abstract Theoretical and practical comprehension of analytical chemistry in order to solve pharmaceutical problems.

Objective Knowledge in Pharmaceutical Analytics in order to solve fundamental analytical problems. Handling of the most important pharmacopeial texts and monographs.

Content Introduction in Pharmaceutical Analytics. Theoretical and practical considerations concerning a lot of methods in different Pharmacopeias. Identification, purity testing, stability testing, assays of drugs and drug formulations.

Lecture notes A script can be purchased at the HCI-Shop, HCI-Building, D floor.

Literature David G. Watson, Pharmaceutical Analysis, Elsevier.

535-0241-AAL Biopharmacy E- 3 credits 6R S.D. Krämer
Enrolment only for MSc students who need this course as additional admission requirement.

Abstract Introduction to the Basics in Biopharmacy. Pharmacokinetic processes (absorption, distribution, metabolism and excretion, ADME), which determine the fate of a drug in the body. Knowledge of the most important pharmacokinetic parameters. Interpretation of concentration-time-profiles of drugs. Pharmacokinetic profiling of drugs in view of therapy optimization and analysis of interaction potential.

Objective Introduction to the Basics in Biopharmacy. Pharmacokinetic processes (absorption, distribution, metabolism and excretion, ADME), which determine the fate of a drug in the body. Knowledge of the most important pharmacokinetic parameters. Interpretation of concentration-time-profiles of drugs. Pharmacokinetic profiling of drugs in view of therapy optimization and analysis of interaction potential.

Content Introduction to pharmacokinetics; definition of the most important pharmacokinetic parameters and their calculation from clinical data (compartment model, statistical model); kinetics of elimination: excretion and biotransformation (physiological model); pharmacokinetic profiling of drugs for therapy optimization and for the analysis of the interaction potential; dosage regimen design.

535-0440-AAL Quality Management in Pharmaceutical Business E- 1 credit 2R A. Sterchi, C. Siegmund
Enrolment only for MSc students who need this course as additional admission requirement.

Abstract The students know the relevance and the role of quality assurance measures to assure quality, efficacy and safety of drugs. The students know the most important Swiss regulations, including the associated European regulations, which are relevant from a quality assurance point of view and they are able to interpret the content of this regulations.

551-0110-AAL Fundamentals of Biology II: Microbiology E- 2 credits 2R J. Vorholt-Zambelli
Enrolment only for MSc students who need this course as additional requirement.

Abstract Structure, function, genetics of prokaryotic microorganisms and fungi.


Lecture notes none


551-0108-AAL Fundamentals of Biology II: Plant Biology E- 2 credits 2R W. Gruissem
Enrolment only for MSc students who need this course as additional requirement.

Abstract Water balance, assimilation, transport in plants; developmental biology, stress physiology.

Objective Water balance, assimilation, transport in plants; developmental biology, stress physiology.

Lecture notes none


551-1323-AAL Fundamentals of Biology II: Biochemistry and Molecular Biology E- 4 credits 11R R. Glockshuber, N. Ban, K. Locher, E. Weber-Ban
Enrolment only for MSc students who need this course as additional requirement.

Abstract The course provides an introduction to Biochemistry / Molecular Biology with some emphasis on chemical and biophysical aspects.

Objective Topics include the structure-function relationship of proteins / nucleic acids, protein folding, enzymatic catalysis, cellular pathways involved in bioenergetics and the biosynthesis and breakdown of amino acids, glycans, nucleotides, fatty acids and phospholipids, and steroids. There will also be a discussion of DNA replication and repair, transcription, and translation.

Lecture notes none


Medicinal and Industrial Pharmaceutical Sciences Master - Key for Type

<table>
<thead>
<tr>
<th>Letter</th>
<th>Key</th>
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</thead>
<tbody>
<tr>
<td>C</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits</td>
</tr>
</tbody>
</table>

O | Recommended, not eligible for credits |
| Z | Courses outside the curriculum |
| Dr | Suitable for doctorate |

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 1079 of 1434
### Key for Hours

<table>
<thead>
<tr>
<th>Letter</th>
<th>Description</th>
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<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
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</table>

**ECTS**

- European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
Micro- and Nanosystems Master

Core Courses

Devices and Systems

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
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<td>Wearable Systems I</td>
<td>W+</td>
<td>6</td>
<td>4G</td>
<td>G. Tröster, U. Blanke</td>
</tr>
</tbody>
</table>

Abstract
Context recognition in mobile communication systems like mobile phone and wearable computer will be studied using advanced methods from sensor data fusion, pattern recognition, statistics, data mining and machine learning.
Context comprises the behavior of individuals and of groups, their activities as well as the local and social environment.

Objective
Future mobile systems will act as personal and cooperative assistant by providing the appropriate information and services. The systems consist of a smart phone which communicates with sensors on-body and in the environment. Context comprises user's behavior, his activities, his local and social environment.

In the data path from the sensor level to signal segmentation to the classification of the context, advanced methods of signal processing, pattern recognition and machine learning will be applied. Sensor data generated by crowdsourcing methods are integrated. The validation using MATLAB is followed by implementation and testing on a smart phone.

Context recognition as the crucial function of mobile systems is the main focus of the course. Using MATLAB the participants implement and verify the discussed methods also using a smart phone.

Content
The next generation of mobile communication systems are integrated in our clothes and act as personal and cooperative assistant providing information we need just now (see www.wearable.ethz.ch). Context recognition - what is the situation of the user, his activity, his environment, how is he doing, what are his needs - as the central functionality of mobile systems constitutes the focus of the course.

The main topics of the course include
- Sensor nets, sensor signal processing, data fusion, time series (segmentation, similarity measures), supervised learning (Bayes Decision Theory, Decision Trees, Random Forest, KNN-Methods, Support Vector Machine, Hidden Markov Models, Adaboost), clustering (k-means, dbscan, topic models); Crowdsourcing.
- The exercises show concrete design problems like motion and gesture recognition using distributed sensors, detection of activity patterns and identification of the local environment.
- Presentations of the PhD students and the visit at the Wearable Computing Lab introduce in current research topics and international research projects.

Language: german/english (depending on the participants)

Lecture notes
Lecture notes for all lessons, assignments and solutions.
http://www.ife.ee.ethz.ch/education/wearable_systems_1

Literature
Literature will be announced during the lessons.

Prerequisites
No special prerequisites

Analog Integrated Circuits

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>227-0166-00L</td>
<td>Analog Integrated Circuits</td>
<td>W</td>
<td>6</td>
<td>2V+2U</td>
<td>Q. Huang</td>
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</table>

Abstract
This course provides a foundation in analog integrated circuit design based on bipolar and CMOS technologies.

Objective
Integrated circuits are responsible for much of the progress in electronics in the last 50 years, particularly the revolutions in the Information and Communications Technologies we witnessed in recent years. Analog integrated circuits play a crucial part in the highly integrated systems that power the popular electronic devices we use daily. Understanding their design is beneficial to both future designers and users of such systems.

Content
- Review of bipolar and MOS devices and their small-signal equivalent circuit models; Building blocks in analog circuits such as current sources, active load, current mirrors, supply independent biasing etc; Amplifiers: differential amplifiers, cascode amplifier, high gain structures, output stages, gain bandwidth product of op-amps; Stability; Comparators; Second-order effects in analog circuits such as mismatch, noise and offset; A/D and D/A converters; Introduction to switched capacitor circuits.
- The exercise sessions aim to reinforce the lecture material by well guided step-by-step design tasks. The circuit simulator SPECTRE is used to facilitate the tasks. There is also an experimental session on op-amp measurements.

Lecture notes
Handouts of presented slides. No script but an accompanying textbook is recommended.

Literature

Energy Conversion and Quantum Phenomena

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<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
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<tr>
<td>402-0595-00L</td>
<td>Semiconductor Nanostructures</td>
<td>W+</td>
<td>6</td>
<td>2V+1U</td>
<td>T. M. Ihn</td>
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</tbody>
</table>

Abstract
The course covers the foundations of semiconductor nanostructures, e.g., materials, band structures, bandgap engineering and doping, field-effect transistors. The physics of the quantum Hall effect and of common nanostructures based on two-dimensional electron gases will be discussed, i.e., quantum point contacts, Aharonov-Bohm rings and quantum dots.

Objective
At the end of the lecture the student should understand four key phenomena of electron transport in semiconductor nanostructures:
1. The integer quantum Hall effect
2. Conductance quantization in quantum point contacts
3. the Aharonov-Bohm effect
4. Coulomb blockade in quantum dots

Content
- Introduction and overview
- Semiconductor crystals: Fabrication and band structures
- k.p-theory, effective mass
- Envelope functions and effective mass approximation, heterostructures and band engineering
- Fabrication of semiconductor nanostructures
- Electrostatics and quantum mechanics of semiconductor nanostructures
- Heterostructures and two-dimensional electron gases
- Drude Transport
- Electron transport in quantum point contacts; Landauer-Büttiker description
- Ballistic transport experiments
- Interference effects in Aharonov-Bohm rings
- Electron in a magnetic field, Shubnikov-de Haas effect
- Integer quantum Hall effect
- Coulomb blockade and quantum dots

Lecture notes
### Material, Surfaces and Properties

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<tr>
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<tr>
<td>151-0524-00L</td>
<td>Continuum Mechanics 1</td>
<td>W+</td>
<td>4 credits</td>
<td>2+1U</td>
<td>E. Mazza</td>
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</table>

#### Abstract
The lecture deals with constitutive models that are relevant for design and calculation of structures. These include anisotropic linear elasticity, linear viscoelasticity, plasticity, viscoplasticity. Homogenization theories and laminate theory are presented. Theoretical models are complemented by examples of engineering applications and experiments.

#### Objective
Basic theories for solving continuum mechanics problems of engineering applications, with particular attention to material models.

#### Content

#### Lecture notes
Yes

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>327-0505-00L</td>
<td>Surfaces, Interfaces and their Applications I</td>
<td>W</td>
<td>3 credits</td>
<td>2+1U</td>
<td>N. Spencer, M. P. Heuberger, L. Isa</td>
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</tbody>
</table>

#### Abstract
After being introduced to the physical/chemical principles and importance of surfaces and interfaces, the student is introduced to the most important techniques that can be used to characterize surfaces. Later, liquid interfaces are treated, followed by an introduction to the fields of tribology (friction, lubrication, wear) and corrosion.

#### Objective
To gain an understanding of the technical and physical chemical principles, as well as the tools and applications of surface science, and to be able to choose appropriate surface-analytical approaches for solving problems.

#### Content
- Introduction to Surface Science
- Physical Structure of Surfaces
- Surface Forces (static and dynamic)
- Adsorbates on Surfaces
- Surface Thermodynamics and Kinetics
- The Solid-Liquid Interface
- Electron Spectroscopy
- Vibrational Spectroscopy on Surfaces
- Scanning Probe Microscopy
- Introduction to Tribology
- Introduction to Corrosion Science

#### Literature
- Lecture notes
  - Script Download: https://www.surface.mat.ethz.ch/education/courses/surfaces_interfaces_and_their_applications_I

### Modelling and Simulation

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-2037-00L</td>
<td>Microscale Acoustofluidics</td>
<td>W</td>
<td>5 credits</td>
<td>4G</td>
<td>C. Hafner, J. Leuthold, J. Smajic</td>
</tr>
</tbody>
</table>

#### Abstract
In this lecture the basics as well as practical aspects (from modelling to design and fabrication) are described from a solid and fluid mechanics perspective with applications to microsystems and lab on a chip devices.

#### Objective
Understanding acoustophoresis, the design of devices and potential applications

#### Content
Linear and nonlinear acoustics, foundations of fluid and solid mechanics and piezoelectricity, Gorkov potential, numerical modelling, acoustic streaming, applications from ultrasonic microbotics to surface acoustic wave devices

#### Literature

### High Performance Computing for Science and Engineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

#### Objective
The lecture is suitable for all physics students beyond the bachelor of science degree. Basic knowledge of solid state physics is recommended. Very ambitioned students in the third year may be able to follow. The lecture can be chosen as part of the PhD-program.

#### Content
The course is taught in English.
Abstract
This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.

Objective
Introduction to HPC for scientists and engineers
Fundamental of:
1. Parallel Computing Architectures
2. MultiCores
3. ManyCores

Content
Programming models and languages:
1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)

Computers and methods:
1. Hardware and architectures
2. Libraries
3. Particles: N-body solvers
4. Fields: PDEs
5. Stochastics: Monte Carlo

Lecture notes
http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1
Class notes, handouts

►► Laboratory Course

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0620-00L</td>
<td>Embedded MEMS Lab</td>
<td>W+</td>
<td>5 credits</td>
<td>3P</td>
<td>C. Hierold, S. Blunier, M. Haluska</td>
</tr>
</tbody>
</table>

Abstract
Practical course: Students are introduced to the process steps required for the fabrication of MEMS (Micro Electro Mechanical System) and carry out the fabrication and testing steps in the clean rooms by themselves. Additionally, they learn the requirements for working in clean rooms. Processing and characterization will be documented and analyzed in a final report. Limited access

Objective
Students learn the individual process steps that are required to make a MEMS (Micro Electro Mechanical System). Students carry out the process steps themselves in laboratories and clean rooms. Furthermore, participants become familiar with the special requirements (cleanliness, safety, operation of equipment and handling hazardous chemicals) of working in the clean rooms and laboratories. The entire production, processing, and characterization of the MEMS is documented and evaluated in a final report.

Content
With guidance from a tutor, the individual silicon microsystem process steps that are required for the fabrication of an accelerometer are carried out:
- Photolithography, dry etching, wet etching, sacrificial layer etching, critical point drying, various cleaning procedures
- Packaging and electrical connection of a MEMS device
- Testing and characterization of the MEMS device
- Written documentation and evaluation of the entire production, processing and characterization

Lecture notes
A document containing theory, background and practical course content is distributed at the first meeting of the course.

Literature
The document provides sufficient information for the participants to successfully participate in the course.

Prerequisites / notice
Participating students are required to attend all scheduled lectures and meetings of the course.

Participating students are required to provide proof that they have personal accident insurance prior to the start of the laboratory portion of the course.

This master's level course is limited to 15 students per semester for safety and efficiency reasons.
If there are more than 15 students registered, we regret to restrict access to this course by the following rules:

Priority 1: master students of the master's program in "Micro and Nanosystems"

Priority 2: master students of the master's program in "Mechanical Engineering" with a specialization in Microsystems and Nanoscale Engineering (MAVT-tutors Profs Daraio, Dual, Hierold, Koumoutsakos, Nelson, Norris, Park, Poulikakos, Pratsinis, Stemmer), who attended the bachelor course "151-0621-00L Microsystems Technology" successfully.

Priority 3: master students, who attended the bachelor course "151-0621-00L Microsystems Technology" successfully.

Priority 4: all other students (PhD, bachelor, master) with a background in silicon or Microsystems process technology.

If there are more students in one of these priority groups than places available, we will decide by drawing lots.
Students will be notified at the first lecture of the course (introductory lecture) as to whether they are able to participate.

The course is offered in autumn and spring semester.

►► Elective Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0525-00L</td>
<td>Wave Propagation in Solids</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>D. Poulikakos, A. Ferrari</td>
</tr>
</tbody>
</table>

Abstract
The course will cover the basic principles of wave propagation in periodic media. It will discuss the fundamental principles used to describe linear and nonlinear wave propagation in continuum and discrete media. Selected recent scientific advancements in the dynamics of periodic media will also be discussed.

Objective
Students learn the basic principles governing the propagation of waves in discrete and continuum solid media. These methods can be used to engineer materials with predefined properties and to design dynamical systems for a variety of engineering applications (e.g., vibration mitigation, impact absorption and sound insulation).

Content
Wave propagation in solids including applications. Phenomenology of wave propagation (plane waves, harmonic waves, dispersion, attenuation, group and phase velocity), transmission and reflection, impact problems, waves in linear elastic media, discrete media, experimental and numerical methods.

Lecture notes
Handouts

Literature
Various books will be recommended pertaining to the topics covered.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0255-00L</td>
<td>Energy Conversion and Transport in Biosystems</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>D. Poulikakos, A. Ferrari</td>
</tr>
</tbody>
</table>

Abstract
Theory and application of thermodynamics and energy conversion in biological systems and biomedicine at the macro scale and the cellular level.
**Objective**

Theory and application of energy conversion at the macro scale and the cellular level. Understanding of the basic features governing fluid transport in the principal systems of the human cell. Connection of characteristics and patterns from other fields of engineering to biofluidics. Heat and mass transport processes within the human body and relation to biomedical technologies.

**Content**

Mass transfer models for the transport of chemical species in the human cell. Organization and function of the cell membrane and of the cell cytoskeleton. The role of molecular motors in cellular force generation and their function in cell migration. Description of the functionality of these systems and of analytical experimental and computational techniques for understanding of their operation. Introduction to bioengineering approaches for the treatment of common pathogenic conditions of these systems. Introduction to cell metabolism, cellular energy transport and cellular thermodynamics.

**Lecture notes**

Script as well as additional material in the form of hand-outs will be distributed.

**Literature**

Lecture notes and references therein.

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**Course Code:** 402-0572-00L  
**Title:** Aerosols I: Physical and Chemical Principles  
**Credits:** W 4  
**Prerequisites:** 2V+1U  
**Instructor:** M. Gysel, U. Baltensperger, H. Burtscher

**Abstract**

Aerosols I deals with basic physical and chemical properties of aerosol particles. The importance of aerosols in the atmosphere and in other fields is discussed.

**Objective**

Knowledge of basic physical and chemical properties of aerosol particles and their importance in the atmosphere and in other fields

**Content**

physical and chemical properties of aerosols, aerosol dynamics (diffusion, coagulation...), optical properties (light scattering, absorption, extinction), aerosol production, physical and chemical characterization.

**Lecture notes**

Material is distributed during the lecture

**Literature**


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**Course Code:** 151-0605-00L  
**Title:** Nanosystems  
**Credits:** W 4  
**Prerequisites:** 4G  
**Instructor:** A. Stemmer, J.N. Tisserant

**Abstract**

From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles. Intermolecular forces, their macroscopic manifestations, and ways to control such interactions. Self-assembly and directed assembly of 2D and 3D structures. Special emphasis on the emerging field of molecular electronic devices.

**Objective**

Familiarize students with basic science and engineering principles governing the nano domain.

**Content**

The course addresses basic science and engineering principles ruling the nano domain. We particularly work out the links between topics that are traditionally taught separately.

Special emphasis is placed on the emerging field of molecular electronic devices, their working principles, applications, and how they may be assembled.

Topics are treated in 2 blocks:

(I) From Quantum to Continuum
From atoms to molecules to condensed matter: characteristic properties of simple nanosystems and how they evolve when moving towards complex ensembles.

(II) Interaction Forces on the Micro and Nano Scale
Intermolecular forces, their macroscopic manifestations, and ways to control such interactions. Self-assembly and directed assembly of 2D and 3D structures.

**Literature**


**Prerequisites / notice**

Course format:

Lectures and Mini-Review presentations: Thursday 10-13, ML F 36

Homework: Mini-Reviews

Students select a paper (list distributed in class) and expand the topic into a Mini-Review that illuminates the particular field beyond the immediate results reported in the paper.

---

**Course Code:** 529-0611-00L  
**Title:** Characterization of Catalysts and Surfaces  
**Credits:** W 7  
**Prerequisites:** 3G  
**Instructor:** J. A. van Bokhoven, D. Ferri

**Abstract**

Basic elements of surface science important for materials and catalysis research. Physical and chemical methods important for research in surface science, material science and catalysis are considered and their application is demonstrated on practical examples.

**Objective**

Basic aspects of surface science. Understanding of principles of most important experimental methods used in research concerned with surface science, material science and catalysis.

**Content**

Methods which are covered embrace: Gas adsorption and surface area analysis, IR-Spectroscopy, X-ray diffraction, X-ray photoelectron spectroscopy, X-ray absorption, solid state NMR, Electron Microscopy and others.

---

**Course Code:** 529-0643-00L  
**Title:** Process Design and Development  
**Credits:** W 7  
**Prerequisites:** 3G  
**Instructor:** G. Storti

**Abstract**

The course is focused on the design of Chemical Processes, with emphasis on the preliminary stage of the design approach, where process creation and quick selection among many alternatives are important. The main concepts behind more detailed process design and process simulation are also examined in the last part of the course.

**Objective**

The course is focused on the design of Chemical Processes, with emphasis on the preliminary stage of the design approach, where process creation and quick selection among many alternatives are important. The main concepts behind more detailed process design and process simulation are also examined in the last part of the course.
### 752-3103-00L  Food Rheology I

**Abstract**
Rheology is the science of flow and deformation of matter such as polymers, dispersions (emulsions, foams, suspensions), and colloidal systems. The fluid dynamical basis, measuring techniques (rheometry), and the flow properties of different fluids (Newtonian, non-Newtonian, viscoelastic) are introduced and discussed.

**Objective**
The concept of rheological constitutive equations and the application to different material classes. The course provides an introduction on the link between flow and structural properties of flowing material. Rheometrical techniques and appropriate measuring protocols for the characterization of complex fluids will be discussed.

**Content**
Lectures will be given on general introduction (4h), fluid dynamics (4h), complex flow behavior (4h), influence of temperature (2h), rheometers (4h), rheological tests (6h) and structure and rheology of complex fluids (4h).

**Lecture notes**
Notes will be handed out during the lectures.

**Literature**
Provided in the lecture notes.

**Prerequisites / notice**

### 227-0157-00L  Semiconductor Devices: Physical Bases and Simulation

**Abstract**
The course addresses the physical principles of modern semiconductor devices and the foundations of their modeling and numerical simulation. Necessary basic knowledge on quantum-mechanics, semiconductor physics and device physics is provided. Computer simulations of the most important devices and of interesting physical effects supplement the lectures.

**Objective**
The course aims at the understanding of the principle physics of modern semiconductor devices, of the foundations in the physical modeling of transport and its numerical simulation. During the course also basic knowledge on quantum-mechanics, semiconductor physics and device physics is provided.

**Content**
The main topics are: transport models for semiconductor devices (quantum transport, Boltzmann equation, drift-diffusion model, hydrodynamic model), physical characterization of silicon (intrinsic properties, scattering processes), mobility of cold and hot carriers, recombination (Shockley-Read-Hall statistics, Auger recombination), impact ionization, metal-semiconductor contact, metal-insulator-semiconductor structure, and heterojunctions.

The exercises are focussed on the theory and the basic understanding of the operation of special devices, as single-electron transistor, resonant tunneling diode, pn-diode, bipolar transistor, MOSFET, and laser. Numerical simulations of such devices are performed with an advanced simulation package (Sentaurus-Synopsys). This enables to understand the physical effects by means of computer experiments.

**Lecture notes**

**Literature**
The script (in book style) is sufficient. Further reading will be recommended in the lecture.

**Prerequisites / notice**

### 227-0225-00L  Linear System Theory

**Abstract**
The class is intended to provide a comprehensive overview of the theory of linear dynamical systems, their use in control, filtering, and estimation and their applications to areas ranging from avionics to systems biology.

**Objective**
By the end of the class students should be comfortable with the fundamental results in linear system theory and the mathematical tools used to derive them.

**Content**
- Rings, fields and linear spaces, normed linear spaces and inner product spaces.
- Ordinary differential equations, existence and uniqueness of solutions.
- Continuous and discrete time, time varying linear systems. Time domain solutions. Time invariant systems treated as a special case.
- Controllability and observability, canonical forms, Kalman decomposition. Time invariant systems treated as a special case.
- Stability and stabilization, observers, state and output feedback, separation principle.
- Realization theory.

**Lecture notes**

**Prerequisites / notice**
Prerequisites: Control systems (227-0216-00 or equivalent) and sufficient mathematical maturity.

### 227-0377-00L  Physics of Failure and Failure Analysis of Electronic Devices and Equipment

**Abstract**
Failures have to be avoided by proper design, material selection and manufacturing. Properties, degradation mechanisms, and expected lifetime of materials are introduced and the basics of failure analysis and analysis equipment are presented. Failures will be demonstrated experimentally and the opportunity is offered to perform a failure analysis with advanced equipment in the laboratory.

**Objective**
Introduction to the degradation and failure mechanisms and causes of electronic components, devices and systems as well as to methods and tools of reliability testing, characterization and failure analysis.

**Content**
Summary of reliability and failure analysis terminology; physics of failure: materials properties, physical processes and failure mechanisms; failure analysis of ICs, PCBs, opto-electronics, discrete and other components and devices; basics and properties of materials and properties; application in circuit design and reliability analysis

**Lecture notes**
Comprehensive copy of transparencies

### 151-0593-00L  Embedded Control Systems

**Abstract**
This course provides a comprehensive overview of embedded control systems. The concepts introduced are implemented and verified on a microprocessor-controlled haptic device.

**Objective**
Familiarize students with main architectural principles and concepts of embedded control systems.
<table>
<thead>
<tr>
<th>Subject</th>
<th>Content</th>
<th>Objective</th>
<th>Content</th>
<th>Lecture notes</th>
<th>Prerequisites / notice</th>
<th>Literature</th>
<th>Prerequisites / notice</th>
<th>Website</th>
<th>Prerequisites / notice</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermodynamics of Novel Energy Conversion Technologies</td>
<td>In the framework of this course we will look at a broad spectrum of novel energy conversion processes which are not based on the heat-power-conversion. Especially the production of electrical energy without using mechanical work will be covered.</td>
<td>This course deals with novel energy conversion and storage systems such as fuel cells and micro-fuel cells, batteries, hydrogen production and storage, plasmonics and photovoltaics. The focus of the course is on the physics and basic understanding of those systems as well as their real-world applications.</td>
<td>Part 1: Fundamentals: - Thermodynamic overview and exergy analysis; - Thermodynamics of multi-component-systems (mixtures) and phase equilibrium; - Electrochemistry; Part 2: Novel energy conversion and storage systems: - batteries and accumulators; - fuel cells and micro fuel cells (fundamentals, fabrication, modelling, and applications); - hydrogen production and storage, Fuel reforming; - Plasmonics and photovoltaics.</td>
<td>available (ca. 200 pages in English)</td>
<td>This course will be given in English: 1- Weekly exercises, each includes 1 or 2 questions which should be solved and returned at the specified due dates. Exercises count as 15% of the final grade. 2- One programming mini-project which should be finished at the specified due date. It counts as 5% of the final grade. 4- Final exam: Written exam during the regular examination session. It counts as 80% of the final grade.</td>
<td>- Solid State Electronics is an introductory condensed matter physics course covering crystal structure, electron models, classification of metals, semiconductors, and insulators, band structure engineering, thermal and electronic transport in solids, magnetoresistance, and optical properties of solids.</td>
<td><a href="http://www.iis.ee.ethz.ch/stud_area/vorlesungen/solidstateelectronics.en.html">http://www.iis.ee.ethz.ch/stud_area/vorlesungen/solidstateelectronics.en.html</a></td>
<td>Undergraduate physics, mathematics, semiconductor devices</td>
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<tr>
<td>Microsystems Technology</td>
<td>Students are introduced to the basics of micromachining and silicon process technology and will learn about the fabrication of microsystems and devices by a sequence of defined processing steps (process flow).</td>
<td>Students are introduced to the basics of micromachining and silicon process technology and will understand the fabrication of microsystem devices by the combination of unit process steps ( = process flow).</td>
<td>Lecture notes include: - Handouts (available online) - S.M. Sze: Semiconductor Devices, Physics and Technology - W. Menz, J. Mohr, O.Paul: Microsystem Technology - G. Kovacs: Micromachined Transducer Sourcebook</td>
<td>Prerequisites: Physics I and II</td>
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<tr>
<td>Programming Techniques for Scientific Simulations I</td>
<td>This lecture provides an overview of programming techniques for scientific simulations. The focus is on advances C++ programming techniques and scientific software libraries. Based on an overview over the hardware components of PCs and supercomputer, optimization methods for scientific simulation codes are explained.</td>
<td>This course provides fundamental knowledge of surface plasmon polaritons and discusses their applications in plasmonics.</td>
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</table>
### Objective
Electromagnetic oscillations known as surface plasmon polaritons have many unique properties that are useful across a broad set of applications in biology, chemistry, physics, and optics. The field of plasmonics has arisen to understand the behavior of surface plasmon polaritons and to develop applications in areas such as catalysis, imaging, photovoltaics, and sensing. In particular, metallic nanoparticles and patterned metallic interfaces have been developed to utilize plasmonic resonances. The aim of this course is to provide the basic knowledge to understand and apply the principles of plasmonics. The course will strive to be approachable to students from a diverse set of science and engineering backgrounds.

### Content
- Fundamentals of Plasmonics
  - Basic electromagnetic theory
  - Optical properties of metals
  - Surface plasmon polaritons on surfaces
  - Surface plasmon polariton propagation
  - Localized surface plasmons
- Applications of Plasmonics
  - Waveguides
  - Extraordinary optical transmission
  - Enhanced spectroscopy
  - Sensing
  - Metamaterials

### Literature

### Prerequisites
Physics I, II

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Level</th>
<th>Lecturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0642-00L</td>
<td>Seminar on Micro and Nanosystems</td>
<td>4</td>
<td>W</td>
<td>C. Hierold</td>
</tr>
<tr>
<td>151-0511-00L</td>
<td>Mechanics of Nano- and Micro-Materials</td>
<td>6</td>
<td>W</td>
<td>C. Daraio</td>
</tr>
<tr>
<td>227-0663-00L</td>
<td>Nano-Optics</td>
<td>6</td>
<td>W</td>
<td>L. Novotny</td>
</tr>
<tr>
<td>151-0104-00L</td>
<td>Uncertainty Quantification for Engineering &amp; Life Sciences</td>
<td>4</td>
<td>W</td>
<td>J. Beck, P. Kourmoutsakos</td>
</tr>
<tr>
<td>227-0468-00L</td>
<td>Analog Signal Processing and Filtering</td>
<td>6</td>
<td>W</td>
<td>H. Schmid</td>
</tr>
</tbody>
</table>
The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and digital design skills of the students. The learning goal is that the students can apply signal-flow graphs and can understand the signal flow in such circuits and systems (including non-ideal effects) well enough to gain an understanding of further circuits and systems by themselves.

At the beginning, signal-flow graphs in general and driving-point signal-flow graphs in particular are introduced. We will use them during the whole term to analyze circuits and understand how signals propagate through them. The theory and CMOS implementation of active filters is then discussed in detail using the example of Gm-C filters and active-RC filters. The ideal and nonideal behaviour of opamps, current conveyors, and inductor simulators follows. The link to the practical design of circuits and systems is done with an overview over different quality measures and figures of merit used in scientific literature and datasheets. Finally, an introduction to discrete-time and mixed-domain filters and circuits is given, including sensor read-out amplifiers, correlated double sampling, and chopping, and an introduction to sigma-delta A/D and D/A conversion on a system level.

The base for these lectures are lecture notes and two or three published scientific papers. From these papers we will together develop the technical content.

Details: https://people.ee.ethz.ch/~haschmid/asfwiki/

Some material is protected by password; students from ETHZ who are interested can write to haschmid@ethz.ch to ask for the password even if they do not attend the lecture.

Prerequisites: Recommended (but not required): Stochastic models and signal processing, Communication Electronics, Analog Integrated Circuits, Transmission Lines and Filters.

Knowledge of the Laplace transform and z transform and their interpretation (transfer functions, poles and zeros, bode diagrams, stability criteria ...) and of the main properties of linear systems is necessary.

<table>
<thead>
<tr>
<th>151-0735-00L</th>
<th>Dynamic Behavior of Materials and Structures</th>
<th>W</th>
<th>4 credits</th>
<th>2V+2U</th>
<th>D. Mohr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Lectures and computer labs concerned with the modeling of the deformation response and failure of engineering materials (metals, polymers and composites) subject to extreme conditions during manufacturing, crash, impact and blast events.</td>
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<tr>
<td>Objective</td>
<td>Students will learn to apply, understand and develop computational models of a large spectrum of engineering materials to predict their dynamic deformation response and failure in finite element simulations. Students will become familiar with important dynamic testing techniques to identify material model parameters from experiments. The ultimate goal is to provide the students with the knowledge and skills required to engineer modern multi-material solutions for high performance structures in automotive, aerospace and naval engineering.</td>
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</tr>
<tr>
<td>Content</td>
<td>Topics include viscoelasticity, temperature and rate dependent plasticity, dynamic brittle and ductile fracture; impulse transfer, impact and wave propagation in solids; computational aspects of material model implementation into hydrocodes; simulation of dynamic failure of structures;</td>
<td></td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Slides of the lectures, relevant journal papers and users manuals will be provided.</td>
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</tr>
<tr>
<td>Literature</td>
<td>Various books will be recommended covering the topics discussed in class.</td>
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<td></td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Course in continuum mechanics (mandatory), finite element method (recommended)</td>
<td></td>
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</tbody>
</table>

### Multidisciplinary Courses

The students are free to choose individually from the entire course offer of ETH Zurich, ETH Lausanne and the Universities of Zurich and St. Gallen.

### Course Catalogue of ETH Zurich

#### Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-MAVT.

- see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability
- see GESS Compulsory Electives: Language Courses ETH/UEZ

#### Semester Project

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1007-00L</td>
<td>Semester Project Micro- and Nanosystems Only for Micro- and Nanosystems MSc.</td>
<td>O</td>
<td>8 credits</td>
<td>17A</td>
<td>Professors</td>
</tr>
</tbody>
</table>

The subject of the Semester Project and the choice of the supervisor (ETH-professor) are to be approved in advance by the tutor.

Abstract: The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

Objective: The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's programme.

#### Industrial Internship

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1013-00L</td>
<td>Industrial Internship Micro and Nanosystems</td>
<td>O</td>
<td>8 credits</td>
<td></td>
<td>external organisers</td>
</tr>
</tbody>
</table>

The main objective of the 12-week internship is to expose master's students to the industrial work environment. During this period, students have the opportunity to be involved in ongoing projects at the host institution.

Objective: The main objective of the 12-week internship is to expose master's students to the industrial work environment.

#### Master Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 1088 of 1434
Only students who fulfill the following criteria are allowed to begin with their Master Thesis:

a. Successful completion of the Bachelor programme
b. Any additional requirements for admission to the degree programme have been fulfilled
c. Have achieved at least 32 credits in the category “Core Courses”
c. Successful completion of the Semester Project (the corresponding credits have been acquired)

The subject of the Master Thesis and the choice of the supervisor (ETH-professor) are to be approved in advance by the tutor.

To choose an adjunct professor of D-MAVT as a supervisor (http://www.mavt.ethz.ch/people/adjunct/index), please contact the Student Administration Office of D-MAVT.

Abstract
Master's programs are concluded by the master's thesis. The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem. The subject of the master's thesis, as well as the project plan and roadmap, are proposed by the tutor and further elaborated with the student.

Objective
The thesis is aimed at enhancing the student’s capability to work independently toward the solution of a theoretical or applied problem.

<table>
<thead>
<tr>
<th>Micro- and Nanosystems Master - Key for Type</th>
<th>Micro- and Nanosystems Master - Key for Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>O</strong> Compulsory</td>
<td><strong>E-</strong> Recommended, not eligible for credits</td>
</tr>
<tr>
<td><strong>W+</strong> Eligible for credits and recommended</td>
<td><strong>Z</strong> Courses outside the curriculum</td>
</tr>
<tr>
<td><strong>W</strong> Eligible for credits</td>
<td><strong>Dr</strong> Suitable for doctorate</td>
</tr>
</tbody>
</table>

Key for Hours

| **V** lecture                             | **P** practical/laboratory course          |
| **G** lecture with exercise               | **A** independent project                 |
| **U** exercise                            | **D** diploma thesis                      |
| **S** seminar                             | **R** revision course / private study      |
| **K** colloquium                          |                                           |

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Exchange Students

Courses for Exchange Students

Prepare a study plan
In case the course catalogue of the upcoming semester is not available yet, please expect it to be like the year before.
You can study at ETH Zurich as an exchange student for 1 or 2 semesters, starting in the autumn or in the spring semester.
Exchange students may choose courses from different curricula and years, provided that at least two thirds of all courses are taken in the ETH Zurich department they are registered in. Please be sure to coordinate your schedule with your home university.

Exam sessions and End-of-semester examinations
Like all ETH Zurich students, exchange students are obliged to sit their exams during the official examination periods. Students are requested to be present at ETH Zurich during these periods. You are therefore expected to plan your studies, internships, jobs, and financial means accordingly.

by individual arrangement

D-ITET (Exchange Students)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1501-00L</td>
<td>Master's Thesis</td>
<td>W</td>
<td>30 credits</td>
<td>68D</td>
<td>Supervisors</td>
</tr>
<tr>
<td></td>
<td>Admission only if ALL of the following apply: a) bachelor program successfully completed; b) acquired (if applicable) all credits from additional requirements for admission to master program; c) successfully completed both semester projects. Note: the conditions above are not applicable to incoming exchange students. Registration in mystudies required!</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Abstract</td>
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</tr>
<tr>
<td></td>
<td>The Master Program finishes with a 6-months Master Thesis which is directed by a Professor of the Department or a Professor of another Department who is associated with the D-ITET. Students gain the ability to conduct independent scientific research on a specific research problem.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Objective</td>
<td>see above</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1772-10L</td>
<td>Semester Project</td>
<td>W</td>
<td>8 credits</td>
<td>20A</td>
<td>Professors</td>
</tr>
<tr>
<td></td>
<td>Only for Biomedical Engineering MSc Programme Regulations 2013 (i.e. students having started the MSc BME in or after autumn 2013). Please fill in the following form before registering: <a href="http://www.ee.ethz.ch/bme_project_registration">http://www.ee.ethz.ch/bme_project_registration</a>.</td>
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<tr>
<td></td>
<td>Abstract</td>
<td></td>
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<tr>
<td></td>
<td>The semester project is designed to train the students in solving specific biomedical engineering problems. This project uses the technical and social skills acquired during the master's program. The semester project is advised by a professor.</td>
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</tr>
<tr>
<td></td>
<td>Objective</td>
<td>see above</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

D-MAVT (Exchange Students)

Nuclear Engineering MSc

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1009-00L</td>
<td>Master's Thesis Nuclear Engineering</td>
<td>W</td>
<td>30 credits</td>
<td>64D</td>
<td>Professors</td>
</tr>
<tr>
<td></td>
<td>Only students who fulfill the following criteria are allowed to begin with their Master Thesis: a. Successful completion of the Bachelor programme b. Any additional requirements for admission to the degree programme have been fulfilled c. Have achieved a total of at least 72 credits in the categories &quot;Core Subjects&quot; and &quot;Electives&quot; d. Successful completion of the Semester Project (the corresponding credits have been acquired) The supervisor of the Master Thesis and the choice of the supervisor (ETH or EPFL professor) are to be approved in advance by the tutor.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Abstract</td>
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</tr>
<tr>
<td></td>
<td>Master's programs are concluded by the master's thesis. The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem. The subject of the master's thesis, as well as the project plan and roadmap, are proposed by the tutor and further elaborated with the student.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Objective</td>
<td>The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem.</td>
<td></td>
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</tr>
</tbody>
</table>

Mechanical Engineering MSc

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1001-00L</td>
<td>Master's Thesis Mechanical Engineering</td>
<td>W</td>
<td>30 credits</td>
<td>64D</td>
<td>Professors</td>
</tr>
<tr>
<td></td>
<td>Only students who fulfill the following criteria are allowed to begin with their Master's Thesis: a. Successful completion of the Bachelor's programme b. Any additional requirements for admission to the degree programme have been fulfilled c. Successful completion of the Semester Project and Industrial Internship (the corresponding credits have been acquired) The subject of the Master's Thesis and the choice of the supervisor (ETH professor/titular professor) are to be approved by the tutor. To choose a titular professor of D-MAVT as a supervisor (<a href="https://www.mavt.ethz.ch/the-department/people/titular-professors.html">https://www.mavt.ethz.ch/the-department/people/titular-professors.html</a>), please contact</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
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</tr>
</tbody>
</table>
Master's programs are concluded by the master's thesis. The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem. The subject of the master's thesis, as well as the project plan and roadmap, are proposed by the tutor and further elaborated with the student.

Master's Thesis Micro- and Nanosystems MSc

Only students who fulfill the following criteria are allowed to begin with their Master Thesis:
- Successful completion of the Bachelor programme
- Any additional requirements for admission to the degree programme have been fulfilled
- Have achieved at least 32 credits in the category "Core Courses"
- Successful completion of the Semester Project (the corresponding credits have been acquired)

The subject of the Master Thesis and the choice of the supervisor (ETH-professor) are to be approved in advance by the tutor.

To choose an adjunct professor of D-MAVT as a supervisor (http://www.mavt.ethz.ch/people/adjunct/index), please contact the Student Administration Office of D-MAVT.

Master's Thesis Robotics, Systems and Control MSc

Only students who fulfill the following criteria are allowed to begin with their Master Thesis:
- Successful completion of the Bachelor programme
- Any additional requirements for admission to the degree programme have been fulfilled
- Only two courses can be pending in the category "Core Courses"
- Successful completion of the Semester Project (the corresponding credits have been acquired)

The subject of the Master Thesis and the choice of the supervisor (ETH-professor) are to be approved in advance by the tutor.

To choose an adjunct professor of D-MAVT as a supervisor (http://www.mavt.ethz.ch/people/adjunct/index), please contact the Student Administration Office of D-MAVT.

Master's Thesis Process Engineering MSc

Only students who fulfill the following criteria are allowed to begin with their Master Thesis:
- Successful completion of the Bachelor programme
- Any additional requirements for admission to the degree programme have been fulfilled
- Successful completion of the Semester Project and Industrial Internship (the corresponding credits have been acquired)

The subject of the Master Thesis and the choice of the supervisor (ETH-professor) are to be approved in advance by the tutor.

To choose an adjunct professor of D-MAVT as a supervisor (http://www.mavt.ethz.ch/people/adjunct/index), please contact the Student Administration Office of D-MAVT.

D-MTEC (Exchange Students)

The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem.
Only students who fulfill the following criteria are allowed to begin with their master thesis:

a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to gain admission to the master programme;
c. internship fulfilled

Abstract
In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is supervised by the tutor and normally deals with a subject contained in the major fields. The research will be performed normally within a private company or at the ETH Zurich.

Objective
In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is supervised by the tutor and normally deals with a subject contained in the major fields. The research will be performed normally within a private company or at the ETH Zurich.

Exchange Students - Key for Type

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>E-</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
</tr>
</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>Code</th>
<th>Type</th>
<th>Code</th>
<th>Type</th>
<th>Code</th>
<th>Type</th>
<th>Code</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
<td>P</td>
<td>practical/laboratory course</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
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<tr>
<td>K</td>
<td>colloquium</td>
<td></td>
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</table>

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Neural Systems and Computation Master

Core Courses

Compulsory Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1045-00L</td>
<td>Readings in Neuroinformatics [V]</td>
<td>O</td>
<td>3</td>
<td>1S</td>
<td>G. Indiveri, M. Cook, D. Kiper</td>
</tr>
<tr>
<td>Abstract</td>
<td>Thirteen major areas of research have been selected, which cover the key concepts that have led to our current ideas of how the nervous system is built and functions. We will read both original papers and explore the connections between science, the pursuit of basic science questions over a century of research.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>It is a commonplace that scientists rarely cite literature that is older than 10 years and when they do, they usually cite one paper that serves as the representative for a larger body of work that has long since been incorporated anonymously in textbooks. Worse than that, many authors have not even read the papers they cite in their own publications. This course, Foundations of Neuroscience is one antidote. Thirteen major areas of research have been selected, which cover the key concepts that have led to our current ideas of how the nervous system is built and functions. Unusually, we will explore these areas of research by reading the original publications, instead of reading someone else’s digest summary from a textbook or review. By doing this, we will learn how the discoveries were made, what instrumentation was used, how the scientists interpreted their own findings, and how their work, often over many decades and linked together with related findings from many different scientists, generate the current views of mechanism and structure of the nervous system.</td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>Thirteen major areas of research have been selected, which cover the key concepts that have led to our current ideas of how the nervous system is built and functions. Unusually, we will explore these areas of research by reading the original publications, instead of reading someone else’s digest summary from a textbook or review. By doing this, we will learn how the discoveries were made, what instrumentation was used, how the scientists interpreted their own findings, and how their work, often over many decades and by many different scientists, linked together to generate the current view of mechanism and structure. We will explore the personalities of the scientists and the context in which they made their seminal discoveries. To give one concrete example, in 1890 Roy and Sherrington showed that there was a neural activity-dependent regulation of blood flow in the brain. One hundred years later, Ogawa discovered that they could use Nuclear Magnetic Resonance (NMR) to measure a blood oxygen-level dependent (BOLD) signal, which they showed was neural activity-dependent. This discovery led to the development of human functional Magnetic Resonance Imaging (fMRI), which has revolutionized neuropsychology and neuropsychiatry. We will read both these original papers and explore the conceptual links between them and discuss the sociology of science, which in this case, the pursuit of basic science questions over a century of research, led to an explosion in applications. Each week the course members will be given between 2 and 4 papers to read for homework and we will then meet weekly for an hour long interactive seminar. An intimate knowledge of the papers will be assumed so that the discussion does not center simply on an explication of the contents of the papers. Assessment will in the form of a written exam in which the students will be given a paper and asked to write a short abstract of the contents.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>Mind the enrolment deadlines at UZH: <a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a> Experimental data are always as good as the instrumentation and measurement, but never any better. This course provides the very basics of instrumentation relevant to neurophysiology and neuromorphic engineering, it consists of two parts: a common introductory part involving analog signals and their acquisition (Part I), and a more specialized second part (Part II). The goal of Part I is to provide a general introduction to the signal acquisition process. Students are familiarized with basic lab equipment such as oscilloscopes, function generators, and data acquisition devices. Different electrical signals are generated, visualized, filtered, digitized, and analyzed using Matlab (Mathworks Inc.) or Labview (National Instruments). In Part II, the students are divided into small groups to work on individual measurement projects according to availability and interest. Students single-handedly solve a measurement task, making use of their basic knowledge acquired in the first part. Various signal sources will be provided. For each part, students must hand in a written report and present a live demonstration of their measurement setup to the respective supervisor. The supervisor of Part I is the teaching assistant, and the supervisor of Part II is task specific. Admission to Part II is conditional on completion of Part I (report + live demonstration). Reports must contain detailed descriptions of the measurement goal, the measurement procedure, and the measurement outcome. Either confidence or significance of measurements must be provided. Acquisition and analysis software must be documented.</td>
<td></td>
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</tr>
<tr>
<td>227-1031-00L</td>
<td>Journal Club O 2 credits 1S G. Indiveri</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abstract</td>
<td>Mind the enrolment deadlines at UZH: <a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a> The Neuroinformatics Journal club is a weekly meeting during which students present current research papers. The presentation last from 30 to 60 Minutes and is followed by a general discussion.</td>
<td></td>
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</tr>
<tr>
<td>Objective</td>
<td>The Neuroinformatics Journal club aims to train students to present cutting edge research clearly and efficiently. It leads students to learn about current topics in neurosciences and neuroinformatics, to search the relevant literature and to critically and scholarly appraise published papers. The students learn to present complex concepts and answer critical questions.</td>
<td></td>
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</tr>
<tr>
<td>Content</td>
<td>Relevant current papers in neurosciences and neuroinformatics are covered.</td>
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</tbody>
</table>

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 1093 of 1434
### Elective Core Courses

#### Systems Neurosciences

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1051-00L</td>
<td>Introduction to Systems Neuroscience</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>D. Kiper</td>
</tr>
</tbody>
</table>

Objective

To obtain in-depth knowledge of the theoretical foundations of SPM and to understand the basic concepts underlying perceptual, motor, and cognitive functions. Main emphasis sensory systems, with complements on motor and cognitive functions.

Lectures

None

Literature


Prerequisites / notice

None

### Theoretical Neurosciences

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1037-00L</td>
<td>Introduction to Neuroinformatics</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>K. A. Martin, M. Cook, V. Mante, M. Pfeiffer</td>
</tr>
</tbody>
</table>

Objective

Understanding of the characteristics of neuromorphic circuit elements.

Prerequisites

Background in basics of semiconductor physics helpful, but not required.

Literature

"Principles of Neural Science", Kandel, Schwartz, and Jessel.

### Computational Sciences

No course offerings in this semester

### Neuromorphic Engineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1033-00L</td>
<td>Neuromorphic Engineering I</td>
<td>W</td>
<td>6 credits</td>
<td>2V+3U</td>
<td>T. Delbrück, G. Indiveri, S.C. Liu</td>
</tr>
</tbody>
</table>

Objective

Understanding of the characteristics of neuromorphic circuit elements.

Prerequisites

Background in basics of semiconductor physics helpful, but not required.
# Electives

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0151-00L</td>
<td>Linear Algebra</td>
<td>W</td>
<td>4</td>
<td>3G+2U</td>
<td>V. C. Gradinaru</td>
</tr>
<tr>
<td>Abstract</td>
<td>Contents: Linear systems - the Gaussian algorithm, matrices - LU decomposition, determinants, vector spaces, least squares - QR decomposition, linear maps, eigenvalue problem, normal forms - singular value decomposition; numerical aspects; introduction to MATLAB.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>Einführung in die lineare Algebra für Ingenieure unter Berücksichtigung numerischer Aspekte</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literature</td>
<td>K. Nipp / D. Stoffer, Lineare Algebra, vdf Hochschulverlag, S. Auflage 2002</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>401-0603-00L</td>
<td>Stochastics (Probability and Statistics)</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>J. Teichmann</td>
</tr>
<tr>
<td>Abstract</td>
<td>This class covers the following concepts: random variables, probability, discrete and continuous distributions, joint and conditional probabilities and distributions, the law of large numbers, the central limit theorem, descriptive statistics, statistical inference, inference for normally distributed data, point estimation, and two-sample tests.</td>
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<tr>
<td>Objective</td>
<td>Knowledge of the basic principles of probability and statistics.</td>
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<tr>
<td>Content</td>
<td>Introduction to probability theory, some basic principles from mathematical statistics and basic methods for applied statistics.</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Lecture notes</td>
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</tr>
<tr>
<td>Literature</td>
<td>Lecture notes</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>401-0613-00L</td>
<td>Probability and Statistics</td>
<td>W</td>
<td>6</td>
<td>3V+2U</td>
<td>P. Embrechts</td>
</tr>
<tr>
<td>Abstract</td>
<td>Basic concepts from probability and statistics:</td>
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<tr>
<td></td>
<td>- introduction to probability theory</td>
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<tr>
<td></td>
<td>- short introduction to basic concepts and methods from statistics</td>
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<td></td>
<td>b) probabilistic thinking and stochastic modelling</td>
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<td></td>
<td>c) ability to perform basic statistical tests and to interpret the results</td>
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<tr>
<td>Objective</td>
<td>The conceptual goals are</td>
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<td></td>
<td>- the laws of randomness and probabilistic thinking (thinking in probabilities)</td>
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<td></td>
<td>- understanding and intuition for stochastic modelling</td>
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<tr>
<td></td>
<td>- simple and basic methods from statistics</td>
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<tr>
<td>Content</td>
<td>The contents of the course encompasses</td>
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<tr>
<td></td>
<td>- an introduction to probability theory: basic concepts (probability space, probability measure), independence, random variables, discrete and continuous distributions, conditional probability, expectation and variance, limit theorems</td>
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<tr>
<td></td>
<td>- methods from statistics: parameter estimation, maximum likelihood and moment methods, tests, confidence intervals</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes for the course (in German) will be made available electronically at the beginning of the course.</td>
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<tr>
<td>227-1044-00L</td>
<td>Auditory Informatics</td>
<td>W</td>
<td>2</td>
<td>1S</td>
<td>R. Stoop</td>
</tr>
<tr>
<td>Abstract</td>
<td>Invited talks on current research from the following areas: Auditory information processing, auditory sensors (biological and electrical), coding of information, perception, scene-segmentation.</td>
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<tr>
<td>Objective</td>
<td>Exchange with researchers in the domain of auditory informatics. Preparing and giving a presentation on a suitable topic in front of a scientific audience.</td>
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<tr>
<td>Content</td>
<td>The semester program is available under: <a href="http://stoop.ini.uzh.ch/teaching/seminar-on-auditory-informatics">http://stoop.ini.uzh.ch/teaching/seminar-on-auditory-informatics</a></td>
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<tr>
<td>Prerequisites</td>
<td>On request the &quot;Lehrsprache&quot; may be changed to German.</td>
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<tr>
<td>227-1035-00L</td>
<td>Dynamical Systems in Biology</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>R. Stoop</td>
</tr>
<tr>
<td>Abstract</td>
<td>This lecture uses the concepts from dynamical systems (Course: &quot;Computable Chaos in Dynamical Systems&quot;) for the description of salient phenomena in complex examples from population dynamics, neuroinformatics and system biology. A particular focus is on the concept of limit cycle solutions and their coupling.</td>
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<tr>
<td>Objective</td>
<td>Applying concepts from nonlinear dynamics to biological systems. Combining theoretical modeling with supporting computer simulations.</td>
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<tr>
<td>402-0811-00L</td>
<td>Programming Techniques for Scientific Simulations I</td>
<td>W</td>
<td>5</td>
<td>4G</td>
<td>M. Troyer</td>
</tr>
<tr>
<td>Abstract</td>
<td>This lecture provides an overview of programming techniques for scientific simulations. The focus is on advances C++ programming techniques and scientific software libraries. Based on an overview over the hardware components of PCs and supercomputer, optimization methods for scientific simulation codes are explained.</td>
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<tr>
<td>402-0809-00L</td>
<td>Introduction to Computational Physics</td>
<td>W</td>
<td>8</td>
<td>2V+2U</td>
<td>H. J. Herrmann</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course offers an introduction to computer simulation methods for physics problems and their implementation on PCs and super computers: classical equations of motion, partial differential equations (wave equation, diffusion equation, Maxwell's equation), Monte Carlo simulations, percolation, phase transitions.</td>
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<tr>
<td>Prerequisites</td>
<td>Lecture and exercise lessons in english, exams in German or in English</td>
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</table>
This course provides a general introduction into electron microscopy of organic and inorganic materials. In the first part, the basics of transmission- and scanning electron microscopy are presented. The second part includes the most important aspects of specimen preparation, imaging and image processing. In the third part, recent applications in materials science, solid state physics, structural biology, structural geology and structural chemistry will be reported.

**Prerequisites / notice**

Students are offered the opportunity to design a circuit of their own which then gets actually fabricated as a microchip! Students who elect to participate in this program register for a term project at the Integrated Systems Laboratory in parallel to attending the VLSI II course.

**Literature**


**Further details:**

http://www.iis.ee.ethz.ch/stud_area/vorlesungen/visi2.en.html
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Prerequisites / Notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>252-0523-00L</td>
<td>Computational Biology</td>
<td>6</td>
<td>Lecture notes: None</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>Literature: We display articles pertaining to the</td>
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<td>issues we cover in the class on the course's</td>
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<td>webpage. We expect active participation and</td>
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<td></td>
<td></td>
<td>discussions!</td>
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<tr>
<td>252-0535-00L</td>
<td>Machine Learning</td>
<td>6</td>
<td>Lecture notes: Notice</td>
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<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td>Prerequisites: List of courses required for the</td>
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<td></td>
<td>course:</td>
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<td></td>
<td>- local bachelors: course “Discrete-Time and</td>
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<td></td>
<td>Statistical Signal Processing” (5. Sem.)</td>
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<td>- others: solid basis in linear algebra and</td>
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<td></td>
<td></td>
<td>probability theory</td>
</tr>
<tr>
<td>402-0674-00L</td>
<td>Physics in Medical Research: From Atoms to Cells</td>
<td>6</td>
<td>Lecture notes: None</td>
</tr>
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<td></td>
<td>Abstract</td>
<td></td>
<td>Literature: Since we are all experts on</td>
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<td>consciousness, we expect active participation</td>
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<td>and discussions!</td>
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<tr>
<td></td>
<td>Objective</td>
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<td>Content</td>
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<tr>
<td></td>
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<td>Visiting clinical research in a leading university</td>
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<td>hospital will show the usefulness of the course</td>
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<td>lecture series.</td>
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</table>

**Abstract**

Scanning probe and diffraction techniques allow studying activated processes during early stages of epitaxial growth. For quantitative description, rate equation analysis, mean-field nucleation and scaling theories are applied on systems ranging from simple metallic to complex organic materials. The knowledge is expanded to optical and electronic properties as well as to proteins and cells.

**Objective**

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxidic and organic surfaces are introduced.

The atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure's shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quantitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization techniques are vital for optimizing the preparation of medical implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.
The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:

- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

Lecture notes
No lecture notes, but slides will be made available on the course webpage.

Literature

Prerequisites / notice
Solid basic knowledge in analysis, statistics and numerical methods for CSE. Experience in programming for solving the project tasks.

Compulsory Electives in Humanities, Social and Political Sciences
Recommended GESS compulsory elective courses (Type B) for D-ITET.

see GESS Compulsory Electives: Language Courses ETH/UZH

Master Thesis and Semester Papers/Seminars
Option 1: Long Master Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1041-01L</td>
<td>NSC Master Thesis and Exam</td>
<td>W</td>
<td>45 credits</td>
<td>96D</td>
<td>R. Hahnloser</td>
</tr>
</tbody>
</table>

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
UZH Module Code: INI503

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Only students who fulfill the following criteria are allowed to begin with their master thesis:
- a. successful completion of the bachelor programme;
- b. fulfilling of any additional requirements necessary to gain admission to the master programme.

Abstract
The Master thesis concludes the study programme. Thesis work should prove the students' ability to independent, structured and scientific working.

Objective
see above

Option 2: Short Master Thesis and Semester Papers/Seminars
Short Master Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1041-02L</td>
<td>NSC Master Thesis and Exam</td>
<td>W</td>
<td>29 credits</td>
<td>62D</td>
<td>R. Hahnloser</td>
</tr>
</tbody>
</table>

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
UZH Module Code: INI504

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Only students who fulfill the following criteria are allowed to begin with their master thesis:
- a. successful completion of the bachelor programme;
- b. fulfilling of any additional requirements necessary to gain admission to the master programme.

Abstract
The Master thesis concludes the study programme. Thesis work should prove the students' ability to independent, structured and scientific working.

Objective
see above

Semester Papers/Seminars

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1036-01L</td>
<td>NSC Master Short Project I</td>
<td>W</td>
<td>8 credits</td>
<td>17A</td>
<td>R. Hahnloser</td>
</tr>
</tbody>
</table>

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
UZH Module Code: INI505
Abstract
Usually a student selects the topic of a Master Short Project in consultation with his or her mentor.

Objective
see above

227-1036-02L NSC Master Short Project II
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.
UZH Module Code: INI506

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
Usually a student selects the topic of a Master Short Project in consultation with his or her mentor.

Objective
see above

Neural Systems and Computation Master - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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</table>

Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</table>

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Nuclear Engineering Master

MSc Nuclear Engineering is a joint program of EPF Lausanne and ETH Zurich. The first semester takes place in Lausanne. Students therefore have to enroll at EPFL.

For more information about the curriculum and courses see: http://master.epfl.ch/cms/site/master/lang/en/nuclearengineering

Core Courses

1. Semester (EPFL)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-2011-00L</td>
<td>Neutronics (EPFL)</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>external organisers</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>In this course, one acquires an understanding of the basic neutronics interactions occurring in a nuclear fission reactor and, as such, the conditions for establishing and controlling a nuclear chain reaction.</td>
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<td><strong>Objective</strong></td>
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<td>By the end of the course, the student must be able to:</td>
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<td></td>
<td>- Elaborate on neutron diffusion equation</td>
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<td>- Systematize nuclear reaction cross sections</td>
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<td>- Formulate approximations to solving the diffusion equation for simple systems</td>
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<td><strong>Content</strong></td>
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<td>Content:</td>
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<tr>
<td></td>
<td>- Brief review of nuclear physics</td>
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<td><strong>Literature</strong></td>
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<td>Distributed documents, recommended book chapters</td>
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<td></td>
<td><strong>Prerequisites / notice</strong></td>
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<td></td>
<td>Prerequisite for: Reactor Experiments</td>
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<tr>
<td>151-2013-00L</td>
<td>Reactor Experiments (EPFL)</td>
<td>O</td>
<td>4</td>
<td>5U</td>
<td>external organisers</td>
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<td></td>
<td><strong>Abstract</strong></td>
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<td>To gain hands-on experience in the conduction of nuclear radiation measurements, as also in the execution and analysis of reactor physics experiments using the CROCUS reactor.</td>
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<td><strong>Objective</strong></td>
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<td>To gain hands-on experience in the conduction of nuclear radiation measurements, as also in the execution and analysis of reactor physics experiments using the CROCUS reactor.</td>
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<td></td>
<td>Content:</td>
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<tr>
<td></td>
<td>- Radiation detector systems, alpha and beta particles</td>
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<td>- Radiation detector systems, gamma spectroscopy</td>
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<td>- Introduction to neutron detectors (He-3, BF3)</td>
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<td></td>
<td>- Slowing-down area (Fermi age) of Pu-Be neutrons in H2O</td>
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<td>- Approach-to-critical experiments</td>
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<td>- Buckling measurements</td>
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<td>- Reactor power calibration</td>
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<td>- Control rod calibration</td>
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<td><strong>Literature</strong></td>
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<td>Distributed documents, recommended book chapters</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td>Prerequisite for: Special Topics in Reactor Physics (2nd sem.)</td>
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<tr>
<td>151-2015-00L</td>
<td>Reactor Technology (EPFL)</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>H.M. Prasser, external organisers</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td>This course provides an overview of microfabrication processes used to produce micro-scale robots and will cover topics related to microactuators, microsensors, and modeling at these scales. The course will also investigate micromanipulation technologies, inlc. the assembly of micron-sized parts, the manipulation of biological cells, and the types of robots used to perform these types of tasks.</td>
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<td><strong>Objective</strong></td>
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<td>To comprehend (particularly in the context of light water reactors) the basic heat removal phenomena in a reactor core, identify the technological limits for heat generation from the viewpoints of fuel, cladding and coolant, and be introduced to optimization principles in reactor thermal design.</td>
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Content
- Fuel rod, LWR fuel elements
- Temperature field in fuel rod
- Reactor core, design
- Flux and heat source distribution, cooling channel
- Single-phase convective heat transfer, axial temperature profiles
- Boiling crisis and DNB ratio
- Pressurized water reactors, design
- Primary circuit design
- Steam generator heat transfer, steam generator types
- Boiling water reactors
- Reactor design
- LWR power plant technology
- Other types of reactors (overview)
- Generation IV systems

Literature
Distributed documents, recommended book chapters

Prerequisites / notice
Required prior knowledge: Neutronics
Prerequisite for: Nuclear Safety (2nd sem.)

No enrolment to this course at ETH Zurich. Book the corresponding module directly at EPFL.

Abstract
To understand the basic principles governing the advanced energy conversion systems and the perspective for technological progress. To present the characteristics of the main fossil and renewable energy systems from a resource and production technology view. Learning to assess the globally and locally available resources of such energies and be able to dimension roughly the installation required.

Objective
To understand the basic principles governing the advanced energy conversion systems and the perspective for technological progress. To present the essential characteristics of the main fossil and renewable energy systems from a resource and production technology viewpoint. The students will learn to assess the globally and locally available resources of such fossil or renewable energies and be able to make a rough dimensioning of the installations that will use them.

Content
- Overview of fossil and renewable energy resource characteristics
- Reminder of Thermodynamic Laws and exergy theory
- Vapour and gas cycles, combined cycles. Natural gas, coal and nuclear power plants
- Fuel cell principles and technologies. Hybrid fuel cell - turbine cycles
- Technologies of heat pumps (compression, absorption, magnetic) and Organic Rankine Cycles (ORC). Co- and tri-generation
- Biomass technologies for both fuel (liquid or gas) or electricity
- Solar energy resources
- Solar-thermal and photovoltaic systems
- Hydraulic resources
- Hydraulic turbines and schemes
- Wind energy resources
- Wind turbines
- Other renewable technologies

Literature
Bibliographie:
Notes of the lectures;
(distributed course notes and partial translation of chapters of books)

Prerequisites / notice
Required prior knowledge: Basic knowledge of physics and thermodynamics

151-2021-00L Hydraulic Turbomachines (EPFL)
No enrolment to this course at ETH Zurich. Book the corresponding module directly at EPFL.

Abstract
Mastering the scientific design of a hydraulic machine, pump and turbine, by using the most advanced engineering design tools. For each chapters the theoretical basis are first established and then practical solutions are discussed with the help of recent design examples.

Objective
Mastering the scientific design of a hydraulic machine, pump and turbine, by using the most advanced engineering design tools. For each chapters the theoretical basis are first established and then practical solutions are discussed with the help of recent design examples.

Content
- Turbomachine equations, mechanical power balance in a hydraulic machines, moment of momentum balance applied to the runner/impeller, generalized Euler equation.
- Hydraulic characteristic of a reaction turbine, a Pelton turbine and a pump, losses and efficiencies of a turbomachine, real hydraulic characteristics.
- Similarity laws, non dimensional coefficients, reduced scale model testing, scale effects.
- Cavitation, hydraulic machine setting, operating range, adaptation to the piping system, operating stability, start stop transient operation, runaway.
- Reaction turbine design: general procedure, general project layout, design of a Francis runner, design of the spiral casing and the distributor, draft tube role, CFD validation of the design, design fix, reduced scale model experimental validation.
- Pelton turbine design: general procedure, project layout, injector design, bucket design, mechanical problems.
- Centrifugal pump design: general architecture, energetic loss model in the diffuser and/or the volute, volute design, operating stability.

Literature
Notes of cours polycopiées et littérature spécialisée (IMHEF, industrie, associations scientifiques, congrés, etc.).

Title / Title
Hydraulic turbomachines (ME-453)
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>151-2023-00L</td>
<td>Nuclear Fusion and Plasma Physics (EPFL)</td>
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<td><strong>Objective</strong></td>
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<td></td>
<td>Achieve basic understanding of plasma physics concepts for fusion energy,</td>
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<td>and of basic principles of fusion reactors</td>
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<td></td>
<td><strong>Content</strong></td>
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<td>1) Basics of thermonuclear fusion</td>
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<td>2) The plasma state and its collective effects</td>
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<td>3) Charged particle motion and collisional effects</td>
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<td>4) Fluid description of a plasma</td>
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<td>5) Plasma equilibrium and stability</td>
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<td>6) Magnetic confinement: Tokamak and Stellarator</td>
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<td>7) Waves in plasma</td>
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<td>8) Wave-particle interactions</td>
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<td>9) Heating and non inductive current drive by radio frequency waves</td>
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<td>10) Heating and non inductive current drive by neutral particle beams</td>
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<td>11) Material science and technology: Low and high Temperature superconductor</td>
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<td></td>
<td>12) Some nuclear aspects of a fusion reactor: Tritium production</td>
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<td>13) Licensing a fusion reactor: safety, nuclear waste</td>
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<td>14) Inertial confinement</td>
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<td><strong>Literature</strong></td>
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<td></td>
<td>- J. Freidberg, Plasma Physics and Fusion Energy, Cambridge University Press,</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td>Required prior knowledge: Basic knowledge of electricity and magnetism, and</td>
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<td>of simple concepts of fluids</td>
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<td>151-2025-00L</td>
<td>Introduction to Particle Accelerators (EPFL)</td>
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<td><strong>Objective</strong></td>
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<td>By the end of the course, the student must be able to:</td>
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<td>- Design basic linear and non-linear charged particles optics</td>
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<td></td>
<td>- Elaborate basic ideas of physics of accelerators</td>
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<td>- Use a computer code for optics design</td>
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<td>- Optimize accelerator design for a given application</td>
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<td>- Estimate main beam parameters of a given accelerator</td>
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<td><strong>Content</strong></td>
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<td></td>
<td>Overview, history and fundamentals</td>
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<td>Transverse particle dynamics (linear and nonlinear)</td>
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<td>Longitudinal particle dynamics</td>
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<td>Linear accelerators</td>
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<td>Circular accelerators</td>
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<td>Acceleration and RF-technology</td>
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<td>Beam diagnostics</td>
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<td>Accelerator magnets</td>
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<td>Injection and extraction systems</td>
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<td>Synchrotron radiation</td>
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<td>Recommended during the course</td>
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<td><strong>Prerequisites / notice</strong></td>
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<td>Required prior knowledge: Basic knowledge of electricity and magnetism, and</td>
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<td>151-2041-00L</td>
<td>Medical Radiation Physics (EPFL)</td>
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<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>This course covers the physical principles underlying medical imaging using</td>
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<td>ionizing radiation (radiography, fluoroscopy, CT, SPECT, PET). The focus is</td>
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<td>not only on risk and close to the patient and staff, but also on an objective</td>
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<td>description of the image quality.</td>
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<td><strong>Content</strong></td>
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<td></td>
<td>Image quality: Wagner's taxonomy, MTF, NPS, contrast, SNR, DQE, NEQ, CNR</td>
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<td>Dose to the patient: External irradiation, Internal contamination, compartmental</td>
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<td>Physics of computer tomography (CT)</td>
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<td>Risk and radiation: Rational risk and state of our knowledge, Psychological</td>
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<td>aspects, Ethics and communication</td>
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<td>Physics of single-photon emission computed tomography (SPECT)</td>
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<td>Physics of mammography</td>
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<td>Receiver operating characteristics (ROC) and hypothesis testing: Link</td>
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<td>between medical diagnostic and statistical hypothesis testing, Sensitivity,</td>
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<td>specificity, prevalence, predictive values</td>
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<td>Physics of radioscopy</td>
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<td>Model observers in medical imaging: Human visual characteristics and their</td>
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<td>quantification, Bayesian cost and Ideal model observer, Anthropomorphic</td>
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<td>model observers, Detection experiments (rating, M-AFC, yes-no)</td>
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<td>Physics of positron emission tomography (PET)</td>
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<td>Physics of resonance magnetic imaging</td>
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<td>151-2043-00L</td>
<td>Radiation Protection and Radiation Applications (EPFL)</td>
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<td><strong>Prerequisites / notice</strong></td>
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Abstract
An introductory course in the basic concepts of radiation detection and interactions and energy deposition by ionizing radiation in matter, radioisotope production and its applications in medicine, industry and research. The course includes presentations, lecture notes, problem sets and seminars.

Objective
By the end of the course, the student must be able to:

- Explain the basic physics principles that underpin radiotherapy, e.g. types of radiation, atomic structure, etc.
- Explain the interaction mechanisms of ionizing radiation at keV and MeV energies with matter.
- Explain the principles of radiation dosimetry.
- Explain the principles of therapeutic radiation physics including X-rays, electron beam physics, radioactive sources, use of unsealed sources and Brachytherapy.
- Describe how to use radiotherapy equipment both for tumour localisation, planning and treatment.
- Define quality assurance and quality control, in the context of radiotherapy and the legal requirements.
- Explain the principles and practice of radiation protection, dose limits, screening and protection mechanisms.

Content
Basics: radiation sources and interaction with matter, radioisotope production using reactors and accelerators, radiation protection and shielding.
Medical applications: diagnostic tools, radiopharmaceuticals, cancer treatment methodologies such as brachytherapy, neutron capture therapy and proton therapy.
Industrial applications: radiation gauges, radiochemistry, tracer techniques, radioisotope batteries, sterilization, etc.
Applications in research: dating by nuclear methods, applications in environmental and life sciences, etc.

3. Semester

<table>
<thead>
<tr>
<th>Number</th>
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<tr>
<td>151-0104-00L</td>
<td>Uncertainty Quantification for Engineering &amp; Life Sciences</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>J. Beck, P. Koumoutsakos</td>
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<td>Number of participants limited to 60.</td>
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<td>Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.</td>
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<td>The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.</td>
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<td>Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.</td>
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<td>Lecture notes</td>
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<td>The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.</td>
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<td></td>
<td>1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia</td>
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<td>2. Probability Theory: The Logic of Science by E. T. Jaynes</td>
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<td>3. Class Notes</td>
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<td></td>
<td>Fundamentals of Probability, Fundamentals of Computational Modeling</td>
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<td>151-0150-00L</td>
<td>Advanced Topics in Nuclear Reactor Materials</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>M. A. Pouchon, P. J.P. Spättig, M. Streit</td>
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<td>Students registered at ETH Zurich have to enroll to this course at ETH. EPFL students can enroll to this course directly at EPFL.</td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>The course deals with the important challenges for materials (structural and fuel) for current and advanced nuclear power plants. Experimental techniques and tools used for working with active materials are discussed in detail. Students will be well acquainted with analytical and modeling methodologies for damage assessment and residual life determination and with the behavior of high burnup fuel.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>The behaviour of materials in nuclear reactors determines the reliability and safety of nuclear power plants (NPPs). Life extension and the understanding of fuel behavior under high burn-up conditions is of central importance for current-day NPPs. Advanced future systems (fission and fusion) need materials meeting additional challenges such as high temperatures and/or high doses. The course will highlight the above needs from different points of view. Experimental methods for the control and analysis of nuclear components and materials in operating NPPs will be presented. Advanced analytical and modeling tools will be introduced for characterization and understanding of irradiation damage, creep, environment effects, etc. Insights acquired from recent experimental programs into high burnup fuel behavior under hypothetical accident conditions (RIA, LOCA) will be presented. Materials for advanced future nuclear plants will be discussed.</td>
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</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>To acquire hands-on experience with the running of large computer codes in relation to the static analysis of nuclear reactor cores and the multi-physics simulation of nuclear power plant (NPP) dynamic behaviour.</td>
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</tr>
<tr>
<td></td>
<td>Literature</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Distributed documents, recommended book chapters</td>
<td></td>
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<tr>
<td></td>
<td>Prerequisites / notice</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Required prior knowledge: Special Topics in Reactor Physics, Nuclear Safety</td>
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</tr>
</tbody>
</table>
The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

## Electives

Course from the catalogue of Master courses ETH Zurich and EPFL. At least 4 credit points must be collected from the offer of GESS compulsory electives at ETH Zurich or Management of Technology and Entrepreneurship at EPFL.

### Industrial Internship

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1021-00L</td>
<td>Industrial Internship Nuclear Engineering</td>
<td>O</td>
<td>8</td>
<td>external organisers</td>
<td></td>
</tr>
</tbody>
</table>

- **Abstract**: The main objective of the 12-week internship is to expose master's students to the industrial work environment within the field of nuclear energy. During this period, students have the opportunity to be involved in on-going projects at the host institution.

- **Objective**: The main objective of the 12-week internship is to expose master's students to the industrial work environment within the field of nuclear energy.

- **Prerequisites / notice**: The internship must be approved by the tutor.

### Semester Project

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1020-00L</td>
<td>Semester Project Nuclear Engineering</td>
<td>O</td>
<td>8</td>
<td>17A</td>
<td>Professors</td>
</tr>
</tbody>
</table>

- **Abstract**: The subject of the Semester Project and the choice of the supervisor (ETH or EPFL professor) are to be approved in advance by the tutor.

- **Objective**: The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

### Master Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1009-00L</td>
<td>Master’s Thesis Nuclear Engineering</td>
<td>O</td>
<td>30</td>
<td>64D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

- **Abstract**: Only students who fulfill the following criteria are allowed to begin with their Master Thesis:
  a. Successful completion of the Bachelor programme
  b. Any additional requirements for admission to the degree programme have been fulfilled

**Data:** 06.02.2019 13:00  
**Autumn Semester 2015**  
**Page 1104 of 1434**
c. Have achieved a total of at least 72 credits in the categories "Core Subjects" and "Electives"
d. Successful completion of the Semester Project (the corresponding credits have been acquired)

The supervisor of the Master Thesis and the choice of the supervisor (ETH or EPFL professor) are to be approved in advance by the tutor.

Abstract

Master's programs are concluded by the master's thesis. The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem. The subject of the master's thesis, as well as the project plan and roadmap, are proposed by the tutor and further elaborated with the student.

Objective

The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem.

<table>
<thead>
<tr>
<th>Nuclear Engineering Master - Key for Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z</td>
</tr>
<tr>
<td>Dr</td>
</tr>
<tr>
<td>O</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Key for Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
</tr>
<tr>
<td>G</td>
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<tr>
<td>U</td>
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<tr>
<td>S</td>
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<tr>
<td>P</td>
</tr>
<tr>
<td>A</td>
</tr>
<tr>
<td>D</td>
</tr>
<tr>
<td>R</td>
</tr>
</tbody>
</table>

ECTS  European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Pharmaceutical Sciences Bachelor
First Year
First Year Examinations

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

Abstract
First identification with Pharmaceutical Sciences; motivation for profiling in the Natural Sciences, which are focused on within the first two years as a preparation for the specialized studies; sensitization for the duties and the responsibilities of a person with a federal diploma in Pharmacy; information about job opportunities.

Objective
First identification with Pharmaceutical Sciences; motivation for profiling in the Natural Sciences as a preparation for the specialized studies; sensitization for the duties and the responsibilities of a person with a federal diploma in Pharmacy; information about job opportunities.

Content
Introduction to Pharmaceutical Sciences by selected milestones of research and development. Overview on research activities at the Institute of Pharmaceutical Sciences that is focussed on drug delivery and development (from concepts to prototypes). Sensitization for communication skills and information management. Demonstration of job opportunities in community pharmacies, in the hospital, in industry, and in the public sector by experts in the different fields.

Lecture notes
Interactive teaching

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0291-00L</td>
<td>Mathematics I</td>
<td>O</td>
<td>6 credits</td>
<td>4V+2U</td>
<td>A. Caspar</td>
</tr>
</tbody>
</table>

Abstract
Mathematics I/II is an introduction to one- and multidimensional calculus and linear algebra emphasizing on applications.

Objective
Students understand mathematics as a language for modeling and as a tool for solving practical problems in natural sciences.
Students can analyze models, describe solutions qualitatively or calculate them explicitly if need be. They can solve examples as well as their practical applications manually and using computer algebra systems.

Content
**# Eindimensionale diskrete Entwicklungen #**
- linear, exponentiell, begrenzt, logistisch
- Fixpunkte, diskrete Veränderungsrate
- Folgen und Grenzwerte

**# Funktionen in einer Variablen #**
- Reproduktion, Fixpunkte,
- Periodizität,
- Stetigkeit

**# Differentialrechnung (I) #**
- Veränderungsrate/-geschwindigkeit
- Differentialquotient und Ableitungsfunktion
- Anwendungen der Ableitungsfunktion

**# Integralrechnung (I) #**
- Stammfunktion
- Integrationstechniken

**# Gewöhnliche Differentialgleichungen (I) #**
- Qualitative Beschreibung an Beispielen:
  - Beschränkt, Logistisch, Gompertz
- Stationäre Lösungen
- Lineare DGL 1. Ordnung
- Trennung der Variablen

**# Lineare Algebra #**
- Erste Arithmetische Aspekte
- Matrizenrechnung
- Eigenwerte / -vektoren
- Quadratische LGS und Determinante

Lecture notes
In Ergänzung zu den Vorlesungskapiteln der Lehrveranstaltungen fassen wir wichtige Sachverhalte, Formeln und weitere Ausführungen jeweils in einem Vademecum zusammen. Die pdfs finden Sie unter Lernmaterial > Dokumente.

Dabei gilt:
* Die Skripte ersetzen nicht die Vorlesung und/oder die Übungen!
* Ohne den Besuch der Lehrveranstaltungen verlieren die Ausführungen ihren Mehrwert.
* Details entwickeln wir in den Vorlesungen und den Übungen, um die hier bestehenden Lücken zu schliessen.
* Prüfungsrelevant ist, was wir in der Vorlesung und in den Übungen behandeln.
Literatur

**Th. Wihler**
Mathematik für Naturwissenschaften, 2 Bände: Einführung in die Analysis, Einführung in die Lineare Algebra; Haupt-Verlag Bern, UTB.

**H. H. Storrer**
Einführung in die mathematische Behandlung der Naturwissenschaften I; Birkhäuser.
Via ETHZ-Bibliothek:
http://link.springer.com/book/10.1007/978-3-0348-8598-0/page/1

**Ch. Blatter**
Lineare Algebra; VDF
auch als [pdf](http://www.math.ethz.ch/~blatter/dlp.html)

Prerequisites / notice

**Übungen und Prüfungen**
+ Die Übungsaufgaben (inkl. Multiple-Choice) sind ein wichtiger Bestandteil der Lehrveranstaltung.
+ Es wird erwartet, dass Sie mindestens 75 % der wöchentlichen Serien bearbeiten und zur Korrektur einreichen.
+ Der Prüfungsstoff ist eine Auswahl von Themen aus Vorlesung und Übungen. Für eine erfolgreiche Prüfung ist die konzentrierte Bearbeitung der Aufgaben unerlässlich.

**Einschreibung in die Übungen**
Die Einschreibung in die Übungen erfolgt online. Alle unter http://www.mystudies.ethz.ch/ für die Vorlesung Eingeschriebenen erhalten rechtzeitig per Email einen personalisierten Link zur Einschreibung. Behalten Sie diesen Link.

**Zugang Übungsserien**
Erfolgt auch online. Alle unter http://www.mystudies.ethz.ch/ für die Vorlesung Eingeschriebenen erhalten rechtzeitig per Email einen 2. personalisierten Link. Behalten Sie auch diesen Link.

252-0852-00L Foundations of Computer Science O 4 credits 2V+2U J. Hromkovic, H.J. Böckenhauer, M. Dahinden, L. E. Fässler, D. Komm

Abstract
Students learn to apply selected concepts and tools from computer science for working on interdisciplinary projects.

The following topics are covered: modeling and simulations, introduction to programming, visualizing multi-dimensional data, introduction matrices, managing data with lists and tables and with relational databases, universal methods for algorithm design.

Objective
The students learn to
- understand the role of computer science in science,
- to control computer and automate processes of problem solving by programming,
- choose and apply appropriate tools from computer science,
- process and analyze real-world data from their subject of study,
- handle the complexity of real-world data,
- know universal methods for algorithm design.

Content
1. The role of computer science in science
2. Introduction to Programming with Python
3. Modeling and simulations
4. Introduction to Matrices with Matlab
5. Visualizing multidimensional data
6. Data management with lists and tables
7. Data management with a relational database
8. Universal methods for algorithm design

Lecture notes
All materials for the lecture are available at www.gdi.ethz.ch

Prerequisites / notice
This course is based on application-oriented learning. The students spend most of their time working through projects with data from natural science and discussing their results with teaching assistants. To learn the computer science basics there are electronic tutorials available.

529-1001-01L General Chemistry (for Biology/Pharmacy/HST) O 4 credits 4V W. Uhlig

Abstract
The lecture deals with a number of basic chemistry concepts. These include (amongst others) chemical reactions, energy transfer during chemical reactions, properties of ionic and covalent bonds, Lewis structures, properties of solutions, kinetics, thermodynamics, acid-base equilibria, electrochemistry and properties of metal complexes.

Objective
The course is designed to provide an understanding of the basic principles and concepts of general and inorganic chemistry.

Content

Furtherführende Literatur:
Brown, LeMay, Bursten CHEMIE (deutsch)
Housecroft and Constable, CHEMISTRY (englisch)
Oxtoby, Gillis, Nachtrieb, MODERN CHEMISTRY (englisch)

529-1011-00L Organic Chemistry I (for students of Biology, Pharmaceutical Sci., and Health Sci., & Tech.) O 4 credits 4G C. Thilgen

Abstract
Fundamentals of Organic Chemistry: molecular structure. Bonding and functional groups; nomenclature; resonance and aromaticity; stereochemistry; conformation; bond strength; organic acids and bases; basic reaction thermodynamics and kinetos; reactive intermediates: carbanions, carbenium ions and radicals.

Objective
Understanding the basic concepts and definitions of organic chemistry. Knowledge of the functional groups and classes of compounds that are important in biological systems. Understanding the relationship between structure and reactivity.

Introduction into basic skills of rhetoric, presentation, communication. Introduction into learning and working techniques and writing protocols. The text-book "Biology" (Campbell, Reece) (10th edition) is the basis of the course.

The course consists of plenary lectures (2 h per week) and problem-solving lessons (2 h per week, groups of ca. 25 people). In addition, online exercises are available in the e-learning environment Moodle (Course OG I).

The course provides an introduction to the basics of molecular- and cell biology and genetics. The structure of the course is largely identical with that of the text-book. Certain sections of the text-book must be studied by self-instruction.

### Additional First Year Courses

#### 535-0567-00L

**Fundamentals of Biology IA**

- **Objective**
  - Students . . .
  - (1) recognize the importance of effective communication/presentation regarding objectives and audience;
  - (2) know the basics of rhetoric, communication, presentation, learning and working techniques;
  - (3) are enabled to prepare presentations (with slides/powerpoint);
  - (4) know four types of protocols;
  - (5) are enabled to write protocols;
  - (6) know possibilities to optimize their learning and working success;
  - (7) are enabled to scrutinize a scientific text.

- **Content**
  - Communication: models
  - Preparation of presentation
  - Analysis of the audience; definition of goals
  - Language, pronunciation, technique, space
  - Stage fright
  - Protocols: types, writing protocols
  - Scientific text: scrutinize
  - Learning effectively
  - Working rules

- **Literature**
  - Stadelwieser Jürg, Kommunikation als Schlüssel zum Erfolg, Tobler, 2000 (vergriffen/Bibliothek).

- **Lecture notes**
  - no script; handout and working papers.

- **Number**
  - 535-0567-00L

- **Title**
  - Communication and Social Competences

- **Type**
  - O

- **ECTS**
  - 5

- **Hours**
  - 5G

- **Lecturers**
  - M. Aebi, E. Hafen

- **Prerequisites / notice**
  - None.

- **Abstract**
  - Introduction to modern biology and to principal biological concepts.

- **Content**
  - 1. Basic principles of Evolution.
  - 2. Chemistry of Life: Water; Carbon and molecular diversity; biomolecules
  - 3. The cell; structure; membrane structure and function, cell cycle
  - 4. Metabolism: Respiration; Photosynthesis; Fermentation
  - 5. Inheritance: meiosis and sexual reproduction; Mendelian genetics, chromosomal basis of inheritance, molecular basis of inheritance, from gene to protein, regulation of gene expression; genomes and their evolution

- **Literature**
  - R. O. Kissner, K. H. Altmann, J. Hall, D. Neri, G. Schneider, M. D. Wörle

- **Prerequisites / notice**
  - The course of the course is largely identical with that of the text-book.
  - Certain sections of the text-book must be studied by self-instruction.

- **Number**
  - 535-1001-00L

- **Title**
  - Laboratory Course General Chemistry (for Biology and Pharmacy)

- **Type**
  - O

- **ECTS**
  - 6

- **Hours**
  - 8P

- **Lecturers**
  - R. O. Kissner, K. H. Altmann, J. Hall, D. Neri, G. Schneider, M. D. Wörle

- **Abstract**
  - Information about the practical course will be given on the first day.

- **Objective**
  - Introduction to the practical work in a chemistry laboratory. The most important manipulations and techniques are treated, as well as the most fundamental chemical reaction types.

- **Content**
  - Knowledge of the basic chemical laboratory methods.
  - Basic knowledge of the scientific approach in experimenting.
  - Observation and interpretation of real-world chemical processes.
  - Keeping of a reliable laboratory journal.

- **Literature**
  - Stadelwieser Jürg, Kommunikation als Schlüssel zum Erfolg, Tobler, 2000 (vergriffen/Bibliothek).

- **Lecture notes**
  - no script; handout and working papers.

- **Prerequisites / notice**
  - Information about the practical course will be given on the first day.

- **Abstract**
  - Introduction to modern biology and to principal biological concepts.

- **Content**
  - 1. Basic principles of Evolution.
  - 2. Chemistry of Life: Water; Carbon and molecular diversity; biomolecules
  - 3. The cell; structure; membrane structure and function, cell cycle
  - 4. Metabolism: Respiration; Photosynthesis; Fermentation
  - 5. Inheritance: meiosis and sexual reproduction; Mendelian genetics, chromosomal basis of inheritance, molecular basis of inheritance, from gene to protein, regulation of gene expression; genomes and their evolution

- **Literature**
  - R. O. Kissner, K. H. Altmann, J. Hall, D. Neri, G. Schneider, M. D. Wörle

- **Prerequisites / notice**
  - None.

- **Abstract**
  - The course of the course is largely identical with that of the text-book.

- **Content**
  - Introduction into basic skills of rhetoric, presentation, communication. Introduction into learning and working techniques and writing protocols. The text-book "Biology" (Campbell, Reece) (10th edition) is the basis of the course.

- **Literature**
  - R. O. Kissner, K. H. Altmann, J. Hall, D. Neri, G. Schneider, M. D. Wörle

- **Prerequisites / notice**
  - None.

- **Abstract**
  - The course of the course is largely identical with that of the text-book.

- **Content**
  - Introduction into basic skills of rhetoric, presentation, communication. Introduction into learning and working techniques and writing protocols. The text-book "Biology" (Campbell, Reece) (10th edition) is the basis of the course.

- **Literature**
  - R. O. Kissner, K. H. Altmann, J. Hall, D. Neri, G. Schneider, M. D. Wörle

- **Prerequisites / notice**
  - None.
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-1042-00L</td>
<td>Analytics</td>
<td>O</td>
<td>2</td>
<td>1.5G</td>
<td>M. Badertscher</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Principles of the most important separation techniques and the interpretation of molecular spectra.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
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<td></td>
<td></td>
<td>Knowledge of the necessary basics and the possibilities of application of the relevant spectroscopic and separation methods in analytical chemistry.</td>
</tr>
<tr>
<td></td>
<td>Lecture notes</td>
<td></td>
<td></td>
<td></td>
<td>A comprehensive script is available in the HCl-Shop. A summary of the part &quot;Spektroskopie&quot; defines the relevant material for the exam.</td>
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<td></td>
<td>- Pretsch E., Bühlmann P., Badertscher M., Spektroskopische Daten zur Strukturaufklärung organischer Verbindungen, fünfte Auflage, Springer-Verlag, Berlin 2010;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- K. Cammann, Instrumentelle Analytische Chemie, Verfahren, Anwendungen, Qualitätssicherung, Spektrum Akademischer Verlag, Heidelberg, 2001;</td>
</tr>
<tr>
<td></td>
<td>Prerequisites / notice</td>
<td></td>
<td></td>
<td></td>
<td>- 529-1001-01 V &quot;Allgemeine Chemie I (für Biol./Pharm.Wiss.),&quot;</td>
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<td>- 535-1001-00 P &quot;Allgemeine Chemie I (für Biol./Pharm.Wiss.),&quot;</td>
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<td></td>
<td>- 529-1011-00 G &quot;Organische Chemie I (für Biol./Pharm.Wiss.),&quot;</td>
</tr>
<tr>
<td>535-0223-00L</td>
<td>Pharmaceutical Analytics I</td>
<td>O</td>
<td>1</td>
<td>1.5G</td>
<td>I. A. Werner Kaeslin</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Theoretical and practical comprehension of analytical chemistry in order to solve pharmaceutical problems.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>Knowledge in Pharmaceutical Analytics in order to solve fundamental analytical problems. Handling of the most important pharmacoepial texts and monographs.</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
<td></td>
<td>Introduction in Pharmaceutical Analytics. Theoretical and practical considerations concerning a lot of methods in different Pharmacopeias. Identification, purity testing, stability testing, assays of drugs and drug formulations.</td>
</tr>
<tr>
<td></td>
<td>Lecture notes</td>
<td></td>
<td></td>
<td></td>
<td>The script can be downloaded from the IPW homepage, &quot;course materials&quot;.</td>
</tr>
<tr>
<td></td>
<td>Prerequisites / notice</td>
<td></td>
<td></td>
<td></td>
<td>A passed exam of the annual course (Pharmaceutical Analytics I and II) is required for admission to the laboratory course in Pharmaceutical Analytics 535-0219-00.</td>
</tr>
<tr>
<td>376-0151-01L</td>
<td>Anatomy I</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>M. Ristow, L. Slomianka, D. P. Wolfer</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Principles of human embryology, anatomy and histology</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>Basic Knowledge of human embryology, anatomy and histology with focus on vegetative Anatomy; understanding structure - function relationships.</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
<td></td>
<td>3rd semester: histology, embryology, nervous system and sensory organs, cardiovascular system, respiratory system</td>
</tr>
<tr>
<td></td>
<td>Lecture notes</td>
<td></td>
<td></td>
<td></td>
<td>Unterlagen: <a href="http://www.dpwolfer.ch/dpwolfer/TEAstu-ge.htm">http://www.dpwolfer.ch/dpwolfer/TEAstu-ge.htm</a></td>
</tr>
<tr>
<td></td>
<td>Literature</td>
<td></td>
<td></td>
<td></td>
<td>Buchempfehlungen: <a href="http://www.dpwolfer.ch/dpwolfer/TEAstu-ge.htm">http://www.dpwolfer.ch/dpwolfer/TEAstu-ge.htm</a></td>
</tr>
<tr>
<td>376-0151-02L</td>
<td>Physiology I</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>M. Ristow, M. Flück, C. Spengler, N. Wenderoth</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Basic knowledge of the anatomy and physiology of tissues, the embryonal and postnatal development, the cardiovascular system, kidney, the intestines and the basics of pathology.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
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<td></td>
<td>Foundations of human anatomy and physiology and basics of clinical pathophysiology.</td>
</tr>
<tr>
<td></td>
<td>Content</td>
<td></td>
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<td></td>
<td>3rd semester: Cytology, histology, embryology, blood, heart, blood vessels, urinary system, water, electrolyte, and acid-base balance, digestive system, general pathology.</td>
</tr>
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<td></td>
<td>4th semester: Respiratory system, skin, endocrine system, neuroanatomy, sense organs, muscular and nervous tissue, motor system, thermoregulation, male and female reproductive system, pregnancy and child birth.</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td>Physiologie: Schmidt/Lang/Theewes: Physiologie des Menschen, Springer-Verlag,Heidelberg</td>
</tr>
<tr>
<td>551-0103-00L</td>
<td>Fundamentals of Biology II: Cell Biology</td>
<td>O</td>
<td>5</td>
<td>5V</td>
<td>E. Hafen, U. Kutay, J. Matos, G. Schertler, U. Suter, S. Werner</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>The goal of this course is to provide students with a wide general understanding in cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.</td>
</tr>
</tbody>
</table>

Data: 06.02.2019 13:00
Autumn Semester 2015
Page 1109 of 1434
Objective
The goal of this course is to provide students with a wide general understanding of cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

Content
The focus is animal cells and the development of multicellular organisms with a clear emphasis on the molecular basis of cellular structures and phenomena. The topics include biological membranes, the cytoskeleton, protein sorting, energy metabolism, cell cycle and division, viruses, extracellular matrix, cell signaling, embryonic development and cancer research.

Lecture notes
The lectures are presented in the Powerpoint format. These are available on the WEB for ETH students over the nethz (Moodle). Some lectures are available on the ETH WEB site in a live format (Livestream) at the above WEB site.

Literature

Prerequisites / notice
Some of the lectures are given in the English language. Certain sections of the text-book must be studied by self-instruction.

551-1323-00L

<table>
<thead>
<tr>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fundamentals of Biology II: Biochemistry and Molecular Biology</td>
<td>O</td>
<td>4 credits</td>
<td>4V</td>
<td>K. Locher, N. Ban, R. Glockshuber, E. Weber-Ban</td>
</tr>
</tbody>
</table>

Abstract
The course provides an introduction to Biochemistry / Molecular Biology with some emphasis on chemical and biophysical aspects.

Objective
Topics include the structure-function relationship of proteins / nucleic acids, protein folding, enzymatic catalysis, cellular pathways involved in bioenergetics and the biosynthesis and breakdown of amino acids, glycans, nucleotides, fatty acids and phospholipids, and steroids. There will also be a discussion of DNA replication and repair, transcription, and translation.

Lecture notes
none

Literature

Prerequisites / notice
Some of the lectures are given in the English language.

529-1023-00L

<table>
<thead>
<tr>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Chemistry I (for Biology and Pharmacy)</td>
<td>O</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>R. Riek, H. P. Löthi</td>
</tr>
</tbody>
</table>

Abstract

Objective
Understanding the fundamental thermodynamical properties of chemical and biological systems.

Content

Lecture notes
in process, will be distributed at the beginning of the first lecture

Literature

Prerequisites / notice
Prerequisite: mathematics I-II, functions of multiple variables, partial derivatives.

Laboratory Courses 2nd Year

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0229-00L</td>
<td>Practical Course Organic Chemistry (for Students of Biology and Pharmaceutical Sciences)</td>
</tr>
</tbody>
</table>

Latest online enrolment is one week before the beginning of the semester.

Abstract
Analytical part: basic operations for the separation of mixtures of organic compounds (recrystallization, distillation, extraction, chromatography)

Synthetic part (main part): at least 8 synthetic steps (one- or two-step syntheses).

Objective
Learn the basic techniques for the preparation and purification of organic compounds.

Learn to take accurate notes of the experiments.

Deepen the understanding of reaction mechanisms.

Content
Analytical part: basic operations for the separation of mixtures of organic compounds (recrystallization, distillation, extraction, chromatography).

Synthetic part (main part): at least 8 synthetic steps (one- or two-step syntheses).

Introduction to database searches (Reaxys, SciFinder).

Lecture notes
Documentation will be handed out at the beginning of the course.

Literature
1) P. Wörfel, M. Bitzer, U. Claus, H. Felber, B. Vollenweider, Laborpraxis (Bd. 1: Einführung, allgemeine Methoden; Bd. 2: Messmethoden; Bd. 3: Trennungsmethoden; Bd. 4: Analytische Methoden), Birkhäuser Verlag.

Prerequisites / notice
Prerequisite: mathematics I-II, functions of multiple variables, partial derivatives.

Third Year

Medicinal Chemistry I

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-0230-00L</td>
<td>Medicinal Chemistry I</td>
</tr>
</tbody>
</table>

The lectures give an overview of selected drugs and the molecular mechanisms underlying their therapeutic effects in disease. The historical and modern-day methods by which these drugs were discovered and developed are described. Structure-function relationships and the biophysical rules underlying ligand-target interactions will be discussed and illustrated with examples.

Objective
Basic understanding of therapeutic agents with respect to molecular, pharmacological and pharmaceutical properties.

Content
Molecular mechanisms of action of drugs. Structure function and biophysical basis of ligand-target interactions.

Lecture notes
will be provided in parts before each individual lecture.
### 535-0421-00L Galenical Pharmacy I

**Abstract**
Principles and technologies for the manufacturing of dosage forms and drug delivery systems. Knowledge of pharm. excipients, materials, containers, liquid and semi-solid dosage forms, their production, function, quality and application. Comprehension of molecular interactions in solution and colloidal systems. Comprehension of interfacial phenomena and stabilization measures in dosage forms.

**Objective**
Knowledge of the most important pharmaceutical excipients, materials, containers, liquid and semi-solid dosage forms, of their production, function, quality, stability and application. Comprehension of the molecular interactions in solution and colloidal systems. Comprehension of interfacial phenomena and stabilization measures in disperse dosage forms.

**Content**
Introduction and overview of important fundamentals, principles and technologies for the development and manufacturing of dosage forms and drug delivery systems. Overview of the most important pharmaceutical excipients and polymers, their structure, properties and processing; importance of materials properties for containers. Pharmaceutical solvents, fundamentals of solubility and solubilization of drugs. Water treatment processes, sterilization techniques and quality requirements of pharmaceutical water. Parenteral dosage forms and liquid ophthalmics. Surfactants, micell formation and colloidial systems. Liquid suspensions and emulsions, Stabilization measures in dosage forms.

**Literature**
C.-D. Herzelfeld und J. Kreuter (Hrsg.) Grundlagen der Arzneiformenlehre, Springer Verlag, Berlin 1999

**Prerequisites / notice**
Requirements: Knowledge of physical and organic chemistry, biochemistry and biology.

#### 535-0521-00L Pharmacology and Toxicology I

**Abstract**
The two-semester lecture course will provide a detailed understanding of the fundamentals of drug action and the mechanisms of action and therapeutic use of the important classes of drugs. The lectures are intended for students of pharmaceutical sciences.

**Objective**
The lectures will provide a comprehensive survey of pharmacology and toxicology. Special emphasis is placed on the interrelationship between pharmacological, pathophysiological and clinical aspects.

**Content**
Topics include disease-relevant macroscopic, microscopic, pathobiochemical and functional disturbances of specific organs and organ systems. The lectures integrate disease pathology with mechanisms of drug action, usage, metabolism, pharmacokinetics, side effects, toxicity, contraindications and dosage of relevant drug classes. Basic principles of clinical pharmacology and pharmacotherapy will be covered.

**Lecture notes**
Für jede Vorlesung wird ein Skript abgegeben, das eine Zusammenfassung mit den wichtigsten Stichpunkten beinhaltet.

**Literature**
Recommended reading:


or


Comprehensive overview:

English version

The classic textbook in Pharmacology:

**Prerequisites / notice**
Voraussetzungen: Abschluss Grundstudium
The structure and biosynthesis of plant constituents and the pharmacological effects and therapeutic applications of biogenic drugs of plant origin (extract-based herbal medicines; isolated natural products) are discussed. Areas of focus are (a) major biosynthetic pathways for plant-derived natural products, (b) pharmacological effects of herbal extracts, and (c) molecular mechanisms of action.

The understanding of the biosynthesis of plant-derived natural products. Acquisition of fundamental knowledge on the medical applications of important herbal medicines and of isolated natural products (general disease areas, molecular constituents of medicinal plants and herbal medicines in general, molecular constituents responsible for pharmacological activity, possible mechanisms of action, available clinical data to support medical use).

The lecture is centered around the discussion of medicinal plants and herbal medicines and their common medical applications. The main areas addressed in the lecture are (a) the structure and biosynthesis of plant constituents (i.e. plant-derived natural products) and (b) the pharmacological effects and therapeutic applications of biogenic drugs of plant origin (herbal medicines based on plant extracts as well as isolated natural products). The basic pathways for the biosynthesis of the most important classes of plant-derived natural products are discussed in detail. Likewise, the molecular basis of the pharmacological effects of medicinal plant extracts (and derived herbal medicines) and their individual constituent components (isolated natural products) is broadly addressed. As part of this discussion the availability of clinical data (or lack thereof) to support specific clinical applications of herbal medicines will be repeatedly highlighted. Potential risks associated with the use of herbal medicines are discussed for selected cases.

The lecture is structured according to the major classes of natural products prevalent in medicinal plants and herbal medicines: Carbohydrates, lipids, terpenes, phenolic compounds, alkaloids, essential oils.

There is no English translation of the above textbook (or any reasonably equivalent text). Students intending to take the exam for the course and are not sufficiently proficient in German should contact the lecturer before the start of the course.

Requirements: Lecture courses in basic organic chemistry, biochemistry, and biology.
Clinical Microbiology

**Abstract**
Thorough knowledge of major pathogens involved in infectious diseases; principles of laboratory diagnosis of pathogenic bacteria and fungi.

**Objective**
Thorough knowledge of all major pathogens involved in infectious diseases; principles of laboratory diagnosis of pathogenic bacteria and fungi.

**Content**
- Basics and principles of clinical microbiology:
  - Host-pathogen interaction
  - Symptoms and diagnosis of major bacterial pathogens
  - Therapeutic regimens commonly used against bacterial disease
  - Major aspects of medical mycology, virology and parasitology
  - Epidemiology
- Brock, Mikrobiologie, Pearson, 13. aktualisierte Auflage
- Kayser F. et al., Medizinische Mikrobiologie, Thieme, Stuttgart, New York
- Aktuellste Auflage (derzeit 12. Auflage 2010)

**Literature**

**Prerequisites / notice**
Basic knowledge in biochemistry, general microbiology, immunology

**Laboratory Courses 3rd Year**

Respective lectures must be attended before/together with the Laboratory Courses. Special schedule for the Laboratory Courses.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-0219-00L</td>
<td>Laboratory Course in Pharmaceutical Analytics</td>
<td></td>
<td></td>
<td></td>
<td>I. A. Werner Kaeslin</td>
</tr>
<tr>
<td>535-0166-00L</td>
<td>Medical Microbiology Practical Course</td>
<td></td>
<td></td>
<td></td>
<td>A. Lehner</td>
</tr>
<tr>
<td>535-0239-00L</td>
<td>Practical Course in Medicinal Chemistry</td>
<td></td>
<td></td>
<td></td>
<td>J. Hall, M. Detmar, C. Halin Winter, D. Neri</td>
</tr>
</tbody>
</table>

**Compensatory Courses**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0297-00L</td>
<td>Applied Ecotoxicology</td>
<td>W</td>
<td>2</td>
<td>2V</td>
</tr>
</tbody>
</table>

Besides regarding basic concepts, this lecture focus on applied aspects of ecotoxicology. Case studies and effects of environmental chemicals on cells, organisms up to ecosystems are regarded. In a multidisciplinary approach based on toxicological concepts, pollutants are analysed, in particular hormonally active compounds and their effects on reproduction.
This lecture focusses on basic concepts of ecotoxicology and their application to environmental chemicals and environmental pollution problems. Basic concepts are regarded with respect to their consequences for the environment. Toxicological effects on organisms are assessed at different levels of organisation, from the molecular to the ecosystem level. Case studies are regarded in order to understand chemical's actions and their effects. In addition bioaccumulation and their consequences, the methods in ecotoxicology and environmental effects of various compounds will be regarded. Emphasis will be placed on hormonally active compounds and their effects to aquatic organisms. Furthermore, methods of environmental risk assessment of environmental pollutants will be discussed.


The aim is to give a deepened insight on the normal development, of the nervous system based on molecular, cellular and biochemical approaches.

Tissue and Cellular Biomechanics, Molecular Biomechanics and Biopolymers, Computational Biomechanics, Biomaterials, Tissue Engineering, Radiation and Radiographic Imaging, Diagnostic Ultrasound Imaging, Magnetic Resonance Imaging, Biomedical Optics and Lasers.

Handouts provided during the classes and references therin. (available online via ETH library)


Handouts provided during the classes and references therin.
Advanced lecture class providing a broad overview on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis. This concept class will be based on common concepts (Grundlagen der Biologie IIB, Teil Mikrobiologie) and introduce to the enormous diversity among bacteria and archaea. It will cover the current research on bacterial cell structure, genetics, metabolism, symbiosis and pathogenesis.

Content notes
Updated handouts will be provided during the class.

Lecture notes
Current literature references will be provided during the lectures.

Prerequisites / notice
The lecture "Grundlagen der Biologie II: Mikrobiologie" is the basis for this advanced lecture.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Lectures</th>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0319-00L</td>
<td>Cellular Biochemistry (Part I)</td>
<td>3</td>
<td>W</td>
<td>U. Kutay, C. M. Azzalin, B. Kommann, M. Peter</td>
</tr>
<tr>
<td>752-1003-00L</td>
<td>Food Chemistry II</td>
<td>3</td>
<td>W</td>
<td>L. Nyström, M. Erzinger</td>
</tr>
<tr>
<td>752-4005-00L</td>
<td>Food Microbiology I</td>
<td>3</td>
<td>W</td>
<td>M. Loesner</td>
</tr>
</tbody>
</table>

Objective
To familiarize with the structure, properties and reactivity of food constituents. To understand the relationship between the multiple chemical reactions and the quality of food.

Abstract
To familiarize with the structure, properties and reactivity of food constituents. To understand the relationship between the multiple chemical reactions and the quality of food.

Content
Descriptive chemistry of food constituents (proteins, lipids, carbohydrates, plant phenolics, flavour compounds). Reactions which affect the colour, flavour, texture, and the nutritional value of food raw materials and food products during processing, storage and preparation in a positive or in a negative way (e.g. lipid oxidation, Maillard reaction, enzymatic browning). Links to food analysis, food processing, and nutrition.

Lecture notes
The lectures Food Chemistry I and Food Chemistry II constitute a unit.

Literature
H.-D. Belitz, W. Grosch, P. Schieberle, Lehrbuch der Lebensmittelchemie, Springer-Verlag, Berlin, Heidelberg. 2008

Objective
To familiarize with the structure, properties and reactivity of food constituents. To understand the relationship between the multiple chemical reactions and the quality of food.

Abstract
The lecture offers insights into the basics, practical consequences and applications of Food Microbiology. Contents include basic microbiology of the different bacteria, yeasts and molds present in foods, as well as the occurrence and control of foodborne pathogens and spoilage organisms. The focus of this first part of the lecture will be on the organisms, but also on the factors which determine spoilage and foodborne disease.
Content
1. History of Food Microbiology
1.1. Short synopsis of foodborne microorganisms
1.2. Spoilage of Foods
1.3. Foodborne Disease
1.4. Food Preservation
1.5. VIPs of Food Microbiology
2. Overview of Microorganisms in Foods
2.1. Origin of foodborne Microorganisms
2.2. Bacteria
2.3. Yeasts
2.4. Molds
3. Microbial Spoilage of Foods
3.1. Intrinsic and Extrinsic Parameters
3.2. Meats, Seafoods, Eggs
3.3. Milk and Milk Products
3.4. Vegetable and Fruit Products
3.5. Miscellaneous (baked goods, nuts, spices, ready-to-eat products)
3.6. Drinks and Canned Foods
4. Foodborne Disease
4.1. Significance and Transmission of Foodborne pathogens
4.2. Staphylococcus aureus
4.3. Gram-positive Sporeformers (Bacillus & Clostridium)
4.4. Listeria monocytogenes
4.5. Salmonella, Shigella, Escherichia coli
4.6. Vibrio, Yersinia, Campylobacter
4.7. Brucella, Mycobacterium, Aeromonas, Plesiomonas
4.8. Parasites
4.9. Viruses and Bacteriophages
4.10. Mycotoxins
4.11. Bioactive Amines
4.12. Miscellaneous (Antibiotic-resistant Bacteria, Biofilms)

Lecture notes
Electronic copies of the presentation slides (PDF) will be made available for download.

Literature
Recommendations will be given in the first lecture.

376-2017-00L  Biomechanics of Sports Injuries and Rehabilitation  W  3 credits  2V  K.U. Schmitt, J. Goldhahn
Abstract
This lectures introduces the basic principles of injury mechanics and rehabilitation focussing on sports injuries.
Objective
Within the scope of this lecture you will learn the basic principles of trauma biomechanics. Based on examples from sports, you will get to
know different mechanisms that can possibly result in injury. Investigating the background and cause of injury should allow you to assess
the injury risk for sports activities. Furthermore you should be able to develop measures to prevent such injury.
Content
This lecture deals with the basic principles of injury mechanics and rehabilitation. Mechanisms that can result in injury are presented.
Furthermore possibilities to prevent injuries are discussed. Therefore the lecture focuses on sports injuries.
Lecture notes
Handouts can be downloaded.
Literature
Prerequisites / notice
A course work is required. The mark of this course work contributes to the final credits for this lecture. Details will be given during the first lecture.

752-4009-00L  Molecular Biology of Foodborne Pathogens  W  3 credits  2V  M. Loessner, M. Schuppler
Abstract
The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant
molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.
Objective
Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the
microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the
associated pathogens and microbial risks.
Content
Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc) and toxin-producing organisms (Bacillus,
Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How
is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be
done to interfere with the potential risks?
Lecture notes
Electronic copies of the presentation slides (PDF) will be made available for download to registered students.
Literature
Recommendations will be given in the first lecture.
Prerequisites / notice
Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until 11:15 h), with no break.

752-5103-00L  Functional Microorganisms in Foods  W  3 credits  2G  C. Lacroix, T. de Wouters, L. Meile, C. Schwab
Abstract
This integration course will discuss new applications of microorganisms with functional properties in food and functional food products.
Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of functional
microorganisms to produce food with high quality, safety and potential health benefits for consumers.
Objective
To understand the principles, roles and mechanisms of microorganisms with metabolic activities of high potential for application in
traditional and functional foods utilization with high quality, safety and potential health benefits for the consumers. This course will integrate
basic knowledge in food microbiology, microbial physiology, biochemistry, and technology.
Content

This course will address selected and current topics on new applications of microorganisms with functional properties in food and functional food products and characterization of functionality and safety of food bacteria. Specialists from the Laboratory of Food Biotechnology, as well as invited speakers from the industry will contribute to the selected topics as follows:

- Probiotics and Prebiotics: Probiotics, functional foods and health, towards understanding molecular modes of probiotic action; Challenges for the production and addition of probiotics to foods; Prebiotics and other microbial substrates for gut functionality.

- Bioprotective Cultures and Antimicrobial Metabolites: Antifungal cultures and applications in foods; Antimicrobial peptide-producing cultures (bacteriocins) for enhancing food quality and safety; Development of new protective cultures, the long path from research to industry.

- Legal and Protection Issues Related Functional Foods

- Industrial Biotechnology of Flavor and Taste Development

- Safety of Food Starter Cultures and Probiotics

Lecture notes

Students will be required to complete a group project on food products and ingredients with of from functional bacteria. The project will involve information research and analysis followed by an oral presentation and short written report.

Literature

A list of references will be given at the beginning of the course for the different topics presented during this course.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>752-6101-00L</td>
<td>Nutrition and Chronic Disease (HS)</td>
<td>W 3</td>
<td>M. B. Zimmermann</td>
</tr>
<tr>
<td>752-6105-00L</td>
<td>Epidemiology and Prevention</td>
<td>W 3</td>
<td>M. Eichholzer</td>
</tr>
<tr>
<td>752-5001-00L</td>
<td>Food Biotechnology I</td>
<td>W 4</td>
<td>C. Lacroix, M. Meile, M. Stevens</td>
</tr>
</tbody>
</table>

Objective

To have the student gain understanding of the links between the diet and the etiology and progression of chronic diseases, including diabetes, gastrointestinal diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.

Students are able

- to evaluate the scientific evidence on the effects of diet on human health
- to describe the role of nutritional factors in the prevention of chronic diseases
- to assess the nutritional status of a population (Switzerland taken as an example)
- to put forward preventive measures addressing individuals but also our society in relation to the obesity epidemic

Content

The course evaluates food and food ingredients in relation to primary and secondary prevention of chronic diseases including diabetes, cardiovascular diseases, kidney disease, cardiovascular disease, arthritis and food allergies.

To be provided by the individuals lecturers, at their discretion.

Prerequisites / notice

No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.

Courses outside the curriculum

Data: 06.02.2019 13:00

Autumn Semester 2015

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<table>
<thead>
<tr>
<th>Key for Hours</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
Pharmaceutical Sciences Master

First Year

Compulsory and Compensatory Courses

Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-0010-00L</td>
<td>Drug Seminars I</td>
<td>O</td>
<td>0</td>
<td>1S</td>
<td>K.H. Altmann</td>
</tr>
<tr>
<td></td>
<td>6 credit points are awarded after successful presentation in the Seminar Week.</td>
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</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
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<tr>
<td></td>
<td>Drug therapy is nothing less than interference with a highly complex biological system, which is affected by various internal and external factors. A profound understanding of drug effects thus requires a transdisciplinary approach of investigation. The drug seminars provide a platform for the presentation and discussion of these transdisciplinary approaches for the investigation of drug action.</td>
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<td></td>
<td>Objective</td>
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<td>The faculty members of the Institute of Pharmaceutical Sciences offer specific projects from different areas of the pharmaceutical sciences, each of which is elaborated by a small group of students (4-8). Each group is tutored by a faculty member. The objective of this work is to achieve an in-depth understanding of the problem investigated and to present the results of the work to an audience composed of all students participating in the drug seminar and the faculty of the Institute of Pharmaceutical Sciences. Presentations will take place in the framework of a dedicated mini-symposium, which is part of the external seminar week. The possibility exists to invite external experts from industry or the public health sector to participate in the mini-symposium. Students are strongly encouraged to make use of this option and will again be supported in these efforts by the faculty members.</td>
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<td>Handouts to the lectures will be available for downloading under <a href="http://www.pharma.ethz.ch/scripts/index">http://www.pharma.ethz.ch/scripts/index</a></td>
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<tr>
<td>535-0030-00L</td>
<td>Therapeutic Proteins</td>
<td>O</td>
<td>3</td>
<td>3G</td>
<td>C. Halin Winter, D. Neri</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>The course consists of two parts:</td>
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<td>In a first part, students will complete their training of pharmaceutical immunology (Chapter 13 - 16 Immunobiology VIII textbook). This part particularly focuses on the pathogenic mechanisms of immune-mediated diseases. Deepened knowledge of immunology will be relevant for understanding the mechanism of action of many therapeutic proteins, as well as for understanding one major concern related to the use of protein-based drugs, namely, immunogenicity.</td>
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<td>Students know and understand:</td>
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<td>- basic mechanisms and regulation of the immune response</td>
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<td></td>
<td>- the pathogenic mechanisms of the most important immune-mediated disorders</td>
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<td>- the most frequently used expression systems for the production of therapeutic proteins</td>
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<td>- the use of protein engineering tools for modifying different features of therapeutic proteins</td>
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<td>- the mechanism of action of selected therapeutic proteins and their application</td>
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<td>- basic concepts in the GMP production of therapeutic proteins</td>
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<td>In this course, various topics related to the development, GMP production and application of therapeutic proteins will be discussed. Furthermore, students will expand their training in pharmaceutical immunology and will be introduced to the basic concepts of pharmaceutical product quality management.</td>
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<td>Content</td>
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<td>Lecture notes</td>
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<td>Handouts to the lectures will be available for downloading under <a href="http://www.pharma.ethz.ch/scripts/index">http://www.pharma.ethz.ch/scripts/index</a></td>
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<td>Literature</td>
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<td></td>
<td>- Chapters 13-16 of the Immunobiology VIII book (Janeway et al.)</td>
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<td></td>
<td>- Lecture Handouts</td>
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<td>- Paper References provided in the Scripts</td>
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<td>- EMEA Dossier for Humira</td>
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<tr>
<td>535-0041-00L</td>
<td>Pharmacology and Toxicology III</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>M. Detmar, U. Quitterer</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
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<td>The course is divided into two parts. The first part provides a detailed understanding of drugs and pharmacotherapy of infectious diseases and cancer. The second part gives an overview of the field of pharmacogenomics with a special focus on the role of genetic polymorphisms in disease susceptibility, drug response and adverse effects.</td>
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<td>Objective</td>
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<td>The course advances basic knowledge in pharmacology and toxicology. Special emphasis is placed on the interrelationship between pharmacological, pathophysiological and clinical aspects of drug therapy in the fields of infectious diseases and cancer. The course also provides an overview of the field of pharmacogenomics, with a special focus on the role of genetic polymorphisms in disease susceptibility, drug response and adverse effects.</td>
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<td>Topics include the pharmacology and pharmacotherapy of infectious diseases and cancer. In the field of pharmacogenomics, the course is focused on genetics, genome-wide association studies, genetic disease predisposition, examples of genetic variability of drug metabolism and drug responses, identification of new drug targets, relevance of pharmacogenomics for clinical drug development, and toxicogenomics.</td>
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<tr>
<td></td>
<td>Lecture notes</td>
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<td></td>
<td>A script is provided for each lecture course. The scripts define important and exam-relevant contents of lectures. Scripts do not replace the lecture.</td>
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<td></td>
<td>Literature</td>
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<td>Recommended reading:</td>
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<td></td>
<td>The classic textbook in Pharmacology:</td>
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<td></td>
<td>Goodman and Gilman`s The Pharmacological Basis of Therapeutics</td>
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<td></td>
<td>Laurence Brunton, Bruce Chabner, Bjorn Knollman.</td>
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<tr>
<td></td>
<td>12th edition - 1808 pages</td>
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<td></td>
<td>Klaus Aktories, Ulrich Förstermann, Franz Hofmann, Klaus Starke.</td>
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<tr>
<td></td>
<td>Allgemeine und spezielle Pharmakologie und Toxikologie.</td>
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<td></td>
<td>11th edition - 1216 pages</td>
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<tr>
<td>535-0050-00L</td>
<td>Pharmacoepidemiology and Drug Safety</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>S. Russmann</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>Drug therapy is nothing less than interference with a highly complex biological system, which is affected by various internal and external factors. A profound understanding of drug effects thus requires a transdisciplinary approach of investigation. The drug seminars provide a platform for the presentation and discussion of these transdisciplinary approaches for the investigation of drug action.</td>
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<td>Objective</td>
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<td></td>
<td>In parallel appropriate tools to critique pharmacoepidemiologic studies in medical literature will be given and applied.</td>
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<tr>
<td></td>
<td>Content</td>
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<td>University of Zurich.</td>
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Data: 06.02.2019 13:00 Autumn Semester 2015 Page 1119 of 1434
Objective

Objectives:
To familiarize participants with the principles of pharmacoepidemiology and epidemiology in addressing drug related questions with concern to the use, effects and risks of medicinal products in a large population.
To introduce participants to fundamental statistical, economic and epidemiological concepts and methods.
To provide the appropriate tools to critique pharmacoepidemiologic studies in the literature and to critically read and understand papers in the medical literature which relate to drug benefits, risks, and costs.
To address controversial topics in drug use and benefit-risk assessment, and to critically appraise the outcome of drug therapy.
To equip participants with skills to facilitate further studies in these areas.

Content

The contribution of epidemiology to the study of drug uses, effects and risks:
- Pharmacoepidemiology study methodologies, concepts and strategies,
- Detection and identification of unintended drug effects (pharmacovigilance),
- Quantifying unintended effects and drug interactions,
- Bias and confounding by indication,
- Drug utilization

Meta-analysis in pharmacoepidemiology.

Pharmacoepidemiology and regulatory decision making in drug safety

Lecture notes

This course will be a combination of formal lectures, group discussions and self-directed project work. Course material will be taught through seminars, case studies and group projects. Reading material and scripts will be given for each week.

Literature

A reading list pertinent to the course will be provided during the course.

Methodological referen

Strom B; Pharmacoepidemiology, 3rd ed. Wiley, Chichester, 2000
Rothman K, Greenland S; Modern Epidemiology, 2nd ed. Lippincott, Philadelphia, 1998
Mann R, Andrews E; Pharmacovigilance, Wiley, Chichester, 2003

Compensatory Courses

Elective courses can be used as compensatory courses.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>535-0023-00L</td>
<td>Computer-Assisted Drug Design (Practical Course)</td>
<td>W Dr</td>
<td>4 credits</td>
<td>6P</td>
<td>G. Schneider, J. A. Hiss</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>The practical course is open for master and graduate students to get an introduction into hands-on computer-assisted drug design. The class includes an introduction to computer-based screening of a virtual compound library, subsequent synthesis of candidate ligands, and biochemically testing for activity on pharmacologically important drug targets.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Participants become familiar with state-of-the-art methodologies in a real-life computer-aided medicinal chemistry project. Participants work as small teams, perform literature research and discuss recent research findings. A seminar talk is to be given presenting the molecular design strategy chosen and the results obtained during the course.</td>
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<tr>
<td><strong>Content</strong></td>
<td>The course offers the possibility for people with and without computational and or laboratory background to get an introduction into computer-assisted drug design, as well as practical training in a modern chemical laboratory. Using various software suites, the participants will computationally create and screen a virtual compound library for potential active small molecules. The process will involve an introduction to screening a virtual compound library, synthesizing candidate inhibitors, and biophysical testing against a pharmacologically important drug target.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Detailed information will be handed out during the course.</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>The class is organized as a two-week block course. The number of participants is limited. Kick-off meeting and confirmation of registration (Vorbesprechung und Platzvergabe); During the last lecture of the class &quot;Computer-Assisted Drug Design&quot; (535-0022-00).</td>
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535-0024-00L | Methods in Drug Design | W Dr   | 1 credit | 1V   | G. Schneider |
| **Abstract** | The lecture is organized as a two-week block during the practical course "Computer-Assisted Drug Design" (535-0023-00 P), totalling 10 two-hour lectures. It provides an introduction to advanced drug design techniques and approaches emphasizing computer-assisted molecular design. |        |       |      |                              |
| **Objective** | Participants will learn about computational algorithms and advanced experimental approaches to drug discovery and design, including selected actual topics and practical applications. The contents of the lecture will allow for a deeper understanding of modern computer-assisted drug design methods and how they are linked to experimental applications. The main focus is on computational medicinal chemistry, so that participants will be able to use relevant computer-based methods in own research projects. |        |       |      |                              |
| **Prerequisites / notice** | Additional selected literature will be provided during the lecture. |        |       |      |                              |

Electives

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<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>535-0250-00L</td>
<td>Biotransformation of Drugs and Xenobiotics</td>
<td>W Dr</td>
<td>1 credit</td>
<td>1V</td>
<td>S.D. Krämer</td>
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<tr>
<td><strong>Abstract</strong></td>
<td>Knowledge of the major reactions of biotransformation in drug therapy, prediction of possible metabolites of drugs and xenobiotics, recognition of structure elements and reactions which can lead to toxic metabolites. Knowledge of inter- and intraindividual factors influencing metabolism.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Goals: knowledge of the major reactions of biotransformation in drug therapy, prediction of possible metabolites of drugs and xenobiotics, recognition of structure elements and reactions which can lead to toxic metabolites. Knowledge of inter- and intraindividual factors influencing metabolism.</td>
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</table>
Content

Major reactions of biotransformation. Major enzymes and reaction partners involved in the biotransformation of drugs and xenobiotics.
Toxic reactions of metabolites. Factors which affect the biotransformation.

Lecture notes

Biotransformation of drugs and xenobiotics

Literature


535-0137-00L Clinical Chemistry II W Dr 1 credit 1V M. Hersberger

Abstract

Detailed knowledge on particular aspects of clinical chemistry and medical laboratory diagnostics concerning quality control, point-of-care analytics, analytics of kidney stones, tumor markers, diagnosis of HIV and hepatitis, pharmacogenetics, thyroid function, bone metabolism and laboratory diagnosis of hypertension.

Objective

Detailed knowledge on the implementation and interpretation of clinical laboratory diagnostic tests. Competence to interpret selected tests.

Content

Internal and external quality control, point-of-care analytics, analytics of kidney stones, use of tumor marker determinations, diagnosis of HIV and hepatitis, pharmacogenetics, thyroid function, bone metabolism and laboratory diagnosis of hypertension.

Lecture notes

Documentation will be available before the lectures electronically.

Literature

- Jürgen Hallbach, Klinische Chemie und Hämatologie für den Einstieg, Thieme Verlag
- Harald Renz, Praktische Labordiagnostik, de Gruyter Verlag
- Walter Guder, Das Laborbuch für Klinik und Praxis, Elsevier Verlag
- Lothar Thomas, Labor und Diagnose, Thi Books
- William Marshall, Clinical Chemistry, Mosby Ltd.
- Alan H.B. Wu, Tietz, Clinical Guide to Laboratory Tests, Saunders

Prerequisites / notice

Requirement: basic knowledge in clinical chemistry and laboratory diagnostics

535-0015-00L History of Pharmacy W 1 credit 1V M. Fankhauser

Abstract

The students will receive the basic knowledge of the history of pharmacy. This knowledge will allow them to have a detailed approach to the actual pharmacy and the development of the materia medica.

Objective

The students will receive the basic knowledge of the history of pharmacy. This knowledge will allow them to have a detailed approach to the actual pharmacy and the development of the materia medica.

Content

In the first part of the lecture we will talk about the position of the pharmacist in the past and in society. We go through the milestones of the social and legal development of pharmacy. The second part will deal with the history of pharmacology with development of therapeutical theories and the evolution of the used remedies. It also includes their sometimes mystical and symbolical dimension.

Literature

Wird in der ersten Veranstaltung mitgeteilt.

Prerequisites / notice

Voraussetzungen: Keine. Interesse für die Rolle der Pharmazie und der Medikamente in der Vergangenheit von Vorteil.

535-0344-00L From Ethnopharmacy to Molecular Pharmacognosy W Dr 1 credit 1V B. Frei Haller, J. Gertsch

Abstract

Basic understanding and awareness of ethnopharmaceutical and ethnopharmacological issues and research. Knowledge of methods used in drug discovery from natural sources. Discussion of the issues around law and international treaties. Importance of ethnopharmaceutical knowledge for world health.

Objective

Basic understanding and awareness of ethnopharmaceutical and ethnopharmacological issues and research. Knowledge of methods used in drug discovery from natural sources. Discussion of the issues around law and international treaties. Importance of ethnopharmaceutical knowledge for world health.

Content

Introduction into ethnopharmacy and related disciplines; definitions of terms, working methods, research projects, bioprospecting.

Literature

Handouts will be provided.

Prerequisites / notice


535-0423-00L Drug Delivery and Drug Targeting W Dr 2 credits 2V J.C. Leroux, D. Brambilla

Abstract

The students gain an overview on current principles, methodologies and systems for controlled delivery and targeting of drugs. This enables the students to understand and evaluate the field in terms of scientific criteria.

Objective

The students dispose of an overview on current principles and systems for the controlled delivery and targeting of drugs. The focus of the course lies on developing a capacity to understand the involved technologies and methods, as well as an appreciation of the chances and constraints of their therapeutic usage, with prime attention on anticancer drugs, therapeutic peptides, proteins, nucleic acids and vaccines.

Content

The course covers the following topics: drug targeting and delivery principles, radiopharmaceuticals, macromolecular drug carriers, liposomes, micelles, micro/nanoparticles, gels and implants, administration of vaccines, delivery of active agents in tissue engineering, targeting at the gastrointestinal level, synthetic carriers for nucleic acid drugs, ophthalmic devices and novel trends in transdermal and nasal drug delivery.

Literature

Selected lecture notes, documents and supporting material will be directly provided or may be downloaded using http://www.galenik.ethz.ch/teaching/drug_del_drug_targ

The website also displays additional information on peroral delivery systems, transdermal systems and systems for alternative routes (nasal, pulmonary) of delivery. These fields are covered in detail in the course Galenische Pharmazie II (Galenical Pharmacy II).

Prerequisites / notice

Further references will be provided in the course.

535-0300-00L Molecular Mechanisms of Drug Actions and Targets W Dr 1 credit 1V V. I. Otto

Abstract

In the last 10 years, an average of one drug per year was withdrawn from the market. Using selected examples of such drug failures, the course aims at analyzing the present explanations of drug actions as well as the design and predictive power of animal models and clinical trials. In addition, the ethical, societal, and economical expectations in new drugs shall be reflected.

Objective

To develop a critical understanding of the relevance and limitations of the current approaches to explaining and anticipating drug effects. To critically appraise the ethical, societal, economical and political expectations in the development of new drugs.
Content
In December 2006, Pfizer stopped a large phase III study on the use of Torcetrapib for the prevention of atherosclerosis and cardiovascular disease. 800 million $ in development costs and 21 billion $ in stocks were annihilated overnight. The failure of Torcetrapib has pinpointed the limitations of an extremely reductionist view of atherosclerosis and it's prevention by drug therapy. It has also highlighted what high expectations we have in a safe and wide applicability of drugs and of their economical success. Torcetrapib is not a single case. In the last 10 years, on average one drug per year was withdrawn from the market due to lack of efficacy, unexpected side effects or toxicity. This clearly shows that the common investigations and the modern understanding of drug actions are often not sufficient to predict the effects a drug will have in large patient populations. These are the topics of the present course. Using three particularly informative examples of drug failures, the problems encountered and the concepts and informative value of preclinical and clinical studies will be analyzed and discussed. Furthermore, the ethical, societal, economical and political expectations in new drugs shall be reflected.

Lecture notes
Printouts of the slides used for the lectures and literature for reading and discussions will be available online.

Literature
Recommended reading: John Abramson, Overdo$ed America, Harper Perennial, New York 2008

Prerequisites / notice
Requirements: basic knowledge in Medicinal Chemistry and Pharmacology. Ability to read and understand scientific publications in English.

535-0022-00L Computer-Assisted Drug Design

W Dr 1 credit 1V G. Schneider

Abstract
The lecture series provides an introduction to computer applications in medicinal chemistry. A focus is on molecular representations, property predictions, molecular similarity concepts, virtual screening techniques, and de novo drug design. All theoretical concepts and algorithms presented are illustrated by practical applications and case studies.

Objective
The students will learn how computer simulation generates ideas for drug design and development, understand the theoretical principles of property prediction and computer-generated compound generation, and understand possibilities and limitations of computer-assisted drug design in pharmaceutical chemistry. As a result, they are prepared for professional assessment of computer-assisted drug design studies in medicinal chemistry projects.

Literature
Recommended textbooks:

Prerequisites / notice
Successful participation in this course is required for a research project ("Forschungspraktikum") in the CADD group.

535-0546-00L Patents

W 1 credit 1V A. Koepf, P. Pliska

Abstract
Knowledge in the field of intellectual property, especially of patents and trademarks, with particular emphasis on pharmacoeconomics. Introduction into intellectual property; prosecution of patent applications; patent information; exploitation and enforcement of patents; peculiarities in pharmacoeconomics and medicine; social, political and ethical aspects; Trademarks.

Objective
Basic knowledge in the field of industrial property, especially of patents and trademarks, with particular emphasis on the chemical, pharmaceutical and biotech field.

Content
1. Introduction into industrial property (patents, trademarks, industrial designs);
2. Prosecution of patent applications (patentability);
3. Patent information (patent publications, databases, searches);
4. Exploitation and enforcement of patents (possibilities of exploitation, licenses, parallel imports, scope of protection, patent infringement);
5. Peculiarities in pharmacoeconomics and medicine (supplementary protection certificates, experimental use exemption, therapy and diagnosis, medical indication);
6. Social, political and ethical aspects (patents and prices for medicinal products, traditional knowledge and ethnomedicine, bioprospecting and biopiracy, human DNA inventions);
7. Trademarks, types of trademarks, grounds for refusal, peculiarities of pharma-trademarks.

Lecture notes
A script is available in electronic form during the lecture.

Literature

535-0310-00L Glycobiology in Drug Development

W Dr 1 credit 1V V. I. Otto

Abstract
Protein-based drugs constitute around 25% of new approvals and most of them are glycoproteins. Using selected examples the course aims at providing insight into our present knowledge on glycosylation-activity relationships and the production and analysis of glycoprotein-based drugs.

Objective
Gaining insight into the glyobiology of therapeutically used glycoproteins. This implies knowing and understanding
- the major types of protein-linked glycans and their biosynthesis
- the most important expression systems for production of recombinant glycoproteins
- methods used to alter or manipulate glycosylation
- the most prominent clinically used glycoproteins and how glycosylation influences their therapeutic profile.

Current methods for the qualitative and quantitative characterization of glycoproteins and being able to apply this knowledge in other contexts.

Content
1. Proteins wearing a "sugar dress" - Glycans in cell-cell communication and molecular recognition in multicellular organisms
2. Tissue plasminogen activator (t-PA), glucosamine oxidase and the biosynthesis of N-glycans
3. PSGL-1 and the biosynthesis of O-glycans; P-selectin and other lectins
4. The glycoprotein hormones and the production and analysis of therapeutic glycoproteins
5. Monoclonal antibodies and the modification of their therapeutic profile through glycoengineering
6. EPO "the same but different"
7. Current topics: Biosimilars and the currently marketed ‘Biopharmaceuticals’

Lecture notes
The slides used for the lectures will be provided online.

Literature

Prerequisites / notice
Requirements: Basic knowledge in molecular biology, protein chemistry and analytics. Basic knowledge in pharmacology.
**Abstract**  
Vitamins are essential organic compounds that cannot be synthesized by an organism and hence, they have to be acquired from the diet. This lecture will give an overview about the application of vitamins in health and disease.

**Objective**  
The aim of this lecture is a critical examination of the students with the topic of "Vitamins in Health and Disease". The students will get an overview of vitamins, of their medical applications and the role of the pharmacist with "over-the-counter" products.

**Content**  
Deficiencies of particular vitamins result in specific diseases such as for example scurvy (vitamin C deficiency). Such disease patterns are usually easily recognized and facile to be treated. The clinical utility of supplementation concerns people with severe deficiencies and a risk of complications. Latent vitamin deficiencies might result in variable disorders and risks. As an example neurological disorders in elderly as a consequence of chronic lack of vitamin B12 should be mentioned. Subclinical deficiencies are often difficult to assess. However, these are exactly the cases where advice of a pharmacist is requested. A large intake of vitamins by over-supplementation or food fortification might be dangerous (hypervitaminosis). This is in particular the case for fat-soluble vitamins or in the case of constant intake of high amounts of water-soluble vitamins over a long time period.

The lecture 'Vitamins in Health and Disease' will give an overview about the history and applications of vitamins and their functions to preserve good health. The utility of vitamin supplementation during conditions of deficiencies, potential consequences of a latent deficiency as well as risks of over-supplementation will be discussed.

**Lecture notes**  
Hand-outs will be distributed during the lecture (in English).

**Literature**  
Book recommendation: reference books:
- Handbuch Nährstoffe, Burgerstein, Trias Verlag ISBN 978-3-8304-6071-8

**Prerequisites / notice**  
Requirements: Basic knowledge in biochemistry and pharmacology. Ability to read and understand scientific publications in English.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Type</th>
<th>Credit</th>
<th>Lecturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>353-0360-00L</td>
<td>Evidence Based Phytotherapy</td>
<td>W Dr</td>
<td>1 credit</td>
<td>J. Drewe, K. Berger Büter</td>
</tr>
</tbody>
</table>

**Abstract**  
Based on epidemiology, economic importance and evidence-based medicine, basic principles of rational phytotherapy will be discussed: a) Identification of drug candidates, b) registration requirements, c) criteria to assess efficacy, d) biomarkers and pharmacokinetics, e) safety and f) principles of extract generation. Important prototypes will be discussed.

**Objective**  
Students should learn the importance of rational (= evidence based) pharmacotherapy with herbal extracts:
- How are interesting development candidates being identified? What are the strategies?
- What are the regulatory requirements (traditional use, well-established use, new herbal entities)?
- What are the selection criteria?
- Assessment of efficacy (animal-human studies, biomarker)
- Pharmacokinetics
- Safety (Toxicity, unwanted adverse effects, drug-drug interactions)
- Pharmaceutical quality
- Securing of herbal identity (collections, agriculture)
- Quality management
- Selection of appropriate extraction procedures?

Important prototypes will be presented and critically discussed:
- Cannabis sativa
- Crataegus sp.
- Echinacea
- Ginkgo biloba
- Hypericum perforatum
- Iberogast®
- Kava kava
- Perlargonium
- Punica granatum
- Serenoa repens

**Content**  
17.09.2014  
Einführung: Qualität Arzneipflanzen-Fertigprodukte, Monographien (Kommission E, ESCOP, HMPC), Unterschiede hinsichtlich des Registrierungsstatus und -anforderungen: traditional use, well established use und new herbal entities, Methoden Produktentwicklung (Pflanzenauswahl, Anbau, Extraktentwicklung, präklinische und klinische Entwicklung) Grundlegende Begriffe der evidenzbasierten Medizin

24.09.2014  
Hypericum perforatum  
1.10.2014  
A) Echinacea
B) Iberogast (Beispiel eines Multikomponentenproduktes)

8.10.2014  
A) Serenoa repens
B) Ginkgo biloba

15.10.2014  
A) Cannabis sativa
B) Kava kava

22.10.2014  
A) Silybum marianum
B) Rhodiola rosea

29.10.2014  
A) Artichoke
B) MC-Prüfung

**Lecture notes**  
Die Skripten werden vor den jeweiligen Vorlesungen per Email an die Teilnehmer versandt
Research Project

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>535-0655-00L</td>
<td>Research Project</td>
<td>O</td>
<td>10</td>
<td>20A</td>
<td>Lecturers</td>
</tr>
<tr>
<td></td>
<td>The Research Project accustoms students to scientific work.</td>
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</table>

Objective: Students are accustomed to scientific work and they get to know one specific research field.

Content: Students work on a current field of research.

Master Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-0660-00L</td>
<td>Master’s Thesis</td>
<td>O</td>
<td>30</td>
<td>40D</td>
<td>Lecturers</td>
</tr>
<tr>
<td></td>
<td>Only students who fulfill the following criteria are allowed to begin with their master thesis: a. successful completion of the bachelor programme; b. fulfilling of any additional requirements necessary to gain admission to the master programme.</td>
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</table>

Abstract: In the Master thesis students prove their ability to independent, structured and scientific working. The Master thesis is usually carried out in a subject area of Pharmaceutical Sciences as chosen by the student.

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-CHAB.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Second Year

Compulsory and Compensatory Block Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>535-5501-00L</td>
<td>Applied Pharmacology</td>
<td>O</td>
<td>6</td>
<td>7G</td>
<td>P. Wiedemeier, S. Erni, B. Falch, K. Fünfschilling</td>
</tr>
<tr>
<td></td>
<td>Overview of the most important clinical pictures: symptoms, recognition, differentiation, pharmacotherapy for the most important general and special medical indications. Groups of pharmaceutical compounds, active pharmaceutical ingredients, proprietary medicinal products: mechanisms of action, contraindication, therapeutic patterns, side effects, interactions.</td>
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<tr>
<td></td>
<td>Students have a thorough knowledge of all clinical pictures and their symptoms regarding outpatient treatment. They know the main groups of indications including active pharmaceutical self-medication and ingredients, mechanisms of action, pharmacokinetics, pharmacodynamics and dosage. They are also able to identify the relevant side effects and interactions.</td>
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</tbody>
</table>

Content: Pathophysiology of selected clinical pictures and their main symptoms and clinical parameters. Recognition of alarm symptoms and distinction between pharmaceutical self-medication and the need for medical treatment. Detailed coverage of the pharmacotherapy of all fields of indication encountered in outpatient treatment. Outlining of therapeutic strategies and patterns with regard to suitable pharmaceutical compounds, active pharmaceutical ingredients and representative range of proprietary medicinal products. Discussion of the most important mechanisms of action, contraindications, side effects and interactions.

535-5502-00L Pharmaceutical Manufacturing in Small Quantities | O | 3 credits | 3G | J. Fröhlich, H. Hartenberg, C. Meier |

Abstract: Hands-on course in pharmaceutical manufacturing in the pharmacy according to "GMP regulations for small quantities" defined in the pharmacopeia; Design and practical approach in compounding of formulas using the most important dosage forms including their risks and quality assurance.

Objective: Students are able to manufacture, to package, to quality-control and document pharmaceutical compounding on their own, "lege arts" and according to GMP regulations, using the appropriate techniques. They know the most important properties of active ingredients and excipients frequently used. They achieve the necessary knowledge including the relevant literature and other sources of information, as well as the legal requirements regarding pharmaceutical manufacturing in small quantities.

Content: To impart knowledge about the principal techniques and processes in the manufacturing of pharmaceuticals in small quantities (formulas), focusing on the design, manufacturing, quality assurance and risk based self-appraisal including the patient specific dispensing. During the practical training periods: by means of pharmaceutical relevant examples the design, the planning, the manufacturing including the correct use of the equipment, the in-process control, the packaging and the quality assurance are practiced for various dosage forms and recipes. Quality assurance and control are mainly risk adapted considering as well hygiene regulations according to current pharmaceutical practice. The participants will thus improve their general GMP knowledge and skills.

535-5503-00L Institutional Pharmacy | O | 3 credits | 3G | P. Wiedemeier, J. Beney |

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 1124 of 1434
Abstract
Organisation of institutional environments (emergency hospitals), with special focus on the medication process and institutional pharmaceutical care (continuum of care).

Objective
Students understand the concept of continuum of care and its practical implementation. They know the medication process within an institutional environment. They are able to find the necessary information and deal with problems in connection with pharmaceuticals, to evaluate them and to communicate and documentate their findings adequately. They know how a hospital is organised (procedures, possible problems), responsibilities of the different members of the staff and, most importantly, what the function of a hospital pharmacy is.

Content
Principals of the organisation of institutional environments (emergency hospitals), with special focus on medication processes and institutional pharmaceutical care (circulation of medication, continuum of care), Hygiene regulations, medical products, applications, drug formularies, patient files, SOAP notes, kardex study. Participation at interdisciplinary visits, internal trainings and doctors’ reports as well as visitation of the emergency room. Drug interaction, generic substitution, quality management and pharmacovigilance.

535-5504-00L  Basics of Practical Pharmacy  O  6 credits  7G  P. Wiedemeier, S. Erni, B. Falch, K. Füntschilling

Abstract
Introduction to managed care systems (Pharmaceutical Care und Public Health): problems with regard to therapy and approaches to solutions, service, first aid and medicinal products. Methods of illness prevention and health promotion. Important additional assortments including complementary medicine. Law and economy in everyday pharmacy, structures of the national health care system.

Objective
Students know the most important concepts and methods of pharmaceutical care of patients with regard to OTC and Rx-only drugs as well as the essential concepts and methods of public health, prevention and health care. They master the basic rules concerning the pharmaceutical triage and their implications. For the clinical pictures covered during the course, they are able to make therapeutic plans or accompany and optimize doctor’s orders. Students show an adequate understanding of the rights and duties of pharmacists as medical personnel regarding medical care and service within the framework of the Swiss health care system. They are capable of handling important medical products and instructing patients about their use. Students have the necessary basic skills and applications of first aid and emergency medicine. They know the essence, chances and limits with reference to additional assortments, therapeutic options like phytotherapy, complementary medicine, veterinary pharmacy and non-medical methods of healing. Students have the essential knowledge of legal aspects and regulations concerning pharmacists and know the basics of business administration.

Content
Pharmaceutical Care: possibilities of pharmaceutical care of patients regarding OTC and Rx-only drugs in the officinal pharmacy. Good pharmaceutical triage in practical, introduction to the pharmaceutic validation of prescriptions, recognition of medicinal, patient related, therapeutic problems and the finding of solutions: Choice of therapy (OTC), accompanying and optimizing therapies (Rx), compliance, correct administration of drugs, cooperation with other medical professions in the field of outpatient treatment. Traditional and proactive pharmaceutical service.: development of adequate means of documentations of intervention and consultation as well as pharmaceutical follow-up care. Public health: role and possiblities of officinal pharmacies as partners within the Swiss health care system: primary health care, prevention, campaigns, early detection, instruction and mediation, referral to doctors. Needs of customers, patients and employees, and social interaction. Significance of the medical profession (illness, suffering, promotion of health and well-being). Basic training in first aid, emergency medicine and wound care. Medical products: handling of important applications and instruction of patients. Important and additional forms of therapy and assortments: phytotherapy, complementary medicine, veterinary pharmacy, non-medical methods of healing. Economy and law in everyday pharmacy: overview of the Swiss legal system. Relevant legal framework, jurisdiction and regulations and their meaning with regard to quality assurance for practicing pharmacists. Basics of finance and accounting as well as personnel management and insurance matters.

Organisation and competencies of the various partners within the Swiss health care system, focusing on the intermediate position and the role of pharmacists as part of the medical community.

Compensatory Block Courses
All Elective Block Courses of the second year in Master studies are eligible as Compensatory Block Courses. Elective Block courses take place in Spring Semester.

Course Units for Additional Admission Requirements
The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>376-0152-AAL</td>
<td>Anatomy and Physiology I+II</td>
<td>E-</td>
<td>10 credits</td>
<td>21R</td>
<td>C. Spengler, D. P. Wolfer</td>
</tr>
<tr>
<td>406-0603-AAL</td>
<td>Stochastics (Probability and Statistics)</td>
<td>E-</td>
<td>4 credits</td>
<td>9R</td>
<td>M. Kalisch</td>
</tr>
</tbody>
</table>

Abstract
Introduction to basic methods and fundamental concepts of statistics and probability theory for non-mathematicians. The concepts are presented on the basis of some descriptive examples. Learning the statistical program R for applying the acquired concepts will be a central theme.

Objective
The objective of this course is to build a solid fundament in probability and statistics. The student should understand some fundamental concepts and be able to apply these concepts to applications in the real world. Furthermore, the student should have a basic knowledge of the statistical programming language “R”.

Content
From “Statistics for research” (online)
Ch 1: The Role of Statistics
Ch 2: Populations, Samples, and Probability Distributions
Ch 3: Binomial Distributions
Ch 6: Sampling Distribution of Averages
Ch 7: Normal Distributions
Ch 8: Student’s t Distribution
Ch 9: Distributions of Two Variables

From “Introductory Statistics with R (online)”
Ch 1: Basics
Ch 2: The R Environment
Ch 3: Probability and distributions
Ch 4: Descriptive statistics and tables
Ch 5: One- and two-sample tests
Ch 6: Regression and correlation
Knowledge in Pharmaceutical Analytics in order to solve fundamental analytical problems. Handling of the most important pharmacopeial
Introduction to the Basics in Biopharmacy. Pharmacokinetic processes (absorption, distribution, metabolism and excretion, ADME), which
Introduction into fundamentals of laboratory diagnostics and overview of the laboratory parameters concerning inflammation, lipid
S.D. Krämer, U. Kutay, J. Matos, G. Schertler, U. Suter, S. Werner

**551-0103-AAL** Fundamentals of Biology II: Cell Biology  E-  5 credits  11R  E. Hafen, U. Kutay, J. Matos, G. Schertler, U. Suter, S. Werner

**Abstract**
The goal of this course is to provide students with a wide general understanding in cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

**Objective**
The goal of this course is to provide students with a wide general understanding cell biology. With this material as a foundation, students have enough of a cell biological basis to begin their specialization not only in cell biology but also in related fields such as biochemistry, microbiology, pharmacological sciences, molecular biology, and others.

**Content**
The focus is animal cells and the development of multicellular organisms with a clear emphasis on the molecular basis of cellular structures and phenomena. The topics include biological membranes, the cytoskeleton, protein sorting, energy metabolism, cell cycle and division, viruses, extracellular matrix, cell signaling, embryonic development and cancer research.

**Literature**

**535-0135-AAL** Clinical Chemistry I  E-  1 credit  2R  M. Hersberger

**Enrolment only for MSc students who need this course as additional admission requirement.**

**Abstract**
Introduction into fundamentals of laboratory diagnostics and overview of the laboratory parameters concerning inflammation, lipid metabolism, myocardial infarction, diabetes, kidney function, urinary diagnostics, liver function, blood coagulation, blood count, therapeutic drug monitoring and drugs of abuse screening.

**Objective**
Overview of the possibilities and limitations in clinical laboratory diagnostics. Indications and methods of everyday parameters are known.

**Content**
Introduction into medical laboratory diagnostics: immunochemical methods, diagnostics of inflammation, acute myocardial infarction, lipid metabolism, diabetes, kidney function and urinary diagnostics, blood coagulation, blood count, therapeutic drug monitoring, drugs of abuse screening, common diagnostics of liver diseases, point-of-care diagnostics.

**Literature**

**535-0222-AAL** Pharmaceutical Analytics  E-  4 credits  9R  I. A. Werner Kaeslin

**Enrolment only for MSc students who need this course as additional admission requirement.**

**Abstract**
Theoretical and practical comprehension of analytical chemistry in order to solve pharmaceutical problems.

**Objective**
Knowledge in Pharmaceutical Analytics in order to solve fundamental analytical problems. Handling of the most important pharmacopeial texts and monographs.

**Content**
Introduction in Pharmaceutical Analytics. Theoretical and practical considerations concerning a lot of methods in different Pharmacopeias. Identification, purity testing, stability testing, assays of drugs and drug formulations.

**Lecture notes**
A script can be purchased at the HCI-Shop, HCI-Building, D floor.

**Literature**
David G. Watson, Pharmaceutical Analysis, Elsevier.

**535-0241-AAL** Biopharmacy  E-  3 credits  6R  S.D. Krämer

**Enrolment only for MSc students who need this course as additional admission requirement.**

**Abstract**
Introduction to the Basics in Biopharmacy. Pharmacokinetic processes (absorption, distribution, metabolism and excretion, ADME), which determine the fate of a drug in the body. Knowledge of the most important pharmacokinetic parameters. Interpretation of concentration-time-profiles of drugs. Pharmacokinetic profiling of drugs in view of therapy optimization and analysis of interaction potential.

**Objective**
Introduction to the Basics in Biopharmacy. Pharmacokinetic processes (absorption, distribution, metabolism and excretion, ADME), which determine the fate of a drug in the body. Knowledge of the most important pharmacokinetic parameters. Interpretation of concentration-time-profiles of drugs. Pharmacokinetic profiling of drugs in view of therapy optimization and analysis of interaction potential.

**Content**
Introduction to pharmacokinetics; definition of the most important pharmacokinetic parameters and their calculation from clinical data (compartment model, statistical model); kinetics of absorption (absorption profiles); distribution of drugs and role of protein binding; kinetics of elimination: excretion and biotransformation (physiological model); pharmacokinetic profiling of drugs for therapy optimization and for the analysis of the interaction potential; dosage regimen design.

**535-0440-AAL** Quality Management in Pharmaceutical Business  E-  1 credit  2R  A. Sterchi, C. Siegmund

**Enrolment only for MSc students who need this course as additional admission requirement.**
### Abstract
The students know the relevance and the role of quality assurance measures to assure quality, efficacy and safety of drugs. The students know the most important Swiss regulations, including the associated European regulations, which are relevant from a quality assurance point of view and they are able to interpret the content of this regulations.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-0110-AAL</td>
<td>Fundamentals of Biology II: Microbiology</td>
<td>E-</td>
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<td>J. Vorholt-Zambelli</td>
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<tr>
<td>Abstract</td>
<td>Structure, function, genetics of prokaryotic microorganisms and fungi.</td>
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<tr>
<td>Prerequisites</td>
<td>none</td>
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<table>
<thead>
<tr>
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<th>Course Title</th>
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<th>Prerequisites</th>
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</thead>
<tbody>
<tr>
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<td>Fundamentals of Biology II: Plant Biology</td>
<td>E-</td>
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<tr>
<td>Abstract</td>
<td>Water balance, assimilation, transport in plants; developmental biology, stress physiology.</td>
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</tr>
<tr>
<td>Objective</td>
<td>Water balance, assimilation, transport in plants; developmental biology, stress physiology.</td>
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<td></td>
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<tr>
<td>Prerequisites</td>
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<th>Credits</th>
<th>Type</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-1323-AAL</td>
<td>Fundamentals of Biology II: Biochemistry and Molecular Biology</td>
<td>E-</td>
<td>4</td>
<td>R. Glockshuber, N. Ban, K. Locher, E. Weber-Ban</td>
</tr>
<tr>
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<td>Enrolment only for MSc students who need this course as additional admission requirement.</td>
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<tr>
<td>Abstract</td>
<td>The course provides an introduction to Biochemistry / Molecular Biology with some emphasis on chemical and biophysical aspects.</td>
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<tr>
<td>Objective</td>
<td>Topics include the structure-function relationship of proteins / nucleic acids, protein folding, enzymatic catalysis, cellular pathways involved in bioenergetics and the biosynthesis and breakdown of amino acids, glycans, nucleotides, fatty acids and phospholipids, and steroids. There will also be a discussion of DNA replication and repair, transcription, and translation.</td>
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</tbody>
</table>

### Pharmaceutical Sciences Master - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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### Key for Hours

<table>
<thead>
<tr>
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<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

### ECTS

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>ECTs</td>
<td>European Credit Transfer and Accumulation System</td>
</tr>
</tbody>
</table>

Special students and auditors need special permission from the lecturers.
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

**Abstract**
Research colloquium

**Prerequisites / notice**
Occasionally, talks may be delivered in German.

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### Physics (General Courses) - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

### Key for Hours

<table>
<thead>
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</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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</tr>
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<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

### ECTS

- European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
# Bachelor of Physics

## First Year

### First Year Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-1261-07L</td>
<td>Analysis I</td>
<td>O</td>
<td>10 credits</td>
<td>6V+3U</td>
<td>H. Knörrer</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>Introduction to the differential and integral calculus in one real variable: fundamentals of mathematical thinking, numbers, sequences, basic point set topology, continuity, differentiable functions, ordinary differential equations, Riemann integration.</td>
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<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>The ability to work with the basics of calculus in a mathematically rigorous way.</td>
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<tr>
<td></td>
<td><strong>Lecture notes</strong></td>
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<tr>
<td></td>
<td><strong>Literature</strong></td>
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<tr>
<td></td>
<td>K. Koenigsberger: Analysis I, Springer-Verlag</td>
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<tr>
<td></td>
<td>D. Courant: Introduction to Calculus and Analysis, Sproinger Verlag</td>
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<tr>
<td></td>
<td>V. Zorich: Mathematical Analysis I, Springer Verlag 2009</td>
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<tr>
<td></td>
<td>H. Heuser: Lehrbuch der Analysis. Teubner Verlag</td>
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<tr>
<td></td>
<td>W. Walter: Analysis I, Springer Verlag</td>
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<tr>
<td></td>
<td>O. Forster: Analysis I, Vieweg Verlag</td>
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<tr>
<td></td>
<td>J.Appell: Analysis in Beispielen und Gegenbeispielen. Springer Verlag <a href="http://www.springerlink.com/content/q67803/?p=091fa376ade4cbbf2b2145fe2cee40&amp;pi=4">http://www.springerlink.com/content/q67803/?p=091fa376ade4cbbf2b2145fe2cee40&amp;pi=4</a></td>
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<tbody>
<tr>
<td>401-1151-00L</td>
<td>Linear Algebra I</td>
<td>O</td>
<td>7 credits</td>
<td>4V+2U</td>
<td>E. Kowalski</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>Introduction to the theory of vector spaces for mathematicians and physicists including solutions of linear equations, linear transformations, determinants, eigenvalues and eigenvectors, bilinear forms, canonical forms for matrices, and selected applications, part I.</td>
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<tr>
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<td><strong>Objective</strong></td>
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</tr>
<tr>
<td></td>
<td>Mastering basic concepts of Linear Algebra</td>
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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>402-1701-00L</td>
<td>Physics I</td>
<td>O</td>
<td>7 credits</td>
<td>4V+2U</td>
<td>G. Dissertori</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>This course gives a first introduction to Physics. The emphasis is on classical mechanics, together with an introduction to thermodynamics.</td>
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<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>Acquire knowledge of the basic principles regarding the physics of classical mechanics and thermodynamics. Skills in solving physics problems.</td>
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<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>252-0847-00L</td>
<td>Computer Science</td>
<td>O</td>
<td>5 credits</td>
<td>2V+2U</td>
<td>B. Gärtner</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>This lecture is an introduction to programming based on the language C++. We cover fundamental types, control statements, functions, arrays, and classes. The concepts will be motivated and illustrated through algorithms and applications.</td>
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<tr>
<td></td>
<td><strong>Objective</strong></td>
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</tr>
<tr>
<td></td>
<td>The goal of this lecture is an algorithmically oriented introduction to programming.</td>
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<tr>
<td></td>
<td><strong>Content</strong></td>
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</tr>
<tr>
<td></td>
<td>This lecture is an introduction to programming based on the language C++. We cover fundamental types, control statements, functions, arrays, and classes. The concepts will be motivated and illustrated through algorithms and applications.</td>
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<tr>
<td></td>
<td><strong>Lecture notes</strong></td>
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<tr>
<td></td>
<td>Lecture notes in English and Handouts in German will be distributed electronically along with the course.</td>
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<tr>
<td></td>
<td><strong>Literature</strong></td>
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## Second Year

### Second Year Compulsory Courses

#### Examination Block I

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<tbody>
<tr>
<td>401-2303-00L</td>
<td>Complex Analysis</td>
<td>O</td>
<td>6 credits</td>
<td>3V+2U</td>
<td>R. Pandharipande</td>
</tr>
<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<tr>
<td></td>
<td>Complex functions of one variable, Cauchy-Riemann equations, Cauchy theorem and integral formula, singularities, residue theorem, index of closed curves, analytic continuation, special functions, Riemann mapping theorem.</td>
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<tr>
<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>Working Knowledge with functions of one complex variables; in particular applications of the residue theorem</td>
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<tr>
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<td><strong>Literature</strong></td>
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<tr>
<td></td>
<td>Th. Gamelin: Complex Analysis, Springer 2001</td>
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<tr>
<td></td>
<td>E. Titchmarsh: The Theory of Functions, Oxford University Press</td>
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<td></td>
<td>D. Salamon: &quot;Funktionentheorie&quot;. Birkhauser, 2011. (In German)</td>
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<td></td>
<td>R. Remmert: Theory of Complex Functions. Springer Verlag</td>
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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-2333-00L</td>
<td>Methods of Mathematical Physics I</td>
<td>O</td>
<td>6 credits</td>
<td>3V+2U</td>
<td>G. Felder</td>
</tr>
</tbody>
</table>

Data: 06.02.2019 13:00  
Autumn Semester 2015  
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**402-2883-00L**

**Abstract**

Introductory course on quantum and atomic physics including optics and statistical physics.

**Objective**

A basic introduction to quantum and atomic physics, including basics of optics and equilibrium statistical physics. The course will focus on the relation of these topics to experimental methods and observations.

**Content**

Evidence for Quantum Mechanics: atoms, photons, photo-electric effect, Rutherford scattering, Compton scattering, de-Broglie waves.

Quantum mechanics: wavefunctions, operators, Schrodinger's equation, infinite and finite square well potentials, harmonic oscillator, hydrogen atoms, spin.

Atomic structure: Perturbation to basic structure, including Zeeman effect, spin-orbit coupling, many-electron atoms. X-ray spectra, optical selection rules, emission and absorption of radiation, including lasers.

Optics: Fermat’s principle, lenses, imaging systems, diffraction, interference, relation between geometrical and wave descriptions, interferometers, spectrometers.

Statistical mechanics: probability distributions, micro and macrostates, Boltzmann distribution, ensembles, equipartition theorem, blackbody spectrum, including Planck distribution

**Lecture notes**

Lecture notes will be provided electronically during the course.

**Literature**


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**Examination Block II**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>402-2203-01L</td>
<td>Classical Mechanics</td>
<td>O</td>
<td>7</td>
<td>4V+2U</td>
<td>A. Wallraff</td>
</tr>
</tbody>
</table>

**Abstract**

A conceptual introduction to theoretical physics: Newtonian mechanics, central force problem, oscillations, Lagrangian mechanics, symmetries and conservation laws, spinning top, relativistic space-time structure, particles in an electromagnetic field, Hamiltonian mechanics, canonical transformations, integrable systems, Hamilton-Jacobi equation.

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**Third Year Compulsory Courses**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>402-0205-00L</td>
<td>Quantum Mechanics I</td>
<td>O</td>
<td>10</td>
<td>3V+2U</td>
<td>3.0</td>
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</tbody>
</table>

**Abstract**

Introduction to non-relativistic single-particle quantum mechanics. In particular, the basic concepts of quantum mechanics, such as the quantization of classical systems, wave functions and the description of observables as operators on a Hilbert space, and the formulation of symmetries will be discussed. Basic phenomena will be analyzed and illustrated by generic examples.

**Objective**

Introduction to single-particle quantum mechanics. Familiarity with basic ideas and concepts (quantization, operator formalism, Dirac-notation, symmetries, perturbation theory) and generic examples and applications (bound states, tunneling, scattering states, in one- and three-dimensional settings). Ability to solve simple problems.

**Content**

Keywords: Schrödinger equation, basic formalism of quantum mechanics (states, operators, commutators, measuring process), symmetries (translations, rotations), quantum mechanics in one dimension, spherically symmetric problems in three dimensions, scattering theory, density matrices, Schrödinger-, Heisenberg-, Dirac-pictures, time reversal, perturbation theory, variational techniques, spin, addition of angular momenta, relation between QM and classical physics.

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**Core Courses**

**Core Courses in Experimental Physics**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>402-0263-00L</td>
<td>Astrophysics I</td>
<td>W</td>
<td>10</td>
<td>3V+2U</td>
<td>A. Refregier</td>
</tr>
</tbody>
</table>

**Abstract**

This introductory course will develop basic concepts in astrophysics as applied to the understanding of the physics of planets, stars, galaxies, and the Universe.

**Objective**

The course provides an overview of fundamental concepts and physical processes in astrophysics with the dual goals of: i) illustrating physical principles through a variety of astrophysical applications; and ii) providing an overview of research topics in astrophysics.

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**Core Courses in Theoretical Physics**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>402-0205-00L</td>
<td>Quantum Mechanics I</td>
<td>W</td>
<td>10</td>
<td>3V+2U</td>
<td>3.0</td>
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</tbody>
</table>

**Abstract**

The course provides an introduction to solid state physics, covering several topics that are later discussed in more detail in other specialized lectures. The central topics are: solids and their lattice structures; interatomic bindings; lattice dynamics, electronic properties of insulators, metals, semiconductors, transport properties, magnetism, superconductivity.

**Objective**

Introduction to Solid State Physics.

**Content**

The course provides an introduction to solid state physics, covering several topics that are later discussed in more detail in other more specialized lectures. The central topics are: solids and their lattice structures; interatomic bindings; lattice dynamics, thermal properties of insulators; metals (classical and quantum mechanical description of electronic states, thermal and transport properties of metals); semiconductors (bandstructure and n/p-type doping); magnetism, superconductivity.

**Lecture notes**

A Manuscript is distributed.

**Literature**

Ibach & Lüth, Festkörperphysik
C. Kittel, Festkörperphysik
Ashcroft & Mermin, Festkörperphysik
W. Känzig, kondensierte Materie

**Prerequisites / notice**

Voraussetzungen: Physik I, II, III wünschenswert

---
Abstract
Introduction to non-relativistic single-particle quantum mechanics. In particular, the basic concepts of quantum mechanics, such as the
quantisation of classical systems, wave functions and the description of observables as operators on a Hilbert space, and the formulation of
symmetries will be discussed. Basic phenomena will be analysed and illustrated by generic examples.

Objective
Introduction to single-particle quantum mechanics. Familiarity with basic ideas and concepts (quantisation, operator formalism, Dirac-
notation, symmetries, perturbation theory) and generic examples and applications (bound states, tunneling, scattering states, in one- and
three-dimensional settings). Ability to solve simple problems.

Content
Keywords: Schrödinger equation, basic formalism of quantum mechanics (states, operators, commutators, measuring process),
symmetries (translations, rotations), quantum mechanics in one dimension, spherically symmetric problems in three dimensions, scattering
theory, density matrices, Schrödinger-, Heisenberg-, Dirac-pictures, time reversal, perturbation theory, variational techniques, spin, addition
of angular momenta, relation between QM and classical physics.

Lecture notes
Deutsch

▶ Practical Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>402-0000-01L</td>
<td>Physics Lab I</td>
<td>O</td>
<td>4 credits</td>
<td>4P</td>
<td>A. Biland, B. Schönfeld</td>
</tr>
<tr>
<td>402-0241-00L</td>
<td>Advanced Physics Laboratory I</td>
<td>O</td>
<td>9 credits</td>
<td>18P</td>
<td>C. Grab, T. M. Ihn</td>
</tr>
<tr>
<td>402-0240-00L</td>
<td>Advanced Physics Laboratory II</td>
<td>W</td>
<td>9 credits</td>
<td>18P</td>
<td>C. Grab, T. M. Ihn</td>
</tr>
</tbody>
</table>

Abstract
This laboratory course provides basic training of experimental skills. These are experimental design, implementation, measurement, data
analysis and interpretation, as well as error analysis. Written manuals for the individual experiments are available.

Objectives
- Vertiefung der Kenntnisse in Teilbereichen der Elementarphysik.
- die korrekte Auswertung und Beurteilung der Beobachtungen
- der Einsatz von und der Umgang mit Messinstrumenten
- Vertiefung der Kenntnisse in Teilbereichen der Elementarphysik.

Lecture notes
Anleitung zum Physikalischen Praktikum
Versuche (mit Fehlerrechnung) zu Themen aus den Bereichen der Mechanik, Optik, Wärme, Elektrizität und Kernphysik
Aus einer Liste von 33 Versuchen müssen 9 Versuche in Zweiergruppen durchgeführt werden.
Zu Beginn findet eine Einführungsveranstaltung statt.

Proseminars, Experimental and Theoretical Semester Papers

To organise a semester project take contact with one of the instructors.

Not all lecturers are directly eligible in myStudies if "Professors" is the required type of lecturers. In such cases please take contact with the Study

▶ Proseminars, Experimental and Theoretical Semester Papers

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Lecturers</th>
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<tr>
<td>402-0210-95L</td>
<td>Proseminar Theoretical Physics: Particle Physics at the Energy Frontier</td>
<td>W</td>
<td>9 credits</td>
<td>4S</td>
<td>A. Lazopoulos</td>
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<tr>
<td>402-0215-BSL</td>
<td>Experimental Semester Project in a Group of the Physics Department</td>
<td>W</td>
<td>9 credits</td>
<td>18A</td>
<td>Professors</td>
</tr>
<tr>
<td>402-0510-BSL</td>
<td>Advanced Solid State Physics Experiments</td>
<td>W</td>
<td>9 credits</td>
<td>18P</td>
<td>Supervisors</td>
</tr>
</tbody>
</table>

Abstract
This course unit is an alternative if no suitable "Proseminar Theoretical Physics" is available of if the proseminar is already overbooked.
Die Leistungskontrolle erfolgt aufgrund eines oder mehrerer schriftlicher Berichte bzw. einer schriftlichen Arbeit. Vorträge können ein zusätzlicher Bestandteil der Leistungskontrolle sein.

Prerequisites / notice
Die Leistungskontrolle erfolgt aufgrund eines oder mehrerer schriftlicher Berichte bzw. einer schriftlichen Arbeit.

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 1131 of 1434
Abstract
Experiments in condensed matter physics. The work includes the planning, build-up, data taking and analysis, and interpretation of the experimental results.

Objective

Content

Prerequisites /
notice
Arbeiten in einer Forschungsgruppe sind besonders gut geeignet, die Studierenden mit aktuellen Forschungsthemen und mit moderner Instrumentierung bekannt zu machen.
Abstract
Im Mittelpunkt dieser Vorlesung steht die euklidische und die projektive Geometrie.

Objective

Content

Literature
Robin Hartshorne: "Geometry: Euclid and beyond", Springer Verlag
Eric Lord: "Symmetry and Pattern in Projective Geometry", Springer Verlag

Visibility
401-1511-00L

Geometry
Z
3 credits
2V+1U
L. Halbeisen

Additional Courses (from Second Year Mathematics Bachelor)

Number
Title
Type
ECTS
Hours
Lecturers
401-2003-00L
Algebra I
Z
7 credits
4V+2U
R. Pink

Abstract
Introduction and development of some basic algebraic structures - groups, rings, fields.

Objective
Introduction to basic notions and results of group, ring and field theory.

Content
Basic notions and examples of groups;
Subgroups, Quotient groups and Homomorphisms,
Group actions and applications

Basic notions and examples of rings;
Ring Homomorphisms,
ideals, and quotient rings, rings of fractions
Euclidean domains, Principal ideal domains, Unique factorization domains

Basic notions and examples of fields;
Field extensions, Algebraic extensions, Classical straight edge and compass constructions

Literature
G. Fischer: Lehrbuch der Algebra, Vieweg Verlag
Karpfinger-Meyberg: Algebra, Spektrum Verlag
S. Bosch: Algebra, Springer Verlag
B.L. van der Waerden: Algebra I und II, Springer Verlag
S. Lang, Algebra, Springer Verlag
A. Knapp: Basic Algebra, Springer Verlag
G. Fischer: Lehrbuch der Algebra, Vieweg Verlag
Karpfinger-Meyberg: Algebra, Spektrum Verlag
S. Bosch: Algebra, Springer Verlag
B.L. van der Waerden: Algebra I und II, Springer Verlag
S. Lang, Algebra, Springer Verlag
A. Knapp: Basic Algebra, Springer Verlag

Seminars and Colloquia

Number
Title
Type
ECTS
Hours
Lecturers
402-0101-00L
The Zurich Physics Colloquium
E-
0 credits
1K

Abstract
Research colloquium

Prerequisites / notice
Occasionally, talks may be delivered in German.

402-0800-00L
The Zurich Theoretical Physics Colloquium
E-
0 credits
1K

Abstract
Research colloquium

Objective
The Zurich Theoretical Physics Colloquium is jointly organized by the University of Zurich and ETH Zurich. Its mission is to bring both students and faculty with diverse interests in theoretical physics together. Leading experts explain the basic questions in their field of research and communicate the fascination for their work.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-5330-00L</td>
<td>Talks in Mathematical Physics</td>
<td>E-0</td>
<td>1K</td>
<td>A. Cattaneo, G. Felder, M. Gaberdiel, G. M. Graf, K. Knörrer, T. H. Willwacher, University lecturers</td>
</tr>
<tr>
<td>402-0501-00L</td>
<td>Solid State Physics</td>
<td>E-0</td>
<td>1S</td>
<td>B. Batlogg, G. Blatter, C. Degen, K. Ensslin, D. Pescia, M. Sigrist, A. Wallraff, A. Zheludev</td>
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<td>402-0600-00L</td>
<td>Nuclear and Particle Physics with Applications</td>
<td>E-0</td>
<td>2S</td>
<td>A. Rubbia, G. Dissertori, C. Grab, K. S. Kirch, F. Pauss, R. Wallny</td>
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<tr>
<td>402-0893-00L</td>
<td>Particle Physics Seminar</td>
<td>E-0</td>
<td>1S</td>
<td>T. K. Gehrmann</td>
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<tr>
<td>402-0700-00L</td>
<td>Seminar in Elementary Particle Physics</td>
<td>E-0</td>
<td>1S</td>
<td>M. Spira</td>
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<td>402-0746-00L</td>
<td>Seminar: Particle and Astrophysics</td>
<td>E-0</td>
<td>2S</td>
<td>P. Jetzer, C. Grab, University lecturers</td>
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<tr>
<td>402-0530-00L</td>
<td>Mesoscopic Systems</td>
<td>E-0</td>
<td>1S</td>
<td>T. M. Ihn</td>
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<tr>
<td>227-0980-00L</td>
<td>Seminar on Biomedical Magnetic Resonance</td>
<td>E-0</td>
<td>2K</td>
<td>K. P. Prüssmann, S. Kozerke, M. Rudin</td>
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<tr>
<td>227-1043-00L</td>
<td>Neuroinformatics - Colloquia</td>
<td>E-0</td>
<td>1K</td>
<td>S.C. Liu, R. Hahnloser, V. Mante, K. A. Martin</td>
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<tr>
<td>227-1044-00L</td>
<td>Auditory Informatics</td>
<td>E-2</td>
<td>1S</td>
<td>R. Stoop</td>
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<tr>
<td>402-0396-00L</td>
<td>Recent Research Highlights in Astrophysics</td>
<td>E-0</td>
<td>1S</td>
<td>University lecturers</td>
</tr>
</tbody>
</table>

**Abstract**

Occasionally, talks may be delivered in German.

**Prerequisites / notice**

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

**Objective**

- keep other members of the institute oriented on current research
- test new ideas within the institute before going outside
- train students to give scientific talks
<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>402-0911-00L</td>
<td>Programming Techniques for Scientific Simulations I</td>
<td>W</td>
<td>5</td>
<td>4G</td>
<td>M. Troyer</td>
</tr>
<tr>
<td>Abstract</td>
<td>This lecture provides an overview of programming techniques for scientific simulations. The focus is on advanced C++ programming techniques and scientific software libraries. Based on an overview over the hardware components of PCs and supercomputer, optimization methods for scientific simulation codes are explained.</td>
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| 402-0713-00L | Astro-Particle Physics I                       | W    | 6    | 2V+1U | A. Biland  |
| Abstract    | This lecture gives an overview of the present research in the field of Astro-Particle Physics, including the different experimental techniques. In the first semester, main topics are the charged cosmic rays including the antimatter problem. The second semester focuses on the neutral components of the cosmic rays as well as on some aspects of Dark Matter. |
| Objective   | Successful students know:                      |      |      |       |            |
|             | - experimental methods to measure cosmic ray particles over full energy range |
|             | - current knowledge about the composition of cosmic ray |
|             | - possible cosmic acceleration mechanisms     |
|             | - correlation between astronomical object classes and cosmic accelerators |
|             | - information about our galaxy and cosmology gained from observations of cosmic ray |

| 402-0737-00L | Energy and Environment in the 21st Century (Part I) | W    | 6    | 2V+1U | M. Dittmar |
| Abstract    | The energy and related environmental problems, the physics principles of using energy and the various real and hypothetical options are discussed from a physicist point of view. The lecture is intended for students of all ages with an interest in a rational approach to the energy problem of the 21st century. |
| Objective   | Scientists and especially physicists are often confronted with questions related to the problems of energy and the environment. The lecture tries to address the physical principles of today's and tomorrow energy use and the resulting global consequences for the world climate. |
|             | The lecture is for students which are interested participate in a rational and responsible debate about the energy problem of the 21st century. |
| Content     | Introduction: energy types, energy carriers, energy density and energy usage. How much energy does a human need/uses? |
|             | Energy conservation and the first and second law of thermodynamics |
|             | Fossil fuels (our stored energy resources) and their use. |
|             | Burning fossil fuels and the physics of the greenhouse effect. |
|             | Physics basics of nuclear fission and fusion energy |
|             | Controlled nuclear fission energy, the different types of nuclear power plants, uranium requirements and resources, natural and artificial radioactivity and the related waste problems from the nuclear fuel cycle. |
|             | Nuclear reactor accidents and the consequences, a comparison with risks from other energy using methods. |
|             | The problems with nuclear fusion and the ITER project. |
|             | Nuclear fusion and fission: "exotic" ideas. |
|             | Hydrogen as an energy carrier: ideas and limits of a hydrogen economy. |
|             | New clean renewable energy sources and their physical limits (wind, solar, geothermal etc) |
|             | Energy perspectives for the next 100 years and some final remarks. |

| Lecture notes | many more details (in English and German) here: http://ihp-ix2.ethz.ch/energy21/ |
Science promised us truth, or at least a knowledge of such relations as our intelligence can seize: it never promised us peace or happiness.

Gustave Le Bon

Physicists learned to realize that whether they like a theory or they don't like a theory is not the essential question. Rather, it's whether or not the theory gives predictions that agree with experiment.

Richard Feynman, 1985

The goal of this course is to introduce the foundations of quantum information theory. It starts with a brief introduction to the mathematical theory of information and then discusses the basic information-theoretic aspects of quantum mechanics. Further topics include applications such as quantum cryptography and quantum computing.

R. Renner

The course gives an insight into the notion of information and its relevance to physics and, in particular, quantum mechanics. It also serves as a preparation for further courses in the area of quantum information sciences.

R. Chitra

Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can be involved, including physics, maths, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enchantments and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions.

M. Pfeiffer

The course provides an introduction to superconductivity, covering both experimental as well as theoretical aspects. The following subtopics are discussed: occurrence of superconductivity, basic phenomena, thermodynamics, electrodynamics, London equation, Pippard theory, Ginzburg-Landau theory and -equations, flux quantization, magnetic properties of type I and II superconductors, BCS theory, tunnel effects with superconductors, Josephson effects, superconducting quantum interference devices (SQUID), introduction to high-Tc superconductivity.

R. Chitra

Introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.

K. A. Martin

The preceding attendance of the scheduled lecture courses Introduction to Solid State Physics and Quantum Mechanics I are expected.

A. A. Abrikosov “Fundamentals of the Theory of Metals”

P. G. de Gennes “Superconductivity Of Metals And Alloys”

M. Tinkham “Introduction to Superconductivity”

Topics: occurrence of superconductivity, basic phenomena, thermodynamics, electrodynamics, London equation, Pippard theory, Ginzburg-Landau theory and -equations, flux quantization, magnetic properties of type I and II superconductors, BCS theory, tunnel effects with superconductors, Josephson effects, superconducting quantum interference devices (SQUID), short introduction to high-Tc superconductivity.

M. Tinkham

The lecture series is motivated by an overview covering the skin of the crystals, roughness analysis, contact angle measurements, protein absorption/activity and monocyte behaviour.

B. K. R. Müller

As the first step, real structures on clean surfaces including surface reconstructions and surface relaxations, defects in crystals are presented, before the preparation of clean metallic, semiconducting, oxidic and organic surfaces are introduced.

As the atomic processes on surfaces are activated by the increase of the substrate temperature. They can be studied using scanning tunneling microscopy (STM) and atomic force microscopy (AFM). The combination with molecular beam epitaxy (MBE) allows determining the sizes of the critical nuclei and the other activated processes in a hierarchical fashion. The evolution of the surface morphology is characterized by the density and size distribution of the nanostructures that could be quantified by means of the rate equation analysis, the mean-field nucleation theory, as well as the scaling theory. The surface morphology is further characterized by defects and nanostructure's shapes, which are based on the strain relieving mechanisms and kinetic growth processes.

High-resolution electron diffraction is complementary to scanning probe techniques and provides exact mean values. Some phenomena are quantitatively described by the kinematic theory and perfectly understood by means of the Ewald construction. Other phenomena need to be described by the more complex dynamical theory. Electron diffraction is not only associated with elastic scattering but also inelastic excitation mechanisms that reflect the electronic structure of the surfaces studied. Low-energy electrons lead to phonon and high-energy electrons to plasmon excitations. Both effects are perfectly described by dipole and impact scattering.

Thin-films of rather complex organic materials are often quanitatively characterized by photons with a broad range of wavelengths from ultra-violet to infra-red light. Asymmetries and preferential orientations of the (anisotropic) molecules are verified using the optical dichroism and second harmonic generation measurements. These characterization vital for optimizing the preparation of medical implants and the determination of tissue's anisotropies within the human body.

Cell-surface interactions are related to the cell adhesion and the contractile cellular forces. Physical means have been developed to quantify these interactions. Other physical techniques are introduced in cell biology, namely to count and sort cells, to study cell proliferation and metabolism and to determine the relation between cell morphology and function.

3D scaffolds are important for tissue augmentation and engineering. Design, preparation methods, and characterization of these highly porous 3D microstructures are also presented.

Visiting clinical research in a leading university hospital will show the usefulness of the lecture series.

K. A. Martin, M. Cook, V. Mante, M. Pfeiffer

The lecture course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.

Richard Feynman, 1985

Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monocultures of physics, maths, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enchantments and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions.
This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.

401-3531-00L  Differential Geometry I  W  10 credits  4V+1U  M. Burger

Abstract  This course is an introduction to differential and riemannian geometry.

Objective  The aim is to lead students from a reasonable knowledge of advanced calculus, basic knowledge of general topology and solid knowledge of linear algebra to fundamental knowledge of differentiable manifolds and their basic tools. Riemannian geometry, some basic Lie theory, and de Rham cohomology will be developed as applications.

Literature  W. Boothby “An introduction to differentiable manifolds and Riemannian geometry”

J.M. Lee “Introduction to smooth manifolds”

M.P. Do Carmo “Riemannian Geometry”

401-3461-00L  Functional Analysis I  W  10 credits  4V+1U  D. A. Salamon

Abstract  Baire category; Banach and Hilbert spaces, bounded linear operators; Three Fundamental Principles: Uniform Boundedness, Open Mapping/Closed Graph, Hahn-Banach; Convexity; Dual Spaces: weak and weak* topologies, Banach-Alaoglu, reflexive spaces; Ergodic Theorem; compact operators and Fredholm theory, Closed Image Theorem; Spectral theory, self-adjoint operators.

Lecture notes  Lecture Notes on “Functional Analysis” by D.A. Salamon

401-3601-00L  Probability Theory  W  10 credits  4V+1U  A.S. Sznitman

Abstract  Basics of probability theory and the theory of stochastic processes in discrete time

Objective  This course presents the basics of probability theory and the theory of stochastic processes in discrete time. The following topics are planned:

Basics in measure theory, random series, law of large numbers, weak convergence, characteristic functions, central limit theorem, conditional expectation, martingales, convergence theorems for martingales, Galton Watson chain, transition probability, Theorem of Ionescu Tulcea, Markov chains.

Content  This course presents the basics of probability theory and the theory of stochastic processes in discrete time. The following topics are planned:

Basics in measure theory, random series, law of large numbers, weak convergence, characteristic functions, central limit theorem, conditional expectation, martingales, convergence theorems for martingales, Galton Watson chain, transition probability, Theorem of Ionescu Tulcea, Markov chains.

Lecture notes  available, will be sold in the course


H. Bauer, Probability Theory, de Gruyter 1996

J. Jacod and P. Protter, Probability essentials, Springer 2004

A. Klenke, Wahrscheinlichkeitstheorie, Springer 2006

D. Williams, Probability with martingales, Cambridge University Press 1991

401-3621-00L  Fundamentals of Mathematical Statistics  W  10 credits  4V+1U  S. van de Geer

Abstract  The course covers the basics of inferential statistics.

Physics Bachelor - Key for Type

<table>
<thead>
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Key for Hours

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<tr>
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<td>revision course / private study</td>
</tr>
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ECTS  European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Educational Science

General course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
851-0242-06L | Cognitively Activating Instructions in MINT Subjects | W | 2 credits | 2S | R. Schumacher

Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).

- Number of participants limited to 30.
- This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

Abstract
This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.

Objective
- Get to know cognitively activating instructions in MINT subjects
- Get information about recent literature on learning and instruction

Prerequisites / notice
Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin ersucht.

851-0242-07L | Human Intelligence | W | 1 credit | 1S | E. Stern, P. Edelsbrunner, B. Rütsche

Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).

- Number of participants limited to 30.
- This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

Abstract
The focus will be on the book "Intelligenz: Grosse Unterschiede und ihre Folgen" by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.

Objective
- Understanding of research methods used in the empirical human sciences
- Getting to know intelligence tests
- Understanding findings relevant for education

851-0242-08L | Research Methods in Educational Science | W | 1 credit | 1S | P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler

Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).

- Number of participants limited to 30.
- This course unit can only be enrolled after successful participation in, or during enrollment in the course "Human Learning (EW 1)".

Abstract
Literature from the learning sciences is critically discussed with a focus on research methods. At the first meeting, working groups will be assembled and two further meetings will be set up. In the small groups students will write critical essays about the read literature. At the third meeting, we will discuss the essays and develop research questions in group work.

Objective
- Understand research methods used in the empirical educational sciences
- Understand and critically examine information from scientific journals and media
- Understand pedagogically relevant findings from the empirical educational sciences

see Educational Science TC

Subject Didactics and Professional Training

Number | Title | Type | ECTS | Hours | Lecturers
--- | --- | --- | --- | --- | ---
402-0910-00L | Physics Didactics I: Special Didactics of Physics Teaching | O | 4 credits | 3G | M. Mohr

Limited number of participants.
Further information is available from the lecturer via email: mamohr@ethz.ch

Simultaneous enrolment in Introductory Internship Physics - course 402-0920-00L - is compulsory for Teaching Diploma Physic

Objective
Die Studierenden verfügen über fachdidaktisches Grundwissen für den Physikunterricht an einer Mittelschule. Sie können eigene Lektionen unter Berücksichtigung der vielfältigen Rahmenbedingungen planen, durchführen und evaluieren. Sie reflektieren ihren Unterricht und sind bestrebt, ihn didaktisch und pädagogisch weiter zu entwickeln.

Die Studierenden kennen die Einsatzmöglichkeiten, Chancen und Schwierigkeiten verschiedener Unterrichtsmethoden und Hilfsmittel. Sie können die Eignung von Unterrichtsformen im Hinblick auf eine Lernsituation beurteilen. Sie bemühen sich in ihrem Unterricht, geeignete Methoden und Medien angepasst an die Klasse und das Thema einzusetzen.

In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

The topics of the mentored work are mostly chosen from the high school curriculum.

Methods
With the help of the mentor the students individually work on a topic and write a thesis about it.
Content

Introduction: energy types, energy carriers, energy density and energy usage. How much energy does a human needs/uses?

Energy conservation and the first and second law of thermodynamics

Fossile fuels (our stored energy resources) and their use.

Burning fossile fuels and the physics of the greenhouse effect.

Physics basics of nuclear fission and fusion energy

Controlled nuclear fission energy today, the different types of nuclear power plants, uranium requirements and resources, natural and artificial radioactivity and the related waste problems from the nuclear fuel cycle.

Nuclear reactor accidents and the consequences, a comparison with risks from other energy using methods.

The problems with nuclear fusion and the ITER project.

Nuclear fusion and fission: "exotic" ideas.

Hydrogen as an energy carrier: ideas and limits of a hydrogen economy.

New clean renewable energy sources and their physical limits (wind, solar, geothermal etc)

Energy perspectives for the next 100 years and some final remarks

Lecture notes

many more details (in english and german) here:

http://ihp-ix2.ethz.ch/energy21/

Literature


Environmental Physics: Boeker and Egbert New York Wiley 1999

Prerequisites / notice

Science promised us truth, or at least a knowledge of such relations as our intelligence can seize:

it never promised us peace or happiness

Gustave Le Bon

Physicists learned to realize that whether they like a theory or they don't like a theory is not the essential question.

Rather, it's whether or not the theory gives predictions that agree with experiment.

Richard Feynman, 1985

402-0922-00L Mentored Work Specialised Courses in Physics with an Educational Focus A

Mentored Work Specialised Courses in the Respective Subject with an Educational Focus in Physics for TC and Teaching Diploma.

Abstract

In the mentored work on their subject specialisation, students link high-school and university aspects of the subject, thus strengthening their teaching competence with regard to curriculum decisions and the future development of the tuition. They compile texts under supervision that are directly comprehensible to the targeted readers - generally specialist-subject teachers at high-school level.

Objective

Practice in the explanation of complex topics in physics as the core competence of the teaching profession

Content

Improvement of the physics education by providing attractive recent topics with regard to future curricular decisions and the public view of physics

Choice of topic by individual arrangement

402-0944-00L Science in School (Current Topics for the Classroom)

Enrolment in Physics Didactics I (402-0910-00L) and Physics Didactics II (402-0910-00L) is mandatory.

Content

Kennenlernen und erarbeiten (Übungen) von Unterrichtsssequenzen zu modernen Themen der Physik.

Lecture notes

Unterlagen werden verteilt.

Literature

Wird angegeben.

Prerequisites / notice


Physics TC - Key for Type

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<th>Type</th>
<th>Description</th>
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### Key for Hours

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<tr>
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**ECTS**

- European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
Literature from the learning sciences is critically discussed with a focus on research methods. The focus will be on the book “Intelligenz: Grosse Unterschiede und ihre Folgen” by Stern and Neubauer. Participation at the first meeting in teams of two, participants in this seminar conduct their own research project. Each team is advised by one of the researchers serving as lecturers, P. Edelsbrunner, S. Hofer, B. Rütsche, L. Schalk, E. Stern, E. Ziegler.

Student Research Projects: Practical Research on Learning and Instruction

Number of participants limited to 20.

The successful completion of both course no. 851-0240-00L "Menschliches Lernen (EW 1)" and course no. 851-0239-01L "Unterstützung und Diagnose von Wissenserwerbsprozessen (EW 3)" is a necessary prerequisite for this course.

In teams of two, participants in this seminar conduct their own research project. Each team is advised by one of the researchers serving as lecturers in this course. Basic conceptual and methodological issues are the topic of a series of plenary meetings; however, the major part of the work is done in small-group meetings with the advising researcher, and in self-directed research projects.

The course is targeted at advanced students who have taken an interest in gathering practical research experience in the field of Learning & Instruction. In teams of two, students conduct their own research projects (planning, conducting, analyzing, interpreting, and presenting research); thus, the course requires a high amount of self-directed working. Students are personally advised, and supported in their research project, by one of the researchers serving as lecturers in this course. During the first half the semester, relevant methodological knowledge and skills are practiced during plenary meetings and in students’ independent reading (e.g. generating and testing research questions, designing experiments, and analyzing data in the field of Learning and Instruction)

Learning goals include:
- Participants can illustrate and explain basic methods and concepts for research in the fields of Learning and Instruction, e.g. with the help of practical examples.
- Participants can generate testable research questions for a topic relevant in the fields of Learning and Instruction.
- Participants can design and conduct a study that is relevant for answering their research question.
- Participants can summarize and evaluate the main results from a study in the field of learning and Instruction, with regard to the research question being asked.

### Physics Teaching Diploma

The programme “Teaching Diploma, Two Subjects in One-Step Procedure” will not be offered anymore since Autumn Semester 2010. Therefore new matriculations are no longer possible. The courses offered below are valid only for students who have registered before.

**Physics as First Subject**

**Educational Science**

**Course offerings in the category Educational Science are listed under “Programme: Educational Science for Teaching Diploma and TC”.

<table>
<thead>
<tr>
<th>Number</th>
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<td>851-0242-06L</td>
<td>Cognitively Activating Instructions in MINT Subjects</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>R. Schumacher</td>
</tr>
<tr>
<td>851-0242-07L</td>
<td>Human Intelligence</td>
<td>W</td>
<td>1 credit</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner, B. Rütsche</td>
</tr>
<tr>
<td>851-0242-08L</td>
<td>Research Methods in Educational Science</td>
<td>W</td>
<td>1 credit</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler</td>
</tr>
</tbody>
</table>
Subject Didactics in Physics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0910-00L</td>
<td>Physics Didactics I: Special Didactics of Physics Teaching</td>
<td>O</td>
<td>4 credits</td>
<td>3G</td>
<td>M. Mohr</td>
</tr>
</tbody>
</table>

Simultaneous enrolment in Introductory Internship Physics - course 402-0920-00L is compulsory for Teaching Diploma Physics

Objective
Die Studierenden verfügen über fachdidaktisches Grundwissen für den Physikunterricht an einer Mittelschule. Sie können eigene Lektionen unter Berücksichtigung der vielfältigen Rahmenbedingungen planen, durchführen und evaluieren. Sie reflektieren ihren Unterricht und sind bestrebt, ihn didaktisch und pädagogisch weiter zu entwickeln.

Die Studierenden kennen die Einsatzmöglichkeiten, Chancen und Schwierigkeiten verschiedener Unterrichtsmethoden und Hilfsmittel. Sie können die Eignung von Unterrichtsformen im Hinblick auf eine Lernsituation beurteilen. Sie bemühen sich in ihrem Unterricht, geeignete Methoden und Medien angepasst an die Klasse und das Thema einzusetzen.


Content
Thematische Schwerpunkte
Fachspezifisches: Sachstrukturen der gängigen Unterrichtsthemen, Alltagsbezüge, Fehlvorstellungen, Demonstrations- und Schülerexperimente, Arbeitsmittel zu physikalischen Themen des Grundlagen- und Schwerpunktkonzepts
Einsatz verschiedener Unterrichtsmaterialien: Experimente, Computer, Taschenrechner, Video, Simulation
Unterrichtsformen: Lernaufgabe, Werkstatt, Puzzle, Projekt, Gruppenarbeit, Praktikum

Lecture notes
Folien und weitere Unterlagen werden zur Verfügung gestellt

Literature
Die Veranstaltung ist zusammen mit dem Einführungspraktikum zu belegen

Mentored Work Subject Didactics in Physics for TC, Minor Subject.

Abstract
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

Objective
The objective is for the students:
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance of the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.
- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Content
Thematic Focus
The topics of the mentored work are mostly chosen from the high school curriculum.

Methods
With the help of the mentor the students individually work on a topic and write a thesis about it.

Professional Training in Physics

Professional Training (First Subject)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0920-00L</td>
<td>Introductory Internship Physics Teaching</td>
<td>O</td>
<td>3 credits</td>
<td>6P</td>
<td>M. Mohr</td>
</tr>
</tbody>
</table>

Simultaneous enrolment in Physics Didactics: Special Didactics of Physics Teaching - course 402-0910-00L is compulsory.

Abstract
During the introductory teaching practice, the students sit in on five lessons given by the teacher responsible for their teaching practice, and teach five lessons themselves. The students are given observation and reflection assignments by the teacher responsible for their teaching practice.
Objective
Right at the start of their training, students acquire initial experience with the observation of teaching, the establishment of concepts for teaching and the implementation of teaching. This early confrontation with the complexity of everything that teaching involves helps students decide whether they wish to and, indeed, ought to, continue with the training. It forms a basis for the subsequent pedagogical and subject-didactics training.

Content

Literature
Wird von der Praktikumslehrperson bestimmt.

402-0911-00L
Teaching Internship Physics
Teaching Internship Physics for Teaching Diploma
Physics as Major Subject

Abstract
The teaching practice takes in 50 lessons: 30 are taught by the students, and the students sit in on 20 lessons. The teaching practice lasts 4-6 weeks. It gives students the opportunity to implement the contents of their specialist-subject, educational science and subject-didactics training in the classroom. Students also conduct work assignments in parallel to their teaching practice.

Objective
- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics in their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They acquire the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils’ work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Content

Literature
Wird von der Praktikumslehrperson bestimmt.

402-0913-00L
Teaching Internship Physics II
Teaching Internship for students upgrading TC to Teaching Diploma

Abstract
This is a supplement to the Teaching Internship required to obtain a Master of Advanced Studies in Secondary and Higher Education in the corresponding subject. It is aimed at enlarging the already acquired teaching experience. Students observe 10 lessons and teach 15 lessons independently.

Objective
- Die Studierenden können die Bedeutung von Unterrichtsthemen in ihrem Fach unter verschiedenen Blickwinkeln einschätzen. Sie kennen und beherrschen das unterrichtliche Handwerk. Sie können ein gegebenes Unterrichtsthema für eine Gruppe von Lernenden fachlich und didaktisch korrekt strukturieren und in eine adäquate Lernumgebung umsetzen. Es gelingt ihnen, die Balance zwischen Anleitung und Offenheit zu finden, sodass die Lernenden sowohl über den nötigen Freiraum wie über ausreichend Orientierung verfügen, um aktiv und effektiv flexibel nutzbare (Fach-)Wissen zu erwerben.

Literature
Wird von der Praktikumslehrperson bestimmt.

402-0921-01L
Examination Lesson I
Simultaneous enrolment in “Examination Lesson II Physics” (402-0921-02L) is compulsory.

Abstract
In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.

Objective
- On the basis of a specified topic, the candidate shows that they are in a position to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle.
- To analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

Content

Lecture notes
Dokument: Schriftliche Vorbereitung für Prüfungslektionen

Prerequisites / notice
Nach Abschluss der übrigen Ausbildung.

402-0921-02L
Examination Lesson II
Simultaneous enrolment in “Examination Lesson I Physics” (402-0921-01L) is compulsory.

Abstract
- In the context of an examination lesson conducted and graded at a high school, the candidates provide evidence of the subject-matter-based and didactic skills they have acquired in the course of their training.

Objective
On the basis of a specified topic, the candidate shows that they are in a position to develop and conduct teaching that is conducive to learning at high school level, substantiating it in terms of the subject-matter and from the didactic angle.
- To analyze the tuition they have given with regard to its strengths and weaknesses, and outline improvements.

Lecture notes
Dokument: Schriftliche Vorbereitung für Prüfungslektionen

Prerequisites / notice
Nach Abschluss der übrigen Ausbildung.

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 1144 of 1434

Dokument: Schriftliche Vorbereitung für Prüfungslektionen.

Nach Abschluss der übrigen Ausbildung.

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### Professional Training (Two Subjects in One-Step Procedure)

The programme "Teaching Diploma, Two Subjects in One-Step Procedure" will not be offered anymore since Autumn Semester 2010. Therefore new matriculations are no longer possible. The courses offered below are valid only for students who have registered before.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0912-00L</td>
<td>Teaching Internship Physics for Teaching Diploma 2</td>
<td>O</td>
<td>6 credits</td>
<td>13P</td>
<td>M. Mohr</td>
</tr>
<tr>
<td></td>
<td>Subjects in One-Step Procedure and Physics as Major Subject.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Abstract**

In the final phase of their training, students have to apply and test the insights, abilities and skills they have acquired. They spend 3-5 weeks in an educational institution, during which time they observe 10 lessons and teach 30 lessons independently. The Teaching Internship is complemented by 10 further observed lessons, which are integrated into the Mentored Work in Subject Didactics.

**Objective**

Die Studierenden können die Bedeutung von Unterrichtsthemen unter verschiedenen Blickwinkeln einschätzen. Sie kennen und beherrschen das unterrichtliche Handwerk. Sie können ein gegebenes Unterrichtsthema für eine Gruppe von Lernenden fachlich und didaktisch korrekt strukturieren und in eine adäquate Lernumgebung umsetzen. Es gelingt ihnen, die Balance zwischen Anleitung und Offenheit zu finden, sodass die Lernenden sowohl über den nötigen Freiraum wie über ausreichend Orientierung verfügen, um aktiv und effektiv flexibel nutzbares (Fach-)Wissen zu erwerben.

**Content**


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Für Studierende, die ab FS 2014 in das Lehramt eingetreten sind, ist das Fachdidaktikpraktikum Physik obligatorisch. Alle weiteren Lehrveranstaltungen sind individuell wählbar.

Studierende, die vor dem FS 2014 in das Lehramt eingetreten sind, müssen entweder die mentorierte Arbeit oder das jeweils im FS angebotene Fachdidaktikpraktikum Physik als obligatorische Lehrveranstaltung absolvieren. Selbstverständlich können auch beide Lehrveranstaltungen absolviert werden.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0737-00L</td>
<td>Energy and Environment in the 21st Century (Part I)</td>
<td>W</td>
<td>6 credits</td>
<td>2V+1U</td>
<td>M. Dittmar</td>
</tr>
</tbody>
</table>

**Abstract**

The energy and related environmental problems, the physics principles of using energy and the various real and hypothetical options are discussed from a physicist point of view. The lecture is intended for students of all ages with an interest in a rational approach to the energy problem of the 21st century.

**Objective**

Scientists and especially physicists are often confronted with questions related to the problems of energy and the environment. The lecture tries to address the physical principles of todays and tomorrow energy use and the resulting global consequences for the world climate.

The lecture is for students which are interested participate in a rational and responsible debate about the energyproblem of the 21. century.

**Content**

Introduction: energy types, energy carriers, energy density and energy usage. How much energy does a human needs/uses?

Energy conservation and the first and second law of thermodynamics

Fossil fuels (our stored energy resources) and their use.

 Burning fossil fuels and the physics of the greenhouse effect.

 physics basics of nuclear fission and fusion energy

 controlled nuclear fission energy today, the different types of nuclear power plants, uranium requirements and resources, natural and artificial radioactivity and the related waste problems from the nuclear fuel cycle.

 Nuclear reactor accidents and the consequences, a comparison with risks from other energy using methods.

 The problems with nuclear fusion and the ITER project.

 Nuclear fusion and fission: "exotic" ideas.

 Hydrogen as an energy carrier: ideas and limits of a hydrogen economy.

 new clean renewable energy sources and their physical limits (wind, solar, geothermal etc)

 Energy perspectives for the next 100 years and some final remarks
Lecture notes
many more details (in english and german) here:
http://hp-lx2.ethz.ch/energy21/

Literature
Die Energiefrage - Bedarf und Potentiale, Nutzung, Risiken und Kosten:
Environmental Physics: Boeker and Egbert New York Wiley 1999

Prerequisites / notice
Science promised us truth, or at least a knowledge
of such relations as our intelligence can seize:
it never promised us peace or happiness
Gustave Le Bon

Physicists learned to realize that whether they like a theory or
they don't like a theory is not the essential question.
Rather, it's whether or not the theory gives predictions that agree with experiment.
Richard Feynman, 1985

402-0944-00L  Science in School (Current Topics for the Classroom)  W  2 credits  2G  C. Wagner, A. Vaterlaus
Enrolment in Physics Didactics I (402-0910-00L) and
Physics Didactics II (402-0910-00L) is mandatory.

Content
Kennenlernen und erarbeiten (Übungen) von Unterrichtssequenzen zu modernen Themen der Physik.

Lecture notes
Unterlagen werden verteilt.

Literature
Wird angegeben.

Prerequisites / notice

402-0922-00L  Mentored Work Specialised Courses in Physics with an Educational Focus A  W  2 credits  4A  G. Schiltz, A. Vaterlaus, C. Wagner
Mentored Work Specialised Courses in the Respective Subject with an Educational Focus in Physics for TC and Teaching Diploma.

Abstract
In the mentored work on their subject specialisation, students link high-school and university aspects of the subject, thus strengthening their teaching competence with regard to curriculum decisions and the future development of the tuition. They compile texts under supervision that are directly comprehensible to the targeted readers - generally specialist-subject teachers at high-school level.

Objective
Practice in the explanation of complex topics in physics as the core competence of the teaching profession

Content
Choice of topic by individual arrangement

402-0923-00L  Mentored Work Specialised Courses in Physics with an Educational Focus B  W  2 credits  4A  G. Schiltz, A. Vaterlaus, C. Wagner
Mentored Work Specialised Courses in the Respective Subject with an Educational Focus in Physics for Teaching Diploma and for students upgrading TC to Teaching Diploma.

Abstract
In the mentored work on their subject specialisation, students link high-school and university aspects of the subject, thus strengthening their teaching competence with regard to curriculum decisions and the future development of the tuition. They compile texts under supervision that are directly comprehensible to the targeted readers - generally specialist-subject teachers at high-school level.

Objective
Practice in the explanation of complex topics in physics as the core competence of the teaching profession

Content
Choice of topic by individual arrangement

Compulsory Elective Courses

Further course offerings from the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".
Teaching Diploma in 2 Subjects in One-Step Procedure:
a) the course 402-0904-00L "Professional Exercises: Experiments in physics teaching" (takes place in Spring Semester only) must be completed within the category Compulsory Elective Courses;
b) courses from the category Compulsory Elective Courses of the Minor Subject may also be selected;
c) courses from the category Specialized Courses in the Respective Subject, either of the Major or the Minor Subject, may also be selected.

Number  Title  Type  ECTS  Hours  Lecturers
402-0737-00L  Energy and Environment in the 21st Century (Part I)  W  6 credits  2V+1U  M. Dittmar

Abstract
The energy and related environmental problems, the physics principles of using energy and the various real and hypothetical options are discussed from a physicist point of view. The lecture is intended for students of all ages with an interest in a rational approach to the energy problem of the 21st century.

Objective
Scientists and espially physicists are often confronted with questions related to the problems of energy and the environment.
The lecture tries to address the physical principles of todays and tomorrow energy use and the resulting global consequences for the world climate.
The lecture is for students which are interested participate in a rational and responsible debate about the energyproblem of the 21. century.
Introduction: energy types, energy carriers, energy density and energy usage. How much energy does a human need/uses? Energy conservation and the first and second law of thermodynamics. Fossil fuels (our stored energy resources) and their use. Burning fossil fuels and the physics of the greenhouse effect. Physics basics of nuclear fission and fusion energy. Controlled nuclear fission energy today, the different types of nuclear power plants, uranium requirements and resources, natural and artificial radioactivity and the related waste problems from the nuclear fuel cycle. Nuclear reactor accidents and the consequences, a comparison with risks from other energy using methods.

The problems with nuclear fusion and the ITER project. Nuclear fusion and fission: "exotic" ideas. Hydrogen as an energy carrier: ideas and limits of a hydrogen economy. New clean renewable energy sources and their physical limits (wind, solar, geothermal etc)

Energy perspectives for the next 100 years and some final remarks.

Lecture notes: many more details (in English and German) here:

http://ihp-lx2.ethz.ch/energy21/

Literature:


Environmental Physics: Boeker and Egbert New York Wiley 1999

Science promised us truth, or at least a knowledge of such relations as our intelligence can seize: it never promised us peace or happiness

Gustave Le Bon

Physicists learned to realize that whether they like a theory or they don't like a theory is not the essential question. Rather, it's whether or not the theory gives predictions that agree with experiment.

Richard Feynman, 1985
The main topics of the course unit "Computer Science in Secondary School Mathematics" represent a scientific and didactic added value for mathematics classes.

The course covers the didactics of logic, of cryptology, of finite state automata, of computability and of the introduction to programming. The students develop the understanding of fundamental scientific concepts such as algorithm, program, complexity, determinism, computation, automata, verification, testing, security of a cryptosystem and secure communication. They reflect on ways to embed them into a scientifically sound and didactically sustainable mathematics course.

In a semester exercise, the students develop an adaptive teaching unit for computer science. They learn to employ the didactics methods and techniques that are introduced at the beginning of the semester.

Objective

The objective is for the students:

- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is socially as well as methodically sustainable;
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance from a subject-based and pedagogical angle.

Methods

With the help of the mentor the students individually work on a topic and write a thesis about it.

Content

The topics of the mentored work are mostly chosen from the high school curriculum. The students are able to select the topic and the access they have selected to this topic from a specialist, subject-didactics and pedagogical angle and potentially from a social angle too.

The students compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

Lecture notes

Avoid the use of the term "Lecture notes" in the data format as it is not clear what is intended. It could be used to refer to materials provided by the lecturers or the lecturers themselves.

Literature


see Compulsory Elective Courses Teaching Diploma

Physics as Second Subject

Subject Didactics in Physics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0910-00L</td>
<td>Physics Didactics I: Special Didactics of Physics</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>M. Mohr</td>
</tr>
</tbody>
</table>

Further information is available from the lecturer via email: mamohr@ethz.ch

Simultaneous enrolment in Introductory Internship Physics - course 402-0920-00L - is compulsory for Teaching Diploma Physic

Objective

The objective is for the students:

- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is socially as well as methodically sustainable;
- to be able to familiarise themselves with a tuition topic by consulting different sources, acquiring materials and reflecting on the relevance from a subject-based and pedagogical angle.

Methods

With the help of the mentor the students individually work on a topic and write a thesis about it.

Content

The objective is for the students:

- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Methods

With the help of the mentor the students individually work on a topic and write a thesis about it.

Professional Training in Physics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0917-00L</td>
<td>Mentored Work Subject Didactics Physics A</td>
<td>O</td>
<td>2</td>
<td>4A</td>
<td>G. Schiltz, A. Vaterlaus, C. Wagner</td>
</tr>
</tbody>
</table>

Mentored Work Subject Didactics in Physics for TC, Teaching Diploma and Teaching Diploma as Minor Subject.

Abstract

In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

Objective

The objective is for the students:

- to show that they can independently compile a tuition sequence that is conducive to learning and develop this to the point where it is ready for use.

Methods

With the help of the mentor the students individually work on a topic and write a thesis about it.
Teaching Internship Including Examination Lessons

402-0915-00L

Physics

Teaching Internship Physics for TC and Teaching Diploma Physics as Minor Subject.

Repetition of the Teaching Internship is excluded even if Examination Lessons are to be repeated.

Abstract

Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as assessed as Examination Lessons.

Objective

- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils’ work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Content


Die Themen für die beiden Prüfungslektionen am Schluss des Praktikums erfahren die Studierenden in der Regel eine Woche vor dem Prüfungstermin. Sie erstellen eine Vorbereitung gemäss Anleitung und reichen sie bis am Vortrag um 12 Uhr den beiden Prüfungsexperten (Fachdidaktiker/-in, Departementsvertreter/-in) ein. Die gehaltenen Lektionen werden kriteriumsbasiert beurteilt. Die Beurteilung umfasst auch die schriftliche Vorbereitung und eine mündliche Reflexion des Kandidaten/der Kandidatin über die gehaltenen Lektionen im Rahmen eines kurzen Kolloquiums.

Lecture notes

Dokument: schriftliche Vorbereitung für Prüfungslektionen.

Literature

Wird von der Praktikumslehrperson bestimmt.

Physics Teaching Diploma - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Physics Master

Core Courses

One Core Course in Experimental or Theoretical Physics from Physics Bachelor is eligible; however, this Core Course from Physics Bachelor cannot be used to compensate for the mandatory Core Course in Experimental or Theoretical Physics.

For the category assignment keep the choice “no category” and take contact with the Study Administration Office (www.phys.ethz.ch/phys/education/studiensekretariat?lang=en) after having received the credits.

Core Courses in Theoretical Physics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0861-00L</td>
<td>Statistical Physics</td>
<td>W</td>
<td>10 credits</td>
<td>4V+2U</td>
<td>M. Sigrist</td>
</tr>
<tr>
<td>Abstract</td>
<td>This lecture covers the concepts of classical and quantum statistical physics, and some aspects of kinetic gas theory. In a more advanced part Bose-Einstein condensation, general mean field theory and critical phenomena will be addressed. Finally also various aspects of linear response theory will be discussed.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Objective</td>
<td>This lecture gives an introduction in the basic concepts and applications of statistical physics for the general use in physics and, in particular, as a preparation for the theoretical solid state physics education.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literature</td>
<td>Lecture notes will be provided.</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number</th>
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</tr>
</thead>
<tbody>
<tr>
<td>402-0843-00L</td>
<td>Quantum Field Theory I</td>
<td>W</td>
<td>10 credits</td>
<td>4V+2U</td>
<td>G. Isidori</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course discusses the quantisation of fields in order to introduce a coherent formalism for the combination of quantum mechanics and special relativity. Topics include: - Relativistic quantum mechanics - Quantisation of bosonic and fermionic fields - Interactions in perturbation theory - Scattering processes and decays - Radiative corrections</td>
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<tr>
<td>Objective</td>
<td>The goal of this course is to provide a solid introduction to the formalism, the techniques, and important physical applications of quantum field theory. Furthermore it prepares students for the advanced course in quantum field theory (Quantum Field Theory II), and for work on research projects in theoretical physics, particle physics, and condensed-matter physics.</td>
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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>402-0830-00L</td>
<td>General Relativity</td>
<td>W</td>
<td>10 credits</td>
<td>4V+2U</td>
<td>M. Gaberdiel</td>
</tr>
<tr>
<td>Abstract</td>
<td>Manifold, Riemannian metric, connection, curvature; Special Relativity; Lorentzian metric; Equivalence principle; Tidal force and spacetime curvature; Energy-momentum tensor, field equations, Newtonian limit; Post-Newtonian approximation; Schwarzschild solution; Mercury's perihelion precession, light deflection.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>Basic understanding of general relativity, its mathematical foundations, and some of the interesting phenomena it predicts.</td>
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</tbody>
</table>

Core Courses: Experimental Physics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0257-00L</td>
<td>Advanced Solid State Physics</td>
<td>W</td>
<td>10 credits</td>
<td>3V+2U</td>
<td>A. Zheludev</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course is an extension of the introductory course on solid state physics. The purpose of this course is to learn to navigate the complex collective quantum phases, excitations and phase transitions that are the dominant theme in modern solid state physics. The emphasis is on the main concepts and on specific experimental examples, both classic ones and those from recent research.</td>
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<tr>
<td>Objective</td>
<td>The goal is to study how novel phenomena emerge in the solid state.</td>
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</tbody>
</table>
Today's challenges and opportunities in Solid State Physics

- Phase transitions and critical phenomena
  - Main concepts: coherence length, symmetry, order parameter, correlation functions, generalized susceptibility
  - Bragg-Williams mean field theory
  - Landau theory of phase transitions
  - Fluctuations in Landau theory
  - Critical exponents: significance, measurement, inequalities, equalities
  - Scaling and hyperscaling
  - Universality
  - Critical dynamics
  - Quantum phase transitions and quantum criticality
- Fermi surface instabilities
  - The concept of the Landau Fermi liquid in metals
  - Kohn anomalies
  - Charge density waves
  - Metallic ferromagnets and half-metals
  - Spin density waves
- Magnetism of insulators
  - Magnetic interactions in solids and the spin Hamiltonian
  - Magnetic structures and phase transitions
  - Spin waves
  - Quantum magnetism
- Electron correlations in solids
  - Mott insulating state
  - Phases of the Hubbard model
  - Layered cuprates (non-superconducting properties)
- Electron surface instabilities
  - The concept of the Landau Fermi liquid in metals
  - Kohn anomalies
  - Charge density waves
  - Metallic ferromagnets and half-metals
  - Spin density waves
- Magnetism of insulators
  - Magnetic interactions in solids and the spin Hamiltonian
  - Magnetic structures and phase transitions
  - Spin waves
  - Quantum magnetism

Lecture notes
The printed material for this course involves: (1) a self-contained script, distributed electronically at semester start. (2) experimental examples (Power Point slide-style) selected from original publications, distributed at the start of every lecture.

Literature
A list of books will be distributed. Numerous references to useful published scientific papers will be provided.

Prerequisites / notice
This course is for students who like to be engaged in active learning. The "exercise classes" are organized in a non-traditional way: following the idea of "less is more", we will work on only about half a dozen topics, and this gives students a chance to take a look at original literature (provided), and to get the grasp of a topic from a broader perspective.

Students report back that this mode of "exercise class" is more satisfying than traditional modes, even if it does not mean less effort.

402-0442-00L Quantum Optics W 10 credits 3V+2U T. Esslinger

Abstract
This course gives an introduction to the fundamental concepts of Quantum Optics and will highlight state-of-the-art developments in this rapidly evolving discipline. The topics covered include:
- coherence properties of light
- quantum nature of light: statistics and non-classical states of light
- light matter interaction: density matrix formalism and Bloch equations
- quantum description of light matter interaction: the Jaynes-Cummings model, photon blockade
- laser manipulation of atoms and ions: laser cooling and trapping, atom interferometry,
- further topics: Rydberg atoms, optomechanics, quantum computing, complex quantum systems.

Lecture notes
Selected book chapters will be distributed.

Literature
- Text-books:
  - G. Grynberg, A. Aspect and C. Fabre, Introduction to Quantum Optics
  - R. Loudon, The Quantum Theory of Light
  - Atomic Physics, Christopher J. Foot
  - Advances in Atomic Physics, Claude Cohen-Tannoudji and David Guéry-Odelin
  - C. Cohen-Tannoudji et al., Atom-Photon-Interactions
  - M. Scully and M.S. Zubairy, Quantum Optics
  - Y. Yamamoto and A. Imamoglu, Mesoscopic Quantum Optics

402-0891-00L Phenomenology of Particle Physics I W 10 credits 3V+2U A. Gehrmann-De Ridder, C. Grab

Abstract
Topics to be covered both in Phenomenology of Particle Physics I and II:
- relativistic kinematics
- cross section and phase space
- elements of quantum electrodynamics
- perturbation theory
- unitary symmetries and QCD
- electro-weak interaction
- flavour physics
- neutrino physics

Objective
Introduction into modern particle physics

Content
Topics to be covered both in Phenomenology of Particle Physics I and II:
- relativistic kinematics
- cross section and phase space
- elements of quantum electrodynamics
- perturbation theory
- unitary symmetries and QCD
- electro-weak interaction
- flavour physics
- neutrino physics
Ultrafast Processes in Solids

Abstract
Ultrafast processes in solids are of fundamental interest as well as relevant for modern technological applications. The dynamics of the lattice, the electron gas as well as the spin system of a solid are discussed. The focus is on time resolved experiments which provide insight into pico- and femtosecond dynamics.

Objectives
After attending this course you understand the dynamics of essential excitation processes which occur in solids and you have an overview over state of the art experimental techniques used to study fast processes.

Content
1. Experimental techniques, an overview

2. Dynamics of the electron gas
   2.1 First experiments on electron dynamics and lattice heating
   2.2 The finite lifetime of excited states
   2.3 Detection of lifetime effects
   2.4 Dynamical properties of reactions and adsorbents

3. Dynamics of the lattice
   3.1 Phonons
   3.2 Non-thermal melting

4. Dynamics of the spin system
   4.1 Laser induced ultrafast demagnetization
   4.2 Ultrashort spin currents generated by lasers
   4.3 Landau-Lifschitz-Dynamics
   4.4 Laser induced switching

5. Correlated materials

Lecture notes will be distributed

Literature relevant publications will be cited

Prerequisites / notice
This lecture can also be followed by interested non-physics students as basic concepts will be introduced.

This lecture is complementary to the lecture on "ultrafast methods for solid state physics" of the spring semester. Both lectures can be attended independently. The focus of this lecture is on the physical processes whereas the focus of the "ultrafast methods for solid state physics" lecture is on the experimental techniques.

Introduction to Magnetism

Abstract
Atomic paramagnetism and diamagnetism, intra- and inter-atomic exchange, Stoner model, RKKY exchange interaction. Ising and Heisenberg models, the mean field approximation, spin waves, magnetic phase transition, domains and domain walls, dynamical aspects

Content
The lecture "Introduction to Magnetism" is the regular course on Magnetism for the Master curriculum of the Department of Physics of ETH Zurich. With respect to the similar lecture course in previous semesters we have decided that we need to insist on the fundamental aspects of magnetism -- the Quantum mechanical aspects on one side and the statistical physics aspects on the other, which are often not comprehensively spelled out in conventional lectures on solid state physics.

The preliminary Content of the lecture in this semester is the following:
- Magnetism in Atoms (the role of magnetism in classical physics, the quantum mechanics of atoms, exchange interaction)
- These two chapters will be given by D. Pescia. They will give, for instance, the opportunity of revising with concrete examples the subjects related to spin physics that have been treated at a theoretical level in Quantum Mechanics I and Quantum Mechanics II.
- Magnetic order at finite temperatures (Ising and Heisenberg models, mean field approximation, phase transitions, low-dimensional magnetism)
- Topological excitations (domains, domain walls, magnetic anisotropy, dipolar interaction)
- Spin Physics in the time Domain

These three Chapters will be given by A. Vindigni and are an essential introduction to more specialized Topics given in selected lectures, such as the one by R. Allenspach in FS16.

Lecture notes
A manuscript is made available.

Prerequisites / notice
The former title of this course unit was "Fundamental Aspects of Magnetism". This lecture insists on the fundamental aspects -- Quantum physics and statistical physics of magnetism.

Applications to nanoscale magnetism will be discussed within this fundamental Approach.

Semiconductor Nanostructures

Abstract
The course covers the foundations of semiconductor nanostructures, e.g., materials, band structures, bandgap engineering and doping, field-effect transistors. The physics of the quantum Hall effect and of common nanostructures based on two-dimensional electron gases will be discussed, i.e., quantum point contacts, Aharonov-Bohm rings and quantum dots.

Objectives
At the end of the lecture the student should understand four key phenomena of electron transport in semiconductor nanostructures:  
1. The integer quantum Hall effect  
2. Conductance quantization in quantum point contacts  
3. the Aharonov-Bohm effect  
4. Coulomb blockade in quantum dots
1. Introduction and overview
2. Semiconductor crystals: Fabrication and band structures
3. k.p-theory, effective mass
4. Envelope functions and effective mass approximation, heterostructures and band engineering
5. Fabrication of semiconductor nanostructures
6. Electrostatics and quantum mechanics of semiconductor nanostructures
7. Heterostructures and two-dimensional electron gases
8. Drude Transport
9. Electron transport in quantum point contacts; Landauer-Büttiker description
10. Ballistic transport experiments
11. Interference effects in Aharonov-Bohm rings
12. Electron in a magnetic field, Shubnikov-de Haas effect
13. Integer quantum Hall effect
14. Coulomb blockade and quantum dots

Lecture notes

Prerequisites / notice
The lecture is suitable for all physics students beyond the bachelor of science degree. Basic knowledge of solid state physics is recommended. Very ambitioned students in the third year may be able to follow. The lecture can be chosen as part of the PhD-program. The course is taught in English.

402-0313-00L
Materials Research Using Synchrotron Radiation
W 6 credits 2V+1U L. Heyderman, V. Scagnoli

Abstract
The course gives an introduction to the use of synchrotron radiation in materials science. It treats the generation of intense x-ray beams at synchrotron radiation sources and their use for the characterisation of materials properties at different length scales. As part of the course, experiments will be carried out at the Swiss Light Source, Paul Scherrer Institut.

Objective
A comprehensive understanding of the interaction of x-rays with condensed matter and their use in materials analysis; acquiring hands-on experience with the use of synchrotron radiation.

Content
Interaction of x-rays with matter:
Elastic scattering from bound electron, atom and assemblies of atoms; Compton scattering; principles of diffraction from crystals and scattering from disordered systems; thermal diffuse scattering, small-angle scattering from nanometre-sized objects; X-ray absorption spectroscopy; microscopy; comparison with neutron scattering, where appropriate.

The generation of high-brilliance x-ray beams at synchrotron radiation sources:
Undulators, wigglers and bending magnets; comparison with conventional lab sources; the future x-ray free electron laser.

Instrumentation:
Monochromator; diffractometer; detector.

Determination of materials properties:
Crystal structure; defects and strain fields; structure of surfaces and interfaces; chemical bonding properties.

New methods:
Coherent x-ray scattering and diffractive imaging.

Lecture notes
A reader and a guide through the experiments at the Swiss Light Source will be made available on the web.

Literature


Prerequisites / notice
The lab course has been designed by J. Als-Nielsen in collaboration with staff from the SLS.

Part of the course is in the form of practical work at the Swiss Light Source. During two days (dates to be agreed), the following experiments will be performed: (1) elastic and Compton scattering, (2) liquid scattering and powder diffraction, and (4) X-ray absorption spectroscopy.

402-0317-00L
Semiconductor Materials: Fundamentals and Fabrication
W 6 credits 2V+1U S. Schön, W. Wegscheider

Abstract
This course gives an introduction into the fundamentals of semiconductor materials. The main focus is on state-of-the-art fabrication and characterization methods. The course will be continued in the spring term with a focus on applications.

Objective
Basic knowledge of semiconductor physics and technology. Application of this knowledge for state-of-the-art semiconductor device processing.

Content
Fundamentals of Solid State Physics: Semiconductor materials, band structures, carrier statistics in intrinsic and doped semiconductors, p-n junctions, low-dimensional structures;
Bulk Material growth of Semiconductors: Czochralski method, floating zone method, high pressure synthesis;
Semiconductor Epitaxy: Fundamentals, MBE, MOCVD, LPE;
In situ characterization: RHEED, LEED, AES, XPS, process control (temperature, thickness)

Lecture notes
https://moodle-app2.let.ethz.ch/course/view.php?id=1044

402-0543-00L
Neutron Scattering in Solid State Physics
W 6 credits 2V+1U A. Zheludev

Abstract
Introduction to neutron scattering: quantum-mechanical description in terms of correlation functions. Principles of neutron instrumentation. Applications to basic problems of solid state physics: diffraction from crystals, lattice dynamics, scattering by liquids, magnetic structures and magnetic excitations.

Objective
Derivation and comprehension of neutron scattering cross sections, principles of neutron instrumentation, and applications (lecture and exercises) to basic problems of solid state physics: static and dynamics of condensed matter, magnetic structures as well as magnetic excitations.
1. Introduction

The rich physics of the optical properties of semiconductors, as well as the advanced processing available on these material, enabled a good background in basic quantum mechanics and solid state physics.

Accelerator-Based Science from Quantum Information

This course gives a survey of current research topics using accelerator-based probes (photons, neutrons, muons) to study problems in condensed matter and biophysics.

402-0541-65L

Physics in the Smartphone

Physics in today's high-tech smartphone. Examples: network topology and scratch proof glass, spin-orbit coupling - brighter displays, GPS and general theory of relativity, electromagnetic response of matter (transparent metals for displays, GPS signal propagation), light-field cameras, CCD and CMOS light sensors, physics stops Moore's law, meta-materials for antennas, MEMS sensor physics, etc.

2.1 Fundamentals of neutron scattering

2. Nuclear elastic scattering

3. Nuclear inelastic scattering

3.1 Lattice dynamics

3.2 Scattering by phonons

4. Neutron scattering from liquids

5. Magnetic neutron scattering

5.1 Magnetic scattering cross section

5.2 Magnetic structures and neutron diffraction

5.3 Local magnetic excitations

5.4 Spin waves


Former course title "Neutron Scattering in Condensed Matter Physics I"

The course will discuss several current examples of research using accelerator facilities highlighting different technologies and their applications. Specific attention will be given to x-ray spectroscopy and scattering experiments conducted at synchrotrons and x-ray Free Electron Lasers, as well as neutron scattering experiments at spallation sources and muon spin rotation.

Prerequisites / notice

Prerequisites: Solid State Physics, Quantum Mechanics

Abstract

The course aims to give students the ability to follow and explain on a conceptual level the ways in which accelerator-based facilities (photon, neutron and muon sources) enable the study of various problems in a wide range of fields, including for example quantum information theory, solid state dynamics in superconductors and low dimensional systems, quantum phase transitions, as well as structural biology.

Prerequisites / notice

Prerequisites: Quantum Mechanics

402-0464-00L

Optical Properties of Semiconductors

This course presents a comprehensive discussion of optical processes in semiconductors.

This rich physics of the optical properties of semiconductors, as well as the advanced processing available on these material, enabled numerous applications (lasers, LEDs and solar cells) as well as the realization of new physical concepts. Systems that will be covered include quantum dots, exciton-polaritons, quantum Hall fluids and graphene-like materials.

Objective

Electronic states in III-V materials and quantum structures, optical transitions, excitons and polaritons, novel two dimensional semiconductors, spin-orbit interaction and magneto-optics.

Prerequisites / notice

Prerequisites: Quantum Mechanics I, Introduction to Solid State Physics

402-0402-00L

Ultrafast Laser Physics

This lecture will introduce students to active ongoing research topics and provide their fundamental background.

Ultrafast pulse generation, few-cycle pulses, frequency combs, ultrafast measurement techniques

L. P. Gallmann

Data: 06.02.2019 13:00
 Autumn Semester 2015
 Page 1154 of 1434
### 402-0415-62L Terahertz Technology and Applications

#### Abstract
This course gives a practical overview over the generation of THz frequency electromagnetic radiation and over the applications of this radiation in a variety of fields, both scientific and industrial.

#### Objective
Terahertz frequency electromagnetic radiation lies at the border between electronics and optics, and as such has many unique properties that make it well-suited to study the electronic, magnetic and structural properties of many materials. The course objective is to give students the ability to identify problems that can be addressed using terahertz frequency radiation and to design (on a conceptual level) a way to implement solutions to these problems. These problems include both scientific (in physics, chemistry and biology) and industrial (medicine, pharmaceuticals, security) areas.

On the scientific side the applications of THz relate to understanding the electronic, structural and magnetic properties of materials by studying the optical response at low frequencies without the need for physical contact with the sample. The industrial applications tend to be more related imaging (e.g. THz-based airport scanners), but also some spectroscopy is done to identify materials.

#### Content
Topics to be discussed in the class include:

1. Overview of THz & interactions with matter
2. THz generation methods
3. THz optics and electronics
4. THz detection methods
5. THz applications
   - a) Spectroscopy
   - b) Imaging

#### Lecture notes
Although many lectures will follow the course texts, significant deviations will be distributed as a script.

#### Literature
- The readings for the course will be selected from several different texts. All of these are available electronically via the ETH library system.
- You can also order a black-and-white paperback via an "on-demand" system for a pretty reasonable price.

#### Prerequisites / notice

Prerequisites: Basic knowledge of quantum electronics (e.g., 402-0275-00L Quantenelektronik).
The course aims to provide an introduction to selected advanced topics in low energy particle physics with neutrons and muons. Besides the sensitivity to effects related with new physics (e.g. lepton flavor violation, symmetry violations, CPT tests, search for electric dipole moments, new low mass exchange bosons etc.), low energy physics provides the best test of QED (electron g-2), the best tests of bound-state QED (atomic physics and exotic atoms), precise determinations of fundamental constants, information about the CKM matrix, precise information on the weak and strong force even in the non-perturbative regime etc.

In this lecture, we will concentrate on selected experiments, using mainly neutrons and muons, which have significantly improved our understanding of particle physics today. Starting from a general introduction on high intensity/high precision particle physics and the main characteristics of muons and neutrons and their production, we will then focus on the discussion of fundamental problems and ground-breaking experiments:

- Production and characteristics of muon and neutron beams
- Ultracold neutron production
- Measurement of the neutron lifetime and electric dipole moment
- The neutron in the gravitational field and its electric charge
- Muon and neutron decay correlations
- Lepton flavour violations with muons to search for new physics
- What atomic physics can do for particle physics and vice versa
- Laser experiments at accelerators
- From myonic hydrogen to the proton structure and bound-state QED
- From pionic hydrogen to the strong interaction and effective field theories
- etc.

**Literature**

- Golub, Richardson & Lamoreaux: "Ultra-Cold Neutrons"
- Rauch & Werner: "Neutron Interferometry"
- Carlile & Willis: "Experimental Neutron Scattering"
- Byrne: "Neutrons, Nuclei and Matter"
- Klappdor-Kleingrothaus: "Non Accelerator Particle Physics"

**Prerequisites / notice**

Einführung in die Kern- und Teilchenphysik / Introduction to Nuclear- and Particle-Physics
### 402-0851-00L QCD: Theory and Experiment

**W** 3 credits 3G  C. Anastasiou, G. Dissertori

**Abstract**

An introduction to the theoretical aspects and experimental tests of QCD, with emphasis on perturbative QCD and related experiments at colliders.

**Objective**

Knowledge acquired on basics of perturbative QCD, both of theoretical and experimental nature. Ability to perform simple calculations of perturbative QCD, as well as to understand modern publications on theoretical and experimental aspects of perturbative QCD.

**Content**

- QCD Lagrangian and Feynman Rules
- QCD running coupling
- Parton model
- Altarelli-Parisi equations
- Basic processes
- Experimental tests at lepton and hadron colliders
- Measurements of the strong coupling constant

**Literature**

2) R. K. Ellis, W. J. Stirling, B. R. Webber : "QCD and Collider Physics" (Cambridge Monographs on Particle Physics, Nuclear Physics & Cosmology)"

**Prerequisites / notice**

This lecture is also suited for PhD. students

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### 402-0737-00L Energy and Environment in the 21st Century (Part I)

**W** 6 credits 2V+1U  M. Dittmar

**Abstract**

The energy and related environmental problems, the physics principles of using energy and the various real and hypothetical options are discussed from a physicist point of view. The lecture is intended for students of all ages with an interest in a rational approach to the energy problem of the 21st century.

**Objective**

Scientists and especially physicists are often confronted with questions related to the problems of energy and the environment. The lecture tries to address the physical principles of today's and tomorrow energy use and the resulting global consequences for the world climate.

The lecture is for students which are interested participate in a rational and responsible debate about the energy problem of the 21st century.

**Content**

- Introduction: energy types, energy carriers, energy density and energy usage. How much energy does a human need/uses?
- Energy conservation and the first and second law of thermodynamics
- Fossil fuels (our stored energy resources) and their use.
- Burning fossil fuels and the physics of the greenhouse effect.
- Physics basics of nuclear fission and fusion energy
- Controlled nuclear fission energy today, the different types of nuclear power plants, uranium requirements and resources, natural and artificial radioactivity and the related waste problems from the nuclear fuel cycle.
- Nuclear reactor accidents and the consequences, a comparison with risks from other energy using methods.
- The problems with nuclear fusion and the ITER project.
- Nuclear fusion and fission: "exotic" ideas.
- Hydrogen as an energy carrier: ideas and limits of a hydrogen economy.
- New clean renewable energy sources and their physical limits (wind, solar, geothermal etc)
- Energy perspectives for the next 100 years and some final remarks

**Lecture notes**

many more details (in english and german) here:

http://hp-lx2.ethz.ch/energy21/

**Literature**


Environmental Physics: Boeker and Egbert New York Wiley 1999

**Prerequisites / notice**

For students of both ETH and University of Zurich.
### Selection: Theoretical Physics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>402-0883-63L</td>
<td>Symmetries in Physics</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>N. Beisert</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course gives an introduction to symmetry groups in physics. It will explain the relevant mathematical background (finite groups, Lie groups and algebras as well as their representations), and illustrate their important role in modern physics.</td>
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<tr>
<td>Objective</td>
<td>The aim of the course is to give a self-contained introduction into finite group theory as well as Lie theory from a physicists point of view. Abstract mathematical constructions will be illustrated with examples from physics.</td>
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<tr>
<td>402-0898-00L</td>
<td>The Physics of Electroweak Symmetry Breaking</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>not available</td>
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<tr>
<td>Abstract</td>
<td>Does not take place this semester.</td>
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<tr>
<td>Objective</td>
<td>The aim is to understand the need of physics beyond the Standard Model, the basic techniques of model building in theories BSM and the elements of collider physics required to analyze their phenomenological implications. After an introduction to the SM and alternative theories of electroweak symmetry breaking, we will investigate these issues in the context of models with warped extra dimensions.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The former title of this course unit was &quot;The Physics Beyond the Standard Model&quot;. If you already got credits for &quot;The Physics Beyond the Standard Model&quot; (402-0898-00L), you cannot get credits for &quot;The Physics of Electroweak Symmetry Breaking&quot; (402-0898-00L).</td>
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<tr>
<td>402-0899-65L</td>
<td>Higgs Physics</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>M. Donegà, M. Grazzini</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course introduces the theory and phenomenology of the recently discovered Higgs boson. With this course the students will receive a detailed introduction to the physics of the Higgs boson in the Standard Model. They will acquire the necessary theoretical background to understand the main production and decay channels of the Higgs boson at high-energy colliders, and the corresponding experimental signatures.</td>
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<tr>
<td>Objective</td>
<td>With this course the students will receive a detailed introduction to the physics of the Higgs boson in the Standard Model. They will acquire the necessary theoretical background to understand the main production and decay channels of the Higgs boson at high-energy colliders, and the corresponding experimental signatures.</td>
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</tbody>
</table>
| Content     | - Theory part:  
- the Standard Model and the mass problem: WW scattering and the no-lose theorem  
- the Higgs mechanism and its implementation in the Standard Model  
- radiative corrections and the screening theorem  
- theoretical constraints on the Higgs mass; the hierarchy problem  
- Higgs production in e+e- collisions  
- Higgs production at hadron colliders  
- Higgs decays to fermions and vector bosons  
- Higgs differential distributions, rapidity distribution, pt spectrum and jet vetoes  
- Higgs properties and beyond the Standard Model perspective  
- Outlook: The Higgs sector in weakly coupled and strongly coupled new physics scenarios.  
- Experimental part:  
  - Introductory material:  
    - reminders of detectors/accelerators  
    - reminders of statistics: likelihoods, hypothesis testing  
    - reminders of multivariate techniques: Neural Networks, Decision Trees  
  - Main topics:  
    - pre-history (pre-LEP)  
    - LEP1: measurements at the Z-pole  
    - LEP2: towards the limit mH<114 GeV  
    - TeVatron searches  
    - LHC:  
      - main channels overview  
      - dissect on analysis  
      - combine information from all channels  
      - differential measurements  
      - off-shell measurements  
    - Future:  
      - pseudo-observables / EFT  
    - Beyond Standard Model  |
| Literature  | - Higgs Hunter's Guide (by S. Dawson, J. Guion, H. Haber and G. Kane)  
- Beyond Standard Model |
| Prerequisites / notice | Prerequisites: Quantum Field Theory I, Phenomenology of Particle Physics I |
| 402-0849-00L| Introduction to Lattice QCD          | W    | 6    | 2V+1U   | P. De Forcrand             |
| Abstract    | This course offers an introduction to quantum field theories, in particular QCD, formulated on a space-time lattice. The lattice provides a non-perturbative, gauge-invariant regularization scheme for the Euclidean path integral. The course introduces both the theoretical background and the computational tools, like Monte Carlo simulations, used for the quantitative study of quarks and gluons. |
| Objective   | To gain familiarity with the formalism of lattice field theories and their numerical simulation methods. |
| 402-0461-00L| Quantum Information Theory          | W    | 8    | 3V+1U   | R. Renner                  |
| Abstract    | The goal of this course is to introduce the foundations of quantum information theory. It starts with a brief introduction to the mathematical theory of information and then discusses the information-theoretic aspects of quantum mechanics. Further topics include applications such as quantum cryptography and quantum computing. |
| Objective   | The course gives an insight into the notion of information and its relevance to physics and, in particular, quantum mechanics. It also serves as a preparation for further courses in the area of quantum information sciences. |
| 402-0866-00L| Soft Condensed Matter               | W    | 6    | 2V+1U   | V. Geshkenbein             |
| Abstract    | Elasticity, Dislocation mediated melting of 2d crystals, Roughening transition, Liquid crystals (classification, elasticity, defects...), Polymers (single chain, Flory scaling, dynamics...). |
| Content     | Elasticity, Dislocation mediated melting of 2d crystals, Roughening transition, Liquid crystals (classification, elasticity, defects...), Polymers (single chain, Flory scaling, dynamics...), Membranes... |
| 402-0875-65L| Topological Aspects of Condensed Matter Physics | W    | 4    | 2G      | G. M. Graf                |
The course begins with some mathematical background like fibre bundles. It covers the quantum Hall effect from various perspectives (phenomenology, heuristic explanation, role of disorder, Landau Hamiltonian, Kubo formula, Chern numbers, index of a pair of projections, bulk and edge). Also discussed: Topological insulators and their indices; the Kitaev table. If time permits, quantum pumps.

**402-0873-65L**
**Partial Differential Equations of Quantum Physics**

This course covers several fundamental equations of quantum physics: the Schrödinger equation, which lies at the foundation of Quantum Mechanics, the Gross-Pitaevskii, Landau-Lifshitz and Hartree and Hartree-Fock equations playing an important role in condensed matter physics, the Ginzburg-Landau equations of superconductivity, and the Yang-Mills equations of particle physics.

**402-0811-00L**
**Programming Techniques for Scientific Simulations I**

This lecture provides an overview of programming techniques for scientific simulations. The focus is on advances C++ programming techniques and scientific software libraries. Based on an overview over the hardware components of PCs and supercomputer, optimization methods for scientific simulation codes are explained.

**402-0809-00L**
**Introduction to Computational Physics**

This course offers an introduction to computer simulation methods for physics problems and their implementation on PCs and supercomputers: classical equations of motion, partial differential equations (wave equation, diffusion equation, Maxwell’s equation), Monte Carlo simulations, percolation, phase transitions.

**Prerequisites / notice**
Lecture and exercise lessons in english, exams in German or in English

**402-0867-00L**
**Programming Techniques for Scientific Simulations II**

This course covers advanced general and C++ programming techniques relevant for scientific simulations. The course will cover, in particular:

- generic algorithm and library design
- exception safety
- smart pointers and safe memory handling
- polymorphism at compile time, at run time and hybrid designs
- mixed language programs, in particular C++, C, Fortran and Python, and the Boost library
- template meta programming and relevant libraries
- C++ libraries for parallel programming on distributed and shared memory machines
- Useful C++ libraries from Boost and other sources

**402-0580-00L**
**Superconductivity**

Topics: occurrence of superconductivity, basic phenomena, thermodynamics, electrolydynamics, London equation, Pippard theory, Ginzburg-Landau theory and -equations, flux quantization, magnetic properties of type I and II superconductors, BCS theory, tunnel effects with superconductors, Josephson effects, superconducting quantum interference devices (SQUID), introduction to high-Tc superconductivity.

**Prerequisites / notice**
The preceding attendance of the scheduled lecture courses Introduction to Solid State Physics and Quantum Mechanics I are expected.

#### Selection: Astronomy

**402-0375-63L**
**Statistical Methods in Cosmology and Astrophysics**

Statistical methods play a vital role in modern cosmology and astrophysics studies. This course will give an overview of the statistical principles and tools that are used in these fields. Topics covered will include basic probability theory, Bayesian inference, hypothesis testing, sampling and estimators.

**402-0381-64L**
**Hot Topics in Astrophysics**

The theme we want to discuss this year is: what do we know about the assembly of diffuse baryons into galaxies and stars, from the physics that govern the birth of new stars, out to the dark matter halos onto which baryons are accreted on cosmological timescales. Specifically, we will focus on the following two -- or, time-permitting, three -- Hot Topics in Astrophysics.

**402-0353-63L**
**Observational Techniques in Astrophysics**

The course introduces analysis techniques, the basics of astronomical instruments, real-world observational tools, data reduction strategy and software packages used in astrophysics research. The course will also include discussions of current topics in astrophysics with a focus on active galaxies. The course will include the reduction and analysis of real data from a variety of observatories.

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Data: 06.02.2019 13:00  Autumn Semester 2015  Page 1159 of 1434
Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the students to the basic principles of neuroinformatics, including the fundamentals of computation in the brain and how these principles are applied in various fields such as robotics and artificial intelligence.

### Prerequisites
- Astrophysics I is required and Astrophysics II is recommended. Some programming skills in Python or similar languages are necessary.

### Selection: Neuroinformatics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-1035-00L</td>
<td>Dynamical Systems in Biology</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>R. Stoop</td>
</tr>
<tr>
<td></td>
<td>This course uses the concepts from dynamical systems (Course: &quot;Computable Chaos in Dynamical Systems&quot;) for the description of salient phenomena in complex examples from population dynamics, neuroinformatics and system biology. A particular focus is on the concept of limit cycle solutions and their coupling.</td>
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<tr>
<td>227-1033-00L</td>
<td>Neuromorphic Engineering I</td>
<td>W</td>
<td>6</td>
<td>2V+3U</td>
<td>T. Delbrück, G. Indiveri, S.C. Liu</td>
</tr>
<tr>
<td></td>
<td>This course covers analog circuits with emphasis on neuromorphic engineering: MOS transistors in CMOS technology, static circuits, dynamic circuits, systems (silicon neuron, silicon retina, silicon cochlea) with an introduction to multi-chip systems. The lectures are accompanied by weekly laboratory sessions.</td>
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<td></td>
<td>Understanding of the characteristics of neuromorphic circuit elements.</td>
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<tr>
<td>227-1037-00L</td>
<td>Introduction to Neuroinformatics</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>K. A. Martin, M. Cook, V. Mante, M. Pfeiffer</td>
</tr>
<tr>
<td></td>
<td>The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.</td>
<td></td>
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<tr>
<td></td>
<td>Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the students to the basic principles of neuroinformatics, including the fundamentals of computation in the brain and how these principles are applied in various fields such as robotics and artificial intelligence.</td>
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<td>This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the basic structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.</td>
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</table>

### Selection: Biophysics, Physical Chemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>551-1601-00L</td>
<td>Biophysics of Biological Macromolecules</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>G. Wider, F. Allain, A. Cléry</td>
</tr>
<tr>
<td></td>
<td>The course will only take place with a minimum of 4 participants.</td>
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</tbody>
</table>
This lecture course targets physics students and students of interdisciplinary sciences (major physics) for their education in biophysics. In this course the basics of molecular biology are presented bearing in mind the special interests of the physics students. Topics include: properties of biological macromolecules, introduction to the genetic system of E. coli bacteria, transcription, translation, discussion of structure and function of proteins, quantitative description of enzyme function and allosteric interactions, biotechnology, introduction to optical spectroscopy, X-ray crystallography and nuclear magnetic resonance (NMR) spectroscopy of biopolymers in solution.

Lecture notes - additional documentation in support of text book

Prerequisites / notice small classes with active participation of students

### Selection: Medical Physics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0341-00L</td>
<td>Medical Physics I</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>P. Manser</td>
</tr>
<tr>
<td>402-0674-00L</td>
<td>Physics in Medical Research: From Atoms to Cells</td>
<td>W</td>
<td>6</td>
<td>2V+1U</td>
<td>B. K. R. Müller</td>
</tr>
</tbody>
</table>

### Selection: Environmental Physics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0572-00L</td>
<td>Aerosols I: Physical and Chemical Principles</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>M. Gysel, U. Baltensperger, H. Burtscher</td>
</tr>
</tbody>
</table>

### Objective
Basics of molecular biology and biophysics in in view of the special interest of students in physics.

### Content
This lecture course targets physics students and students of interdisciplinary sciences (major physics) for their education in biophysics. In this course the basics of molecular biology are presented bearing in mind the special interests of the physics students. The topics include: properties of biological macromolecules, introduction to the genetic system of E. coli bacteria, transcription, translation, discussion of structure and function of proteins, quantitative description of enzyme function and allosteric interactions, biotechnology, introduction to optical spectroscopy, X-ray crystallography and nuclear magnetic resonance (NMR) spectroscopy of biopolymers in solution.

Lecture notes - additional documentation in support of text book

Prerequisites / notice small classes with active participation of students
Lecture Notes on "Functional Analysis" by D.A. Salamon

(1) "Formation of stars" (S. Stahler and F. Palla - Wiley editions, this is the book on which about half of the classes will be based and available, will be sold in the course

Partial Differential Equations

Hours
R. Teyssier
D. A. Salamon


4V+1U

W

4V


D. Williams, Probability with martingales, Cambridge University Press 1991

A. Klenke, Wahrscheinlichkeitstheorie, Springer 2006

J. Jacod and P. Protter, Probability essentials, Springer 2004

Ionescu Tulcea, Markov chains.

Basics in measure theory, random series, law of large numbers, weak convergence, characteristic functions, central limit theorem, conditional expectation, martingales, convergence theorems for martingales, Galton Watson chain, transition probability, Theorem of Ionescu Tulcea, Markov chains.

Literature

http://www.uzh.ch/studies/application/mobilitaet_en.html

Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobilitaet_en.html

Autumn Semester 2015

ECTS
6 credits

Number
Type
Title
Lecturers

401-7855-00L
Computational Astrophysics (University of Zurich) W 6 credits 2V L. M. Mayer

Literature


Objective

Acquire knowledge of main methodologies for computer-based models of astrophysical systems, the physical equations behind them, and train such knowledge with simple examples of computer programs.

Content

1. Integration of ODE, Hamiltonians and Symplectic integration techniques, time adaptivity, time reversibility
2. Large-N gravity calculation, collisionless N-body systems and their simulation
3. Fast Fourier Transform and spectral methods in general
4. Eulerian Hydrodynamics: Upwinding, Riemann solvers, Limiters
5. Lagrangian Hydrodynamics: The SPH method
6. Resolution and instabilities in Hydrodynamics
7. Initial Conditions: Cosmological Simulations and Astrophysical Disks
8. Physical Approximations and Methods for Radiative Transfer in Astrophysics

Literature

Galactic Dynamics (Binney & Tremaine, Princeton University Press),
Computer Simulation using Particles (Hockney & Eastwood CRC press),
Targeted journal reviews on computational methods for astrophysical fluids (SPH, AMR, moving mesh)

Prerequisites / notice

Some background knowledge of UNIX, scripting languages (see www.physik.uzh.ch/lectures/informatik/python as an example), some prior experience programming, knowledge of C, C++ beneficial.

General Electives

Students may choose General Electives from the entire course programme of ETH Zurich - with the following restrictions: courses that belong to the first or second year of a Bachelor curriculum at ETH Zurich as well as courses from the Compulsory Electives in Humanities, Social and Political Sciences are not eligible here.

The following courses are explicitly recommended to physics students by their lecturers. (Courses in this list may be assigned to the category “General Electives” directly in myStudies. For the category assignment of other eligible courses keep the choice “no category” and take contact with the Study Administration Office (www.phys.ethz.ch/phys/education/studiensekretariat/?lang=en) after having received the credits.)

Number Title Type ECTS Hours Lecturers
529-0433-00L Advanced Physical Chemistry: Statistical Thermodynamics W 7 credits 3G G. Jeschke

Abstract

Introduction to statistical mechanics and thermodynamics. Prediction of thermodynamic and kinetic properties from molecular data.

Objective

Introduction to statistical mechanics and thermodynamics. Prediction of thermodynamic and kinetic properties from molecular data.

Content


Lecture notes

See homepage of the lecture.

Literature

Chemical Thermodynamics, Reaction Kinetics, Molecular Quantum Mechanics and Spectroscopy; Mathematical Foundations (Analysis, Combinatorial Relations, Integral and Differential Calculus)

Prerequisites / notice

Nuclear Energy Conversion

Number Title Type ECTS Hours Lecturers
151-0163-00L Nuclear Energy Conversion W 4 credits 2V+1U H.M. Prasser

Abstract

Physical fundamentals of the fission reaction and the sustainable chain reaction, thermal design, construction, function and operation of nuclear reactors and power plants, light water reactors and other reactor types, conversion and breeding

Objective

Students get an overview on energy conversion in nuclear power plants, on construction and function of the most important types of nuclear reactors with special emphasis to light water reactors. They obtain the mathematical/physical basis for quantitative assessments concerning most relevant aspects of design, dynamic behaviour as well as material and energy flows.

Content

Nuclear physics of fission and chain reaction. Thermodynamics of nuclear reactors. Design of the reactor core. Introduction into the dynamic behaviour of nuclear reactors. Overview on types of nuclear reactors, difference between thermal reactors and fast breeders. Construction and operation of nuclear power plants with pressurized and boiling water reactors, role and function of the most important safety systems, special features of the energy conversion. Development tendencies of reactor technology.

Lecture notes

Handouts will be distributed. Additional literature and information on the website of the lab: https://www.uzh.ch/content/specialinterest/mav/energy-technology/lab-of-nuclear-energy-systems/en/studium/teaching-materials/151-0163-00l-nuclear-energy-conversion.html

Literature

Dieter Smidt: Reaktortechnik, Band 1 und Band 2, G. Braun Karlsruhe, 1971

Fluid Dynamics I

Number Title Type ECTS Hours Lecturers
151-0163-00L Fluid Dynamics I W 3 credits 2V+1U P. Jenny

Abstract


Objective

Expand basic knowledge of fluid dynamics. Concepts, phenomena and quantitative description of irrotational (potential), rotational, and one-dimensional compressible flows.

Content


Lecture notes

Lecture notes are available (in German). (See also info on literature below.)

Literature

Handouts are distributed. Additional literature and information from the textbook


Prerequisites / notice

Analysis III, Knowledge of Fluid Dynamics I, thermodynamics of ideal gas

Fluid Dynamics with the Lattice Boltzmann Method

Number Title Type ECTS Hours Lecturers
151-0213-00L Fluid Dynamics with the Lattice Boltzmann Method W 4 credits 3G I. Karlin

Abstract

The course provides an introduction to theoretical foundations and practical usage of the Lattice Boltzmann Method for fluid dynamics simulations.
Methods like molecular dynamics, DSMC, lattice Boltzmann etc are being increasingly used by engineers all over and these methods require knowledge of kinetic theory and statistical mechanics which are traditionally not taught at engineering departments. The goal of this course is to give an introduction to ideas of kinetic theory and non-equilibrium thermodynamics with a focus on developing simulation algorithms and their realizations.

During the course, students will be able to develop a lattice Boltzmann code on their own. Practical issues about implementation and performance on parallel machines will be demonstrated hands on.

Central element of the course is the completion of a lattice Boltzmann code (using the framework specifically designed for this course).

The course will also include a review of topics of current interest in various fields of fluid dynamics, such as multiphase flows, reactive flows, microflows among others.

Optionally, we offer an opportunity to complete a project of student's choice as an alternative to the oral exam. Samples of projects completed by previous students will be made available.

The course builds upon three parts:
1. Elementary kinetic theory and lattice Boltzmann simulations introduced on simple examples.
2. Theoretical basis of statistical mechanics and kinetic equations.

The content of the course includes:
1. Background: Elements of statistical mechanics and kinetic theory:
   - Particle's distribution function, Liouville equation, entropy, ensembles;
   - Kinetic theory: Boltzmann equation for rarefied gas, H-theorem, hydrodynamic limit and derivation of Navier-Stokes equations, Chapman-Enskog method, Grad method, boundary conditions; mean-field interactions, Vlasov equation;
   - Kinetic models: BGK model, generalized BGK model for mixtures, chemical reactions and other fluids.
2. Basics of the Lattice Boltzmann Method and Simulations:
   - Minimal kinetic models: lattice Boltzmann method for single-component fluid, discretization of velocity space, time-space discretization, boundary conditions, forcing, thermal models, mixtures.
3. Hands on:
   - Development of the basic lattice Boltzmann code and its validation on standard benchmarks (Taylor-Green vortex, lid-driven cavity flow etc).
4. Practical issues of LBM for fluid dynamics simulations:
   - Lattice Boltzmann simulations of turbulent flows; numerical stability and accuracy.
5. Microflow:
   - Rarefication effects in moderately dilute gases; Boundary conditions, exact solutions to Couette and Poiseuille flows; micro-channel simulations.
6. Advanced lattice Boltzmann methods:
   - Entropic lattice Boltzmann scheme, subgrid simulations at high Reynolds numbers; Boundary conditions for complex geometries.
7. Introduction to LB models beyond hydrodynamics:
   - Relativistic fluid dynamics; flows with phase transitions.

Lecture notes
Lecture notes on the theoretical parts of the course will be made available.
Selected original and review papers are provided for some of the lectures on advanced topics.
Handouts and basic code framework for implementation of the lattice Boltzmann models will be provided.

Prerequisites / notice
The course addresses mainly graduate students (MSc/Ph D) but BSc students can also attend.

<table>
<thead>
<tr>
<th>Course ID</th>
<th>Title</th>
<th>Credits</th>
<th>Lecture</th>
<th>Prerequisites / notice</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0105-00L</td>
<td>Quantitative Flow Visualization</td>
<td>W 4</td>
<td>2V+1U</td>
<td>T. Rösgen</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to modern imaging techniques and post processing algorithms with special emphasis on flow analysis and visualization. Understanding of hardware and software requirements and solutions. Development of basic programming skills for (generic) imaging applications.</td>
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<tr>
<td>Content</td>
<td>Fundamentals of optics, flow visualization and electronic image acquisition. Frequently used mage processing techniques (filtering, correlation processing, FFTs, color space transforms). Image Velocimetry (tracking, pattern matching, Doppler imaging). Surface pressure and temperature measurements (fluorescent paints, liquid crystal imaging, infrared thermography). Laser induced fluorescence. (Digital) Schlieren techniques, phase contrast imaging, interferometry, phase unwrapping. Wall shear and heat transfer measurements. Pattern recognition and feature extraction, proper orthogonal decomposition.</td>
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<tr>
<td>Lecture notes</td>
<td>available</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Prerequisites: Fluiddynamics I, Numerical Mathematics, programming skills. Language: German on request.</td>
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</table>

Autumn Semester 2015

<table>
<thead>
<tr>
<th>Course ID</th>
<th>Title</th>
<th>Credits</th>
<th>Lecture</th>
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</tr>
</thead>
<tbody>
<tr>
<td>151-0911-00L</td>
<td>Introduction to Plasmonics</td>
<td>W 4</td>
<td>2V+1U</td>
<td>D. J. Norris</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course provides fundamental knowledge of surface plasmon polaritons and discusses their applications in plasmonics. Electromagnetic oscillations known as surface plasmon polaritons have many unique properties that are useful across a broad set of applications in biology, chemistry, physics, and optics. The field of plasmonics has arisen to understand the behavior of surface plasmon polaritons and to develop applications in areas such as catalysis, imaging, photovoltaics, and sensing. In particular, metallic nanoparticles and patterned metallic interfaces have been developed to utilize plasmonic resonances. The aim of this course is to provide the basic knowledge to understand and apply the principles of plasmonics. The course will strive to be approachable to students from a diverse set of science and engineering backgrounds.</td>
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</tbody>
</table>
Content
Fundamentals of Plasmonics
- Basic electromagnetic theory
- Optical properties of metals
- Surface plasmon polaritons on surfaces
- Surface plasmon polariton propagation
- Localized surface plasmons

Applications of Plasmonics
- Waveguides
- Extraordinary optical transmission
- Enhanced spectroscopy
- Sensing
- Metamaterials

Lecture notes
Class notes and handouts

Literature

Prerequisites /
notice
Physics I, Physics II

151-0107-20L High Performance Computing for Science and Engineering (HPCSE) I

Abstract
This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.

Objective
Introduction to HPC for scientists and engineers
Fundamental of:
1. Parallel Computing Architectures
2. MultiCores
3. ManyCores

Content
Programming models and languages:
1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)

Computers and methods:
1. Hardware and architectures
2. Libraries
3. Particles: N-body solvers
4. Fields: PDEs
5. Stochastics: Monte Carlo

Lecture notes
http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1

Class notes, handouts

151-0621-00L Microsystems Technology

Abstract
Students are introduced to the basics of micromachining and silicon process technology and will learn about the fabrication of microsystems and -devices by a sequence of defined processing steps (process flow).

Objective
Students are introduced to the basics of micromachining and silicon process technology and will understand the fabrication of microsystem devices by the combination of unit process steps (= process flow).

Content
- Introduction to Microsystems technology (MST) and micro electro mechanical systems (MEMS)
- Basic silicon technologies: Thermal oxidation, photolithography and etching, diffusion and ion implantation, thin film deposition.
- Specific microsystems technologies: Bulk and surface micromachining, dry and wet etching, isotropic and anisotropic etching, beam and membrane formation, wafer bonding, thin film mechanical and thermal properties, piezoelectric and piezoresistive materials.

Handouts (available online)

227-0385-10L Biomedical Imaging
New course. Not to be confused with 227-0385-00L of fall 2014.

Abstract
Introduction and analysis of medical imaging technology including X-ray procedures, computed tomography, nuclear imaging techniques using single photon and positron emission tomography, magnetic resonance imaging and ultrasound imaging techniques.

Objective
To understand the physical and technical principles underlying X-ray imaging, computed tomography, single photon and positron emission tomography, magnetic resonance imaging, ultrasound and Doppler imaging techniques. The mathematical framework is developed to describe image encoding/decoding, point-spread function/modular transfer function, signal-to-noise ratio, contrast behavior for each of the methods. Matlab exercises are used to implement and study basic concepts.
### Biomedical Engineering

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Semester</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0386-00L</td>
<td>Biomedical Engineering</td>
<td>4</td>
<td>3G</td>
<td>J. Vörös, S. J. Ferguson, S. Kozerke, U. Moser, M. Rudin, M. P. Wolf, M. Zenobi-Wong</td>
</tr>
</tbody>
</table>

**Abstract**

Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

**Objective**

Introduction into selected topics of biomedical engineering as well as their relationship with physics and physiology. The course provides an overview of the various topics of the different tracks of the biomedical engineering master course and helps orienting the students in selecting their specialized classes and project locations.

**Content**


**Lecture notes**

Introduction to Biomedical Engineering by Enderle, Banchard, and Bronzino

[AND](https://www1.ethz.ch/lbb/Education/BME)

### Micro and Nano-Tomography of Biological Tissues

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Semester</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0965-00L</td>
<td>Micro and Nano-Tomography of Biological Tissues</td>
<td>4</td>
<td>3G</td>
<td>M. Stampanoni, K. S. Mader</td>
</tr>
</tbody>
</table>

**Abstract**

The lecture introduces the physical and technical know-how of X-ray tomographic microscopy. Several X-ray imaging techniques (absorption-, phase- and darkfield contrast) will be discussed and their use in daily research, in particular biology, is presented. The course discusses the aspects of quantitative evaluation of tomographic data sets like segmentation, morphometry and statistics.

**Objective**

Introduction to the basic concepts of X-ray tomographic imaging, image analysis and data quantification at the micro and nano scale with particular emphasis on biological applications.

**Content**

Synchrotron-based X-ray micro- and nano-tomography is today a powerful technique for non-destructive, high-resolution investigations of a broad range of materials. The high-brilliance and high-coherence of third generation synchrotron radiation facilities allow quantitative, three-dimensional imaging at the micro and nanometer scale and extend the traditional absorption imaging technique to edge-enhanced and phase-sensitive measurements, which are particularly suited for investigating biological samples.

The lecture includes a general introduction to the principles of tomographic imaging from image formation to image reconstruction. It provides the physical and engineering basics to understand how imaging beamlines at synchrotron facilities work, looks into the recently developed phase contrast methods, and explores the first applications of X-ray nano-tomographic experiments.

The course finally provides the necessary background to understand the quantitative evaluation of tomographic data, from basic image analysis to complex morphometrical computations and 3D visualization, keeping the focus on biomedical applications.

**Lecture notes**

Available online

[AND](https://www1.ethz.ch/lbb/Education/BME)

### Semiconductor Devices: Physical Bases and Simulation

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Semester</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0157-00L</td>
<td>Semiconductor Devices: Physical Bases and Simulation</td>
<td>4</td>
<td>3G</td>
<td>A. Schenk</td>
</tr>
</tbody>
</table>

**Abstract**

The course addresses the physical principles of modern semiconductor devices and the foundations of their modeling and numerical simulation. Necessary basic knowledge on quantum-mechanics, semiconductor physics and device physics is provided. Computer simulations of the most important devices and of interesting physical effects supplement the lectures.

**Objective**

The course aims at the understanding of the principle physics of modern semiconductor devices, of the foundations in the physical modeling of transport and its numerical simulation. During the course also basic knowledge on quantum-mechanics, semiconductor physics and device physics is provided.

**Content**

The main topics are: transport models for semiconductor devices (quantum transport, Boltzmann equation, drift-diffusion model, hydrodynamic model), physical characterization of silicon (intrinsic properties, scattering processes), mobility of cold and hot carriers, recombination (Shockley-Read-Hall statistics, Auger recombination), impact ionization, metal-semiconductor contact, metal-insulator-semiconductor structure, and heterojunctions. The exercises are focussed on the theory and the basic understanding of the operation of special devices, as single-electron transistor, resonant tunneling diode, pn-diode, bipolar transistor, MOSFET, and laser. Numerical simulations of such devices are performed with an advanced simulation package (Sentaurus-Synopsys). This enables to understand the physical effects by means of computer experiments.

**Lecture notes**

The script (in book style) can be downloaded from: [http://www.iis.ee.ethz.ch/schenk/vorlesung](http://www.iis.ee.ethz.ch/schenk/vorlesung)

**Literature**

The script (in book style) is sufficient. Further reading will be recommended in the lecture.

**Prerequisites / notice**


### VLSI II: Design of Very Large Scale Integration Circuits

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Semester</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0147-00L</td>
<td>VLSI II: Design of Very Large Scale Integration Circuits</td>
<td>7</td>
<td>5G</td>
<td>H. Kaeslin, N. Felber</td>
</tr>
</tbody>
</table>

**Abstract**

This second course in our VLSI series is concerned with how to turn digital netlists into safe, testable and manufacturable mask layout, taking into account various parasitic effects (clock skew, metastability, ground bounce, IR-drop, electromigration, ESD, latchup). Economic aspects and management issues of VLSI projects are also addressed.

**Objective**

Know how to design digital VLSI circuits that are safe, testable, durable, and make economic sense.
The second course begins with a thorough discussion of various technical aspects at the circuit and layout level before moving on to economic issues of VLSI. Topics include:

- Limitations of functional design verification, design for test.
- Synchronous clocking disciplines compared, clock skew, clock distribution, input/output timing.
- Synchronization and metastability.
- CMOS transistor-level circuits of gates, flip-flops and random access memories.
- Sinks of energy in CMOS circuits.
- Power estimation and low-power design.
- Current research in low-energy computing.
- Layout parasitics, interconnect delay, static timing analysis.
- Switching currents, ground bounce, IR-drop, power distribution.
- Floorplanning, chip assembly, packaging.
- Layout design at the mask level, physical design verification.
- Electromigration, electrostatic discharge, and latch-up.
- Models of industrial cooperation in microelectronics.
- The caveats of virtual components.
- The cost structures of ASIC development and manufacturing.
- Market requirements, decision criteria, and case studies.
- Yield models.
- Avenues to low-volume fabrication.
- Marketing aspects and case studies.
- Management of VLSI projects.

Exercises are concerned with back-end design (floorplanning, placement, routing, clock and power distribution, layout verification). Industrial CAD tools are being used.

Lecture notes

All written documents in English.

Literature


Prerequisites / notice

Students are offered the opportunity to design a circuit of their own which then gets actually fabricated as a microchip! Students who elect to participate in this program register for a term project at the Integrated Systems Laboratory in parallel to attending the VLSI II course.

Prerequisites:

"VLSI I: from Architectures to Very Large Scale Integration Circuits and FPGAs" or equivalent knowledge.

Further details:

http://www.iis.ee.ethz.ch/stud_area/vorlesungen/vlsi2.en.html

227-0663-00L Nano-Optics W 6 credits 2V+2U L. Novotny

Abstract

Nano-Optics is the study of optical phenomena and techniques on the nanometer scale. It is an emerging field of study motivated by the rapid advance of nanoscience and technology. It embraces topics such as plasmonics, optical antennas, optical trapping and manipulation, and high-resolution imaging and spectroscopy.

Objective

Understanding concepts of light localization and light-matter interactions on the nanoscale.

Content

Starting with an angular spectrum representation of optical fields the role of inhomogeneous evanescent fields is discussed. Among the topics are: theory of strongly focused light, point spread functions, resolution criteria, confocal microscopy, and near-field optical microscopy. Further topics are: optical interactions between nanoparticles, atomic decay rates in inhomogeneous environments, single molecule spectroscopy, light forces and optical trapping, photonic bandgap materials, and theoretical methods in nano-optics.

Prerequisites / notice

- Electrodynamics (or equivalent)
- Physics I+II

227-0655-00L Nonlinear Optics W 6 credits 2V+1U J. Leuthold

Does not take place this semester.
Takes place in spring 2016

Abstract

Nonlinear Optics deals with the interaction of light with material, the response of material to light and the mathematical framework to describe the phenomena. As an example we will cover fundamental phenomena such as the refractive index, the electro-optic effect, second harmonic generation, four-wave mixing or soliton propagation and others.

Objective

The important nonlinear optical phenomena are understood and can be classified. The effects can be described mathematical by means of the susceptibility.

Content

Chapter 1: The Wave Equations in Nonlinear Optics
Chapter 2: Nonlinear Effects - An Overview
Chapter 3: The Nonlinear Optical Susceptibility
Chapter 4: Second Harmonic Generation
Chapter 5: The Electro-Optic Effect and the Electro-Optic Modulator
Chapter 6: Acousto-Optic Effect
Chapter 7: Nonlinear Effects of Third Order
Chapter 8: Nonlinear Effects in Media with Gain

Literature

Prerequisites / notice

Fundamentals of Electromagnetic Fields (Maxwell Equations) & Bachelor Lectures on Physics

227-0301-00L Optical Communication Fundamentals W 6 credits 2V+1U+1P J. Leuthold

Abstract

The path of an analog signal in the transmitter to the digital world in a communication link and back to the analog world at the receiver is discussed. The lecture covers the fundamentals of all important optical and optoelectronic components in a fiber communication system. This includes the transmitter, the fiber channel and the receiver with the electronic digital signal processing elements.

Objective

An in-depth understanding on how information is transmitted from source to destination. Also the mathematical framework to describe the important elements will be passed on. Students attending the lecture will further get engaged in critical discussion on societal, economical and environmental aspects related to the on-going exponential growth in the field of communications.
Content

- Chapter 1: Introduction: Analog/Digital conversion, The communication channel, Shannon channel capacity, Capacity requirements.
- Chapter 4: The Receiver: Photodiodes, Receiver noise, Detector schemes (direct detection, coherent detection), Bit-error ratios and error estimations.
- Chapter 5: Digital Signal Processing Techniques: Digital signal processing in a coherent receiver, Error detection techniques, Error correction coding.
- Chapter 6: Pulse Shaping and Multiplexing Techniques: WDM/FDM, TDM, OFDM, Nyquist Multiplexing, OCDMA.
- Chapter 7: Optical Amplifiers: Semiconductor Optical Amplifiers, Erbium Doped Fiber Amplifiers, Raman Amplifiers.

Lecture notes

Lecture notes are handed out.

Literature

Govind P. Agrawal; "Fiber-Optic Communication Systems"; Wiley, 2010

A script which covers the topics will be distributed in the lecture and will be accessible through the web page

A comprehensive understanding of the interaction of electrons with condensed matter and details on the instrumentation and methods

, S. Blunier, M. Haluska

A document containing theory, background and practical course content is distributed at the first meeting of the course.

* Chapter 1: Introduction: Analog/Digital conversion, The communication channel, Shannon channel capacity, Capacity requirements.

529-0443-00L

Advanced Magnetic Resonance

W 7 credits 3G B. H. Meier, M. Ernst

Abstract

The course is for advanced students and covers selected topics from magnetic resonance spectroscopy. This year, the course will introduce and discuss the theoretical foundation of high-resolution solid-state NMR under magic-angle spinning.

Objective

The aim of the course is to familiarize the students with the basic concepts of high-resolution solid-state NMR. Starting from the mathematical description of spin dynamics, important building blocks for multi-dimensional experiments are discussed to allow students a better understanding of modern solid-state NMR experiments.

Content

The basic principles of NMR in solids will be introduced. After the discussion of basic tools to describe NMR experiments, basic methods and experiments will be discussed, e.g., magic-angle spinning, cross polarization, decoupling, and recoupling experiments. Such basic building blocks allow a tailoring of the effective Hamiltonian to the needs of the experiment. These basic building blocks can then be combined in different ways to obtain spectra that contain the desired information.

Lecture notes

A script which covers the topics will be distributed in the lecture and will be accessible through the web page http://www.ssnmr.ethz.ch/education/

327-0703-00L

Electron Microscopy in Material Science

W 4 credits 2V+2U H. Gross, R. Erni, S. Gerstl, F. Gramm, F. Krumeich, K. Kunze, R. A. Wepl

Abstract

A comprehensive understanding of the interaction of electrons with condensed matter and details on the instrumentation and methods designed to use these probes in the structural and chemical analysis of various materials.

Objective

A comprehensive understanding of the interaction of electrons with condensed matter and details on the instrumentation and methods designed to use these probes in the structural and chemical analysis of various materials.

Content

This course provides a general introduction into electron microscopy of organic and inorganic materials. In the first part, the basics of transmission- and scanning electron microscopy are presented. The second part includes the most important aspects of specimen preparation, imaging and image processing. In the third part, recent applications in materials science, solid state physics, structural biology, structural geology and structural chemistry will be reported.

Lecture notes

English
327-0702-00L EM-Practical Course in Materials Science

Abstract
Practical work on a TEM and on SEM, treatment of typical problems, data analysis, writing of a report

Objective
Application of basic electron microscopic techniques to materials science problems

Literature
see lecture Electron Microscopy (327-0703-00L)

Prerequisites / notice
Prerequisite: the lecture Electron Microscopy (327-0703-00L) has to be attended with success, maximum number of participants 15, work in groups of 3 people.

363-0541-00L Systems Dynamics and Complexity

Abstract
Finding solutions: what is complexity, problem solving cycle.

Objective
Implementing solutions: project management, critical path method, quality control feedback loop.

Content
Why are problems not simple? Why do some systems behave in an unintended way? How can we model and control their dynamics? The course provides answers to these questions by using a broad range of methods encompassing systems oriented management, classical systems dynamics, nonlinear dynamics and macroeconomic modeling.

Lecture notes
The course is structured along three main tasks:
1. Finding solutions
2. Implementing solutions
3. Controlling solutions

PART 1 introduces complexity as a system immanent property that cannot be simplified. It introduces the problem solving cycle, used in systems oriented management, as an approach to structure problems and to find solutions.

PART 2 discusses selected problems of project management when implementing solutions. Methods for identifying the critical path of subtasks in a project and for calculating the allocation of resources are provided. The role of quality control as an additional feedback loop and the consequences of small changes are discussed.

PART 3, by far the largest part of the course, provides more insight into the dynamics of existing systems. Examples come from biology (population dynamics), management (inventory modeling, technology adoption, production systems) and economics (supply and demand, investment and consumption). For systems dynamics models, the software program VENSIM is used to evaluate the dynamics. For economic models analytical approaches, also used in nonlinear dynamics and control theory, are applied. These together provide a systematic understanding of the role of feedback loops and instabilities in the dynamics of systems. Emphasis is on oscillating phenomena, such as business cycles and other life cycles.

Weekly self-study tasks are used to apply the concepts introduced in the lectures and to come to grips with the software program VENSIM. Weekly exercise sessions (45 min) are used to discuss selected solutions. Regular participation in the exercises is an efficient way to understand the concepts relevant for the final exam.

Prerequisites / notice
Self-study tasks (discussion exercises, Vensim exercises) are provided as homework. The lecture slides are provided as handouts - including notes and literature sources - to registered students only. All material is to be found on the Moodle platform. More details during the first lecture.

8 credits

Proseminars and Semester Papers

To organise a semester project take contact with one of the instructors.

Not all lecturers are directly eligible in myStudies if "Professors" is the required type of lecturers. In such cases please take contact with the Study Administration Office (http://www.phys.ethz.ch/phys/education/studiensekretariat/?lang=en).

Number Title Type ECTS Hours Lecturers
402-0210-95L Proseminar Theoretical Physics: Particle Physics at the Energy Frontier W 9 credits 4S A. Lazopoulos

Abstract
A guided self-study of original papers and of advanced textbooks in theoretical physics. Within the general topic, determined each semester, participants give a presentation on a particular subject and deliver a written report.

402-0217-MSL Theoretical Semester Project in a Group of the Physics Department W 9 credits 18A C. Anastasiou, N. Beisert, M. Sigrist, M. Troyer

Abstract
This course unit is an alternative if no suitable "Proseminar Theoretical Physics" is available of if the proseminar is already overbooked. Die Leistungskontrolle erfolgt aufgrund eines oder mehrerer schriftlicher Berichte bzw. einer schriftlichen Arbeit. Vorträge können ein zusätzlicher Bestandteil der Leistungskontrolle sein.

402-0215-MSL Experimental Semester Project in a Group of the Physics Department W 9 credits 18A Professors

Abstract
The aim of the project is to give the student experience in working in a research environment, carrying out physics experiments, analysing and interpreting the resulting data.

402-0510-MSL Advanced Solid State Physics Experiments W 9 credits 18P Supervisors

Abstract
Erni: Aberration-corrected imaging in transmission electron microscopy, Imperial College Press (2010, and 2nd ed. 2015)


Data: 06.02.2019 13:00 Autumn Semester 2015 Page 1169 of 1434
Supervisors for this experimental semester paper:
Prof. Bertram Batlogg
Prof. Christian Degen
Prof. Leonardo Degiorgi
Prof. Klaus Ensslin
Prof. Thomas Ihn
Prof. Joël Mesot
Prof. Andreas Valerlaus
Prof. Andreas Wallraff
Prof. Werner Wegscheider
Prof. Andrey Zheludev

Abstract
Experiments in condensed matter physics. The work includes the planning, build-up, data taking and analysis, and interpretation of the experimental results.

Objective

Content

Abstract
Implementation of experiments in quantum electronics. Planning, design, realisation, evaluation, and interpretation of the experiments.

Content

Abstract
During the semester break participating students stay for 4 weeks at CERN and perform experimental work relevant to our particle physics projects. Dates to be agreed upon.

Objective
Students learn, by doing, the needed skills to perform a small particle physics experiment: setup, problem solving, data taking, analysis, interpretation and presentation in a written report of publication quality.

Prerequisites / notice
Language of instruction: English or German
begin with their master's thesis:
a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to
gain admission to the master programme.
c. have acquired at least 9 credits in the category
Proseminars and Semester Papers.

Please send the completed form
https://www.phys.ethz.ch/content/dam/ethz/main/educatio
n/bachelor/physik/files/2014-
10-Masterarbeit_%20PHYS_Regl%202007.pdf
to the Study Administration
Further information:
www.phys.ethz.ch/phys/education/master/msc-theses

Abstract
The master's thesis concludes the study programme. Thesis work should prove the students' ability to independent, structured and
scientific working.

Master Thesis (Programme Regulations 2014)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>402-2000-00L</td>
<td>Scientific Works in Physics</td>
<td></td>
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<td>D. Würtz</td>
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<tr>
<td>402-0900-30L</td>
<td>Master's Thesis</td>
<td></td>
<td>30</td>
<td>57D</td>
<td>Supervisors</td>
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</table>

Seminars, Colloquia, and Additional Courses

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<tr>
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<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>402-0247-00L</td>
<td>Electronics for Physicists I (Analogue)</td>
<td>Z</td>
<td>4</td>
<td>2V+2P</td>
<td>R. Horisberger</td>
</tr>
<tr>
<td>402-0800-00L</td>
<td>The Zurich Theoretical Physics Colloquium</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>S. Huber, C. Anastasiou, N. Beisert, G. Blatter, M. Gaberdiel,</td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
<td>E-</td>
<td>Credits</td>
<td>S</td>
<td>Authors</td>
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<tr>
<td>402-0890-00L</td>
<td>Seminars of the Platform for Advanced Scientific Computing (PASC)</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>H. J. Herrmann, T. C. Schulthess, N. Spaldin, M. Troyer</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
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<td></td>
<td>Seminars by invited speakers in the area of advanced scientific computing.</td>
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<tr>
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<td>Objective</td>
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<td></td>
<td>Discourse of state of the art techniques and methodologies in scientific computing.</td>
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<tr>
<td></td>
<td>Content</td>
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<td></td>
<td>This course consists in a series of seminars by invited speakers on subjects of interest for the &quot;Platform for Advanced Scientific Computing&quot;.</td>
</tr>
<tr>
<td></td>
<td>Lecture notes</td>
<td></td>
<td></td>
<td></td>
<td>There is no script.</td>
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<tr>
<td></td>
<td>Literature</td>
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<td></td>
<td>Literature will be provided by the speakers in their respective presentations.</td>
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<tr>
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<td>Prerequisites / notice</td>
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<td></td>
<td>Participants should have experience on advanced scientific computing.</td>
</tr>
<tr>
<td>401-5330-00L</td>
<td>Talks in Mathematical Physics</td>
<td>E-</td>
<td>0</td>
<td>1K</td>
<td>A. Cattaneo, G. Felder, M. Gaberdiel, G. M. Graf, H. Knörrer, T. H. Willwacher, University lecturers</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td>Research colloquium</td>
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<tr>
<td>402-0501-00L</td>
<td>Solid State Physics</td>
<td>E-</td>
<td>0</td>
<td>1S</td>
<td>B. Batlogg, G. Blatter, C. Degen, K. Ensslin, D. Pescia, M. Sigrist, A. Wallraff, A. Zholudev</td>
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<td>Abstract</td>
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<td>Research colloquium</td>
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<td>Research colloquium</td>
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<tr>
<td>402-0600-00L</td>
<td>Nuclear and Particle Physics with Applications</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>A. Rubbia, G. Dissertori, C. Grab, K. S. Kirch, F. Pauss, R. Wallny</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
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<td>Research colloquium</td>
</tr>
<tr>
<td>402-0893-00L</td>
<td>Particle Physics Seminar</td>
<td>E-</td>
<td>0</td>
<td>1S</td>
<td>T. K. Gehrmann</td>
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<td></td>
<td>Abstract</td>
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<td>Research colloquium</td>
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<tr>
<td></td>
<td>Prerequisites / notice</td>
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<td></td>
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<td>Occasionally, talks may be delivered in German.</td>
</tr>
<tr>
<td>402-0700-00L</td>
<td>Seminar in Elementary Particle Physics</td>
<td>E-</td>
<td>0</td>
<td>1S</td>
<td>M. Spira</td>
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<tr>
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<td>Abstract</td>
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<td>Research colloquium</td>
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<td></td>
<td>Objective</td>
<td></td>
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<td></td>
<td>Stay informed about current research results in elementary particle physics.</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>During the semester there is a colloquium every week. In general, colloquia are 20 minutes plus discussion and are given by local researchers. They inform the other members of the Institute of Astronomy about their current work, results, problems and plans. Guests are always welcome. Ph.D. students are expected to give a first research colloquium within their first years of their graduate time, another colloquium in their third year, and their doctoral exam talk before or after the exam. Other members of the institute are also invited to give talks. The goals are: - keep other members of the institute oriented on current research - test new ideas within the institute before going outside - train students to give scientific talks</td>
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<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>Research colloquium</td>
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<tr>
<td>402-0746-00L</td>
<td>Seminar: Particle and Astrophysics</td>
<td>E-</td>
<td>0</td>
<td>2S</td>
<td>P. Jetzer, C. Grab, University lecturers</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
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<td>Research colloquium</td>
</tr>
<tr>
<td></td>
<td>Content</td>
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<td>In Seminarvorträgen werden aktuelle Fragestellungen aus der Teilchenphysik vom theoretischen und experimentellen Standpunkt aus diskutiert. Besonders wichtig erscheint uns der Bezug zu den eigenen Forschungsmöglichkeiten am PSI, CERN und DESY.</td>
</tr>
<tr>
<td>402-0396-00L</td>
<td>Recent Research Highlights in Astrophysics (University of Zurich)</td>
<td>E-</td>
<td>0</td>
<td>1S</td>
<td>University lecturers</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
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<td></td>
<td>No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: AST006 Mind the enrolment deadlines at UZH: <a href="http://www.uzh.ch/studies/application/mobilitaet_en.html">http://www.uzh.ch/studies/application/mobilitaet_en.html</a> Research colloquium</td>
</tr>
<tr>
<td>402-0530-00L</td>
<td>Mesoscopic Systems</td>
<td>E-</td>
<td>0</td>
<td>1S</td>
<td>T. M. Ihn</td>
</tr>
<tr>
<td></td>
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<td>Research colloquium</td>
</tr>
<tr>
<td>402-0620-00L</td>
<td>Current Topics in Accelerator Mass Spectrometry and Their Applications</td>
<td>E-</td>
<td>0</td>
<td>1S</td>
<td>M. Christi, S. Willett</td>
</tr>
</tbody>
</table>
Abstract
The seminar is aimed at all students who, during their studies, are confronted with age determination methods based on long-living radionuclides found in nature. Basic methodology, the latest developments, and special examples from a wide range of applications will be discussed.

227-0980-00L Seminar on Biomedical Magnetic Resonance  E-  0 credits  2K  K. P. Prüssmann, S. Kozerke, M. Rudin
Abstract
Actuel developments and problems of magnetic resonance imaging (MRI)
Objective
Getting insight to advanced topics in Magnetic Resonance Imaging

227-1043-00L Neuroinformatics - Colloquia  E-  0 credits  1K  S.C. Liu, R. Hahnloser, V. Mante, K. A. Martin
Abstract
The colloquium in Neuroinformatics is a series of lectures given by invited experts. The lecture topics reflect the current themes in neurobiology and neuromorphic engineering that are relevant for our Institute.
Objective
The goal of these talks is to provide insight into recent research results. The talks are not meant for the general public, but really aimed at specialists in the field.
Content
The topics depend heavily on the invited speakers, and thus change from week to week.
All topics concern neural computation and their implementation in biological or artificial systems.

227-1044-00L Auditory Informatics  E-  2 credits  1S  R. Stoop
Abstract
Invited talks on current research from the following areas: Auditory information processing, auditory sensors (biological and electrical), coding of information, perception, scene-segmentation.
Objective
Exchange with researchers in the domain of auditory informatics. Preparing and giving a presentation on a suitable topic in front of a scientific audience.
Content
The semester program is available under: http://stoop.ini.uzh.ch/teaching/seminar-on-auditory-informatics
Prerequisites / notice
On request the "Lehrsprache" may be changed to German.

651-1581-00L Seminar in Glaciology  E-  3 credits  2S  A. Bauder
Abstract
Studium aktueller und klassischer Arbeiten der glaziologischen Forschung
Objective
Content
Studium aktueller und klassischer Arbeiten der glaziologischen Forschung
Lecture notes
benötigte Unterlagen werden im Verlauf der Veranstaltung abgegeben

Course Units for Additional Admission Requirements
The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>406-0204-AAL</td>
<td>Electrodynamics</td>
<td>E-</td>
<td>7</td>
<td>15R</td>
<td>C. Anastasiou</td>
</tr>
<tr>
<td></td>
<td>Enrolment only for MSc students who need this course as additional requirement.</td>
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</tr>
<tr>
<td>Objective</td>
<td>Develop a physical understanding for static and dynamic phenomena related to (moving) charged objects and understand the structure of the classical field theory of electrodynamics (transverse versus longitudinal physics, invariances (Lorentz-, gauge-)}. Appreciate the interrelation between electric, magnetic, and optical phenomena and the influence of media. Understand a set of classic electrodynamical phenomena and develop the ability to solve simple problems independently. Apply previously learned mathematical concepts (vector analysis, complete systems of functions, Green's functions, co- and contravariant coordinates, etc.). Prepare for quantum mechanics (eigenvalue problems, wave guides and cavities).</td>
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</tr>
</tbody>
</table>
| Literature | W.K.H Panovsky and M. Phillis, Classical electricity and magnetism  
J.D. Jackson, Classical Electrodynamics  
W.K. H. Mecklenburg, Electrodynamics of continuous media  
S. M. S. Pak, Electrodynamics of continuous media  
A. Sommerfeld, Electricity and Magnetism  
W.K.H Panovsky and M. Phillis, Classical electricity and magnetism  
S. M. S. Pak, Electrodynamics of continuous media  
A. Sommerfeld, Electricity and Magnetism  
M. Born and E. Wolf, Principles of optics  |
| Literature | R. Feynman, R. Leighton, and M. Sands, The Feynman Lectures of Physics, Vol II  |

406-0663-AAL Numerical Methods for CSE  E-  7 credits  15R  R. Hiptmair
Enrolment only for MSc students who need this course as additional admission requirement.  
Abstract
Introduction into fundamental techniques and algorithms of numerical mathematics which play a central role in numerical simulations in science and technology.
Objective
* Knowledge of the fundamental algorithms in numerical mathematics  
* Knowledge of the essential terms in numerical mathematics and the techniques used for the analysis of numerical algorithms  
* Ability to choose the appropriate numerical method for concrete problems  
* Ability to interpret numerical results  
* Ability to implement numerical algorithms efficiently

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 1173 of 1434
The course will cover the following chapters:

1. Direct Methods for linear systems of equations
2. Interpolation
3. Iterative Methods for non-linear systems of equations
4. Krylov methods for linear systems of equations
5. Eigensolvers
6. Least Squares Techniques
7. Filtering Algorithms
8. Approximation of Functions
9. Numerical Quadrature
10. Clustering Techniques
11. Single Step Methods for ODEs
12. Stiff Integrators

Lecture notes
Comprehensive lecture materials are available upon request from the lecturer.

Literature
M. Hanke-Bourgeois "Grundlagen der Numerischen Mathematik und des wissenschaftlichen Rechnens", BG Teubner, 2002
C. Moler, "Numerical computing with MATLAB", SIAM, 2004
P. Deuflhard and A. Hohmann, "Numerische Mathematik I", DeGruyter, 2002

Prerequisites / notice
Solid knowledge about fundamental concepts and techniques from linear algebra & calculus as taught in the first year of science and engineering curricula.

Physics Master - Key for Type

| W+ | Eligible for credits and recommended               | Z   | Courses outside the curriculum |
|    |                                                   |     |                                |
| W  | Eligible for credits                             | Dr  | Suitable for doctorate         |
| E- | Recommended, not eligible for credits            | O   | Compulsory                     |

Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Students in the Joint Degree Master's Programme “Quantitative Finance” must book UZH modules directly at the UZH. Those modules are not listed here.

► Core Courses

►► Economic Theory for Finance

For possible additional course offerings see www.msfinance.ch

►► Mathematical Methods for Finance

For possible additional course offerings see www.msfinance.ch

### Core Courses

#### Economic Theory for Finance

For possible additional course offerings see www.msfinance.ch

#### Mathematical Methods for Finance

For possible additional course offerings see www.msfinance.ch

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<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3913-01L</td>
<td>Mathematical Foundations for Finance</td>
<td>W</td>
<td>4 credits</td>
<td>3V+2U</td>
<td>E. W. Farkas, M. Schweizer</td>
</tr>
</tbody>
</table>

**Abstract**

First introduction to main modelling ideas and mathematical tools from mathematical finance

**Objective**

This course gives a first introduction to the main modelling ideas and mathematical tools from mathematical finance. It aims at a double audience: mathematicians who want to learn the modelling ideas and concepts for finance, and non-mathematicians who need an introduction to the main tools from stochastics used in mathematical finance. The main emphasis will be on ideas, but important results will be given with (sometimes partial) proofs.

**Content**

- financial market models in finite discrete time
- absence of arbitrage and martingale measures
- valuation and hedging in complete markets
- basics about Brownian motion
- stochastic integration
- stochastic calculus: Itô's formula, Girsanov transformation, Itô's representation theorem
- Black-Scholes formula

**Lecture notes**

Lecture notes will be sold at the beginning of the course.

**Literature**

Lecture notes will be sold at the beginning of the course. Additional (background) references are given there.

**Prerequisites / notice**

Prerequisites: Results and facts from probability theory as in the book “Probability Essentials” by J. Jacod and P. Protter will be used freely. Especially participants without a direct mathematics background are strongly advised to familiarise themselves with those tools before (or very quickly during) the course. (A possible alternative to the above English textbook are the (German) lecture notes for the standard course “Wahrscheinlichkeitslehre”.)

For those who are not sure about their background, we suggest to look at the exercises in Chapters 8, 9, 22-25, 28 of the Jacod/Protter book. If these pose problems, you will have a hard time during the course. So be prepared.

### Elective Courses

#### Economic Theory for Finance

For possible additional course offerings see www.msfinance.ch

<table>
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<tr>
<th>Number</th>
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</tr>
</thead>
<tbody>
<tr>
<td>401-4633-00L</td>
<td>Data Analytics in Organisations and Business</td>
<td>W</td>
<td>5 credits</td>
<td>2V+1U</td>
<td>I. Flückiger</td>
</tr>
</tbody>
</table>

**Abstract**

On the end-to-end process of data analytics in organisations & business and how to transform data into insights for fact based decisions. Presentation of the process from the beginning with framing the business problem to presenting the results and making decisions by the use of data analytics. For each topic case studies from the financial service, healthcare and retail sectors will be presented.

**Objective**

The goal of this course is to give the students the understanding of the data analytics process in the business world, with special focus on the skills and techniques used besides the technical skills. The student will become familiar with the "business language", current problems and thinking in organisations and business and tools used.

**Content**

- Framing the Business Problem
- Framing the Analytics Problem
- Data Methodology
- Model Building
- Deployment
- Model Lifecycle

**Lecture notes**

Lecture Notes will be available.

**Prerequisites / notice**

Prerequisites: Basic statistics and probability theory and regression

### Mathematical Methods for Finance

For possible additional course offerings see www.msfinance.ch

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3953-00L</td>
<td>Interest Rate Modeling in Discrete Time</td>
<td>W</td>
<td>4 credits</td>
<td>2V</td>
<td>M. V. Wüthrich</td>
</tr>
</tbody>
</table>

**Abstract**

This course gives an introduction to stochastic interest rate modeling in discrete time. Starting from cash flow valuation with state price deflators, we derive the equivalent martingale measures for pricing financial instruments and derivatives of primary assets. The lecture is supplemented by several examples such as the Vasicek model where we also study model calibration.

**Objective**

The students are familiar with the basic terminology of stochastic interest rate modeling and he is able to transfer his (financial) mathematical knowledge to real world pricing of cash flows and financial instruments.

**Content**

The following topics are covered:
1) stochastic discounting with state price deflators
2) equivalent martingale measures
3) pricing of cash flows and primary assets
4) pricing of derivatives, e.g. European put options
5) (multi-factor) Vasicek state price deflator model
6) Heath-Jarrow-Morton interest rate modeling framework

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 1175 of 1434
New Trends in Stochastic Portfolio Theory

In Mathematical Finance, asset prices are typically assumed to be given exogenously. This leads to tractable models that are well-suited to

For further reading:

Prerequisites / notice
The exams ONLY take place during the official ETH examination period.

Prerequisites: knowledge of probability theory and applied stochastic processes.
Content
Generation of random numbers
Monte Carlo methods for the numerical integration of random variables
Stochastic processes and Brownian motion
Stochastic ordinary differential equations (SODEs)
Numerical approximations of SODEs
Multilevel Monte Carlo methods for SODEs
Applications to computational finance: Option valuation

Lecture notes
Lecture Notes will be available.

Literature
P. Glassermann:
Monte Carlo Methods in Financial Engineering.

P. E. Kloeden and E. Platen:
Numerical Solution of Stochastic Differential Equations.

Prerequisites / notice
Prerequisites:
Mandatory: Probability and measure theory, basic numerical analysis and basics of MATLAB programming.

a) mandatory courses:
Elementary Probability, Probability Theory I.

b) recommended courses:
Stochastic Processes.

401-3922-00L Life Insurance Mathematics
W 4 credits 2V M. Koller
Abstract
The classical life insurance model is presented together with the important insurance types (insurance on one and two lives, term and endowment insurance and disability). Besides that the most important terms such as mathematical reserves are introduced and calculated. The profit and loss account and the balance sheet of a life insurance company is explained and illustrated.

401-4905-60L Interest Rate Theory
W 8 credits 3V+1U not available
Abstract
We introduce and discuss the most important models for interest rate markets. Emphasis will be placed both on theoretical foundations and on numerical implementation and calibration.

Objective
- Gain overview of interest rate markets and the corresponding financial products.
- Understand the various modeling approaches used (short-rate models, Heath-Jarrow-Morton models, LIBOR market models).
- Get a firm grasp of the underlying theory, and practice numerical implementation of concrete examples.
- Learn about extensions that have recently become increasingly important: default risk, multiple yield curves, etc.

Content
- Gain overview of interest rate markets and the corresponding financial products.
- Understand the various modeling approaches used (short-rate models, Heath-Jarrow-Morton models, LIBOR market models).
- Get a firm grasp of the underlying theory, and practice numerical implementation of concrete examples.
- Learn about extensions that have recently become increasingly important: default risk, multiple yield curves, etc.

Literature

Prerequisites / notice
- Option pricing and hedging for equity markets as covered, e.g., in "Mathematical Foundations for Finance".
- Itô calculus.

Master Thesis
see www.oec.uzh.ch/studies/general/theses/oec_en.html

Quantitative Finance Master - Key for Type

<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>ECTS</th>
<th>European Credit Transfer and Accumulation System</th>
</tr>
</thead>
<tbody>
<tr>
<td>V lecture</td>
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<td>practical/laboratory course</td>
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</tr>
<tr>
<td>K colloquium</td>
<td></td>
<td>Special students and auditors need special permission from the lecturers.</td>
</tr>
</tbody>
</table>

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 1177 of 1434
In this course, the following topics are discussed:

- Introduction of the basic principles of the design and operation of transport systems.
- Network layout and its impact on road traffic. Traffic control systems for urban and inter-urban areas. Fundamentals of road safety and infrastructure maintenance.

The aims of this course are:

A. Grêt-Regamey

Lecturers

Futher information and the documents for the lecture can be found on the homepage of the Chair of Spatial Development.

Lecturer notes and slides as well as hints to further literature will be given during the course.

ECTS

Sustainable Spatial Development I, K. W. Axhausen, Transport systems and land use; network design; fundamental model of mobility behaviour; costs and benefits of mobility; transport history

B. Scholl

Type

4G

Title

Transport Systems

Number

101-0467-01L

Objective

- To illustrate the concept of landscape planning, the economic relevance of landscape and nature in the context of the environmental systems (soil, water, air, climate, flora and fauna) and discussed with regard to socio-political questions of the future.

- To show landscape planning as an integral information system for the coordination of different instruments by illustrating the aims, methods, instruments and their functions in landscape planning.

- To show the importance of ecosystem services.

- To point out basic information about nature and landscape: Analysis and assessment of the complex interactions between landscape elements, effects of existing and foreseeable utilization of space (nature goods and services and landscape functions).

- To identify and measure the characteristics of landscape.

- Learn how to use the instrument of GIS appropriately in landscape planning.

Content

- Definition of the concept of landscape
- Landscape change
- Landscape planning
- Methods, instruments and aims of landscape planning (politics)
- Socio-political questions of the future
- Environmental systems, IUCN Red List, ecological connectivity
- Urban landscape services
- Practice of landscape planning
- Use of GIS in landscape planning

Lecture notes

No script. The documentation, consisting of presentation slides are partly handed out and are provided for download on the PLUS website.

Prerequisites / notice

The contents of the course will be illustrated in the associated lecture 103-0347-01 U (Landscape Planning and Environmental Systems (exercises)). An combination of courses is recommended.
<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>103-0377-00L</td>
<td>Introduction to the Data Analysis Software R</td>
<td>W+</td>
<td>1</td>
<td>1G</td>
<td>A. Grit-Regamey, M. J. Van Strien</td>
</tr>
<tr>
<td>Abstract</td>
<td>R is one of the most popular statistical open-source software for data analysis and data modeling. It has proved very useful for a variety of tasks commonly faced by planners, such as data preparation, exploratory analysis, model estimation or graphical display. R is also a programming language providing users with a more flexible and powerful tool for solving more complex problems.</td>
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<tr>
<td>Objective</td>
<td>The aim of this course is to provide participants with an introduction to the statistical open-source software R. Students will learn how to read data from files and write data to files, and how these data can be used to plot graphs and maps. Since R is a command-line software, that is, one has to type in text commands at a prompt, rather than just clicking menus and buttons, students will also learn how to write their own functions.</td>
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</tbody>
</table>
| Content      | Reading data from files
Creating and handling R objects such as matrices, vectors and arrays
Plotting data: histograms, boxplots, scattered plots
Writing data to files
Reading raster and vector data
Writing for- and while-loops
Writing your own functions |      |      |       |                                 |
| Literature   | Handouts of the lectures and exercises will be distributed |      |      |       |                                 |
| Notice       | The course will be held in English and no prior knowledge on R is required. |      |      |       |                                 |

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0647-00L</td>
<td>Introduction to Mathematical Optimization</td>
<td>W</td>
<td>5</td>
<td>2V+1U</td>
<td>R. Zenklusen</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to basic techniques and problems of mathematical optimization.</td>
<td></td>
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<tr>
<td>Objective</td>
<td>The goal is to get a good understanding of some of the most important mathematical optimization techniques used to solve linear programs and basic combinatorial optimization problems.</td>
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</tbody>
</table>
| Content      | Topics covered in this course include:
- Linear programming (simplex method, duality theory, shadow prices, ...).
- Basic combinatorial optimization problems (spanning trees, network flows, knapsack problem, ...). |      |      |       |                                 |
| Literature   | Information about relevant literature will be given in the lecture. |      |      |       |                                 |
| Prerequisites / notice | This course is meant for students who did not already attend the course "Mathematical Optimization", which is a more advance lecture covering similar topics and more. |      |      |       |                                 |

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
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</tr>
</thead>
<tbody>
<tr>
<td>101-0417-00L</td>
<td>Transport Planning Methods</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>K. W. Axhausen</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course provides the necessary knowledge to develop models supporting the solution of given planning problems. This is done by dividing the forecasting problem into sub-problems. The course is composed of a lecture part, providing the theoretical knowledge, and a applied part, in which students develop their own models.</td>
<td></td>
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</tbody>
</table>
| Objective    | - Knowledge of methods and algorithms commonly used in transport planning
- Ability to independently develop a transport model able to solve / answer the given problem / questions
- Understanding of algorithms and their implementations commonly used in transport planning |      |      |       |                                 |
| Content      | The course provides the necessary knowledge to develop models supporting the solution of given planning problems. Examples of such planning problems are the estimation of traffic volumes, prediction of estimated utilization of new public transport lines, and evaluation of effects (e.g. change in emissions of a city) triggered by building new infrastructure and changes to operational regulations. To cope with the forecasting problem it is first divided into sub-problems. Then, these are solved using various algorithms like iterative proportional fitting, shortest path algorithms and the method of successive averages. The course is comprised of a lecture part, providing the theoretical knowledge, and a applied part, in which students create their own models. This part takes place in form of a tutorial and consists in the development of a computer program. The programming part is closely guided and particularly suitable for students with little programming experience. |      |      |       |                                 |
| Lecture notes | The slides of the lecture are provided electronically. |      |      |       |                                 |

### Major in Transport Systems

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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</tr>
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<tr>
<td>103-0377-00L</td>
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<td>W+</td>
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Plotting data: histograms, boxplots, scattered plots
Writing data to files
Reading raster and vector data
Writing for- and while-loops
Writing your own functions |      |      |       |                                 |
| Lecture notes | Handouts of the lectures and exercises will be distributed |      |      |       |                                 |
| Literature   | “Introduction to R” by W. N. Venables and D. M. Smith |      |      |       |                                 |
| Notice       | The course will be held in English and no prior knowledge on R is required. |      |      |       |                                 |
### System and Network Planning

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0427-01L</td>
<td>Public transporst in the context of the transport systems; customer needs in the transport market; service planning processes for regular public transport services; long distance, regional and urban public transport service strategies; access to public transport and the last mile</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>U. A. Weidmann</td>
</tr>
</tbody>
</table>

**Abstract**
Public transporst in the context of the transport systems; customer needs in the transport market; service planning processes for regular public transport services; long distance, regional and urban public transport service strategies; access to public transport and the last mile.

**Objective**
Students will develop a basic knowledge of all stages of the public transport planning process from market demand to service planning; they will understand the most relevant planning methods and will be able to use them.

**Content**
1. Fundamentals of system and network planning: Mobility and transport systems; public transport systems; customer needs versus supply characteristics of regular services. (2) System and network planning in public passenger services: Goals of the system and network planning; generic planning process; demarcation, analysis of the situation, setting of targets; design of public transport services; evaluation and optimization; system planning. (3) Public transport services: long distance service offers; suburban and urban service offers; regional and local service offers; access to public transport and the last mile.

**Lecture notes**
A script in German will be provided for the course. The slides are made available.

**Literature**
A script in German will be provided for the course. The slides are made available. Literature will be provided by the lecturers respective there will be additional information upon registration.

**Prerequisites / notice**
No remarks.

### Basics in Air Transport

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0499-00L</td>
<td>Basics in Air Transport</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>P. Wild</td>
</tr>
</tbody>
</table>

**Abstract**
The course explains main principles of air transport in general and elaborates on simple interdisciplinary topics. Since working on broad topics like aerodynamics, manufacturers, airport operation, business aviation, business models etc. the students gets a good overview in air Transportation.

**Objective**
Understand and explain basics, principles and contexts in the broader air transport industry.

**Content**
Weekly: 1h independent preparation; 2h lectures and 1 h training with an expert in the respective field.

**Prerequisites / notice**
No remarks.

### Introduction to the Data Analysis Software R

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>101-0377-00L</td>
<td>Introduction to the Data Analysis Software R</td>
<td>W</td>
<td>1</td>
<td>1G</td>
<td>A. Grét-Regamey, M. J. Van Strien</td>
</tr>
</tbody>
</table>

**Abstract**
R is one of the most popular statistical open-source software for data analysis and data modeling. It has proved very useful for a variety of tasks commonly faced by planners, such as data preparation, exploratory analysis, model estimation or graphical display. R is also a programming language providing users with a more flexible and powerful tool for solving more complex problems.

**Objective**
The aim of this course is to provide participants with an introduction to the statistical open-source software R. Students will learn how to read data from files and write data to files, and how these data can be used to plot graphs and maps. Since R is a command-line software, that is, one has to type in text commands at a prompt, rather than just clicking menus and buttons, students will also learn how to write their own functions.

**Content**
- Reading data from files
- Writing data to files
- Creating and handling R objects such as matrices, vectors and arrays
- Plotting data: histograms, boxplots, scattered plots
- Writing for- and while-loops
- Writing your own functions
- Reading raster and vector data
- Writing raster and vector data
- Writing your own functions

**Lecture notes**
Handouts of the lectures and exercises will be distributed.

**Literature**
"Introduction to R" by W. N. Venables and D. M. Smith available online at http://cran.r-project.org/doc/manuals/R-intro.pdf

**Prerequisites / notice**
The course will be held in English and no prior knowledge on R is required.

### Site and Project Development

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<thead>
<tr>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0337-00L</td>
<td>Site and Project Development</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>G. Nussbaumer</td>
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</tbody>
</table>

**Abstract**
The main focus of the lecture is on site and project development questions in relation to recycling of industrial wasteland. A semester exercise covers a specific major project and serves as the semester grade (project report and presentation).

**Objective**
Objectives of the lecture are:
1. Get knowledge of comprehensive and multifunctional large-scale projects and their problem areas
2. Get deepened knowledge in selected fields (site analysis, market analysis, project development, cooperative planning, participation processes)
3. Practical orientation, insight into occupational fields
4. Independent acquirement and acquisition of theoretical knowledge
The lecture consists of several modules. The main focus is on site and project development questions in relation to recycling of industrial wasteland. Technical presentations, lectured by scientific staff of the division of Planning of Landscape and Urban Systems PLUS as well as guest referees treat different subjects.

The subjects are:
- Site and market analysis
- Real estate development
- Project development from the perspective of project developers and investors
- Parking and transportation models
- Cooperative planning, participation processes, mediation

The theory is discussed and illustrated at case studies and exercises. Specific large-scale projects that are currently in the development phase will be discussed, for example the area Sihl- Maregg in Zurich (GreenCity) or the area Pilatusmarkt (Niederfeld) Luzern. For one specific industrial wasteland area the students will develop a vision for a possible redevelopment and a new land-use concept, which will be discussed with experts.

Lecture notes
- Handouts of the lectures
- Extracts from relevant scientific articles and theory literature
- Exercise material

Download: http://www.irl.ethz.ch/plus/education

### History of Urban Design I

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>W</th>
<th>Credits</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>051-0363-00L</td>
<td>History of Urban Design I</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
</tr>
</tbody>
</table>

Abstract
The lecture covers the time from the beginning of urban culture until the mid 19th century. With selected examples it emphasizes on the interdependencies between the assessment of a situation, decision making, knowledge and language. The participants know the nature of a decision dilemma and maximes, how to deal with it. Especially they learn that the requirement of information for a decision depends upon the preferences of the deciding actor. They are also familiar with difficulties and pitfalls within these contexts and know what can be done against it.

Content
Assessment of the situation, deciding, language and knowledge are the main parts.

Objective
The participants know the interdependencies between the assessment of a situation, decision making, knowledge and language. They know the nature of a decision dilemma and maximes, how to deal with it. Especially they learn that the requirement of information for a decision depends upon the preferences of the deciding actor. They are also familiar with difficulties and pitfalls within these contexts and know what can be done against it.

Lecture notes
- Exercise material

Prerequisites / notice
Further recommended literature to consult is listed within the script.

### Theory and Methodology of Spatial Planning

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>W</th>
<th>Credits</th>
<th>Semester</th>
</tr>
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<tbody>
<tr>
<td>103-0417-02L</td>
<td>Theory and Methodology of Spatial Planning</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
</tr>
</tbody>
</table>

Abstract
In order to solve problems in spatial planning it is necessary to explore actions and to judge them; finally, one has to argue why a certain option should be preferred to others. Assessments of the situation are the basis for the problems to treat. Specific knowledge, represented in an adequate manner, is required.

Objective
The participants know the interdependencies between the assessment of a situation, decision making, knowledge and language. They know the nature of a decision dilemma and maximes, how to deal with it. Especially they learn that the requirement of information for a decision depends upon the preferences of the deciding actor. They are also familiar with difficulties and pitfalls within these contexts and know what can be done against it.

Content
Assessment of the situation, deciding, language and knowledge are the main parts.

### Space Planning Law and Environment

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>W</th>
<th>Credits</th>
<th>Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0707-00L</td>
<td>Space Planning Law and Environment</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
</tr>
</tbody>
</table>

Abstract
System of swiss planning law, Constitutional and statutory provisions, Space planning and fundamental rights, Instruments, Application, legal protection, enforcement, Practical training.
Objective
Basic understanding of nature and function of space planning from a legal point of view. Basic knowledge of space planning instruments, relationship between space planning and constitutional law (especially property rights), solving of practical cases.

Content

Lecture notes
Haller, Walter/Karlen, Peter, Raumplanung-, Bau- und Umweltrecht, 3.A., Zürich 1999

Hänni, Peter, Planungs-, Bau- und besonderes Umweltschutzrecht, 5.A., Bern 2008

103-0327-00L
History of Spatial Planning
W
1 credit
M. Koll-Schretzenmayr

Abstract
The course examines the patterns of cleavage, conflict, convergence of interest, and consensus that have structured spatial planning.

Objective
This course aims to provide students with knowledge of the historical background to understand the current spatial structure and to face the current challenges in spatial planning.

Social, cultural, and economic forces will be analyzed for the roles they have played in shaping the landscapes and cityscapes and the answers spatial planning had to spatial development. The course focuses on the history of planning ideas, paradigms and approaches. A link is made to current challenges in spatial planning.

Content
Die Veranstaltung gibt einen Überblick über die Geschichte der Raumplanung. Sie möchte das Verständnis für die Ideengeschichte wecken und den historischen Kontext für die gegenwärtige Raumplanung und Raumstruktur vermitteln.

Literature


Kleine Geschichte der Schweiz: Der Bundesstaat und seine Traditionen (edition suhrkamp)


Daniel Kurz: Die Disziplinierung der Stadt - Moderner Städtebau in Zürich 1900 bis 1940. gta Verlag 2008

103-0377-00L
Introduction to the Data Analysis Software R
W+ 1 credit

Objective
R is one of the most popular statistical open-source software for data analysis and data modeling. It has proved very useful for a variety of tasks commonly faced by planners, such as data preparation, exploratory analysis, model estimation or graphical display. R is also a programming language providing users with a more flexible and powerful tool for solving more complex problems.

Abstract
The course aims to provide students with an introduction to the statistical open-source software R. Students will learn how to read data from files and write data to files, and how these data can be used to plot graphs and maps. Since R is a command-line software, that is, one has to type in text commands at a prompt, rather than just clicking menus and buttons, students will also learn how to write their own functions.

Content
Reading data from files
Creating and handling R objects such as matrices, vectors and arrays
Plotting data: histograms, boxplots, scattered plots
Writing data to files
Reading raster and vector data
Writing for- and while-loops
Writing your own functions

Lecture notes
Handouts of the lectures and exercises will be distributed

Prerequisites / notice
The course will be held in English and no prior knowledge on R is required.

103-0307-00L
Multi-Criteria Decision Analysis
W 3 credits

Objective
Planners need to make decisions about the best possible mix of land uses. With increasing availability of spatial databases and the analytical capabilities of GIS, more effective decision support systems can be developed. The goal of the course is to provide the basics of spatial analysis and to teach the integration of spatial data into multicriteria decision-making systems.

Abstract
This course will:
1) introduce students to techniques and issues associated with spatial modeling and decision support systems, including analytical techniques that are unique to spatial analysis
2) provide hands-on training in the use of these spatial tools in R while addressing real planning problems.

Lecture notes
The emphasis is on concepts, resources, and analysis tools that students can use in science, private companies and government careers.

- Handouts of the lectures
- Script
- Exercise material

Prerequisites / notice
Download: http://cran.r-project.org/doc/manuals/R-intro.pdf

The course will be held in German and English. It is highly recommended to attend the lecture "Introduction to the data analysis software R" ("Einführung in die R Umgebung für Datenanalysen"), providing the basic principles of using the R-Software.

103-0347-00L
Landscape Planning and Environmental Systems
W 3 credits

Objective
The course content of the lecture Landscape Planning and Environmental Systems (103-0347-00 V) will be illustrated.

Abstract
To show the importance of ecosystem services.
Analysis and assessment of the complex interactions between landscape elements.
To identify and measure the characteristics of landscape.
Learn how to use the instrument of GIS appropriately in landscape planning.

Prerequisites / notice
Download: http://www.irl.ethz.ch/plus/education

The course will be held in German and English. It is highly recommended to attend the lecture "Introduction to the data analysis software R" ("Einführung in die R Umgebung für Datenanalysen"), providing the basic principles of using the R-Software.
Students should be able to

The course covers the basic history and theory of garden design and landscape architecture from its beginnings to the 21th century. The system of Swiss planning law, constitutional and statutory provisions, space planning and fundamental rights, instruments, application, legal protection, enforcement, practical training.

The lecture series on History and Theory of Garden Design and Landscape Architecture deals with the historical development of designed landscapes within the cultural background. The course covers the basic history and theory of garden design and landscape architecture from its beginnings to the 21st century. The course aims to raise awareness of a changing perception of nature and landscape.

The course introduces the broad variety of conflicts that arise in projects focusing on sustainable management of natural resources. It explores case studies of ecosystem management approaches and considers their practicability, their achievements and possible barriers to their uptake. Students should be able to:

a) propose appropriate and realistic solutions to ecosystem management problems that integrate ecological, economic and social dimensions across relevant temporal and spatial scales.

b) identify important stakeholders, their needs and interests, and the main conflicts that exist among them in the context of land and resource management.

Students should be capable of:

- Environmental systems, IUCN Red List, ecological connectivity
- Calculating urban landscape services
- Practice of landscape planning
- Use of GIS in landscape planning
- Modelling
- Landscape analysis
- Landscape metrics

No script. The documentation, consisting of presentation slides are partly handed out and are pro-vided for download on the PLUS website.

The course aims to raise awareness of a changing perception of nature and landscape.

No script. Handouts and learning material will be provided.

A reading list will be provided for the exams. A reading list will be provided for the exams. General Information for the Final Exam: Bachelor students: Relevant for the examination will be the content of the lectures, the handouts and literature provided by the Chair. The lecture series is conceived as a yearlong course. Since the written session examination will test knowledge from both semesters, it is necessary to fully attend the lectures of both courses. The themes of the examination will be announced at the end of the semester. The Chair will provide scripts and literature available for download.

Handouts and literature will also be provided for this purpose. The students are additionally requested to contact the Chair.

This course provides an introduction to ecosystem management, and in particular the importance of integrating ecology into management systems to meet multiple societal demands. The course explores the extent to which human-managed terrestrial systems depend on underlying ecological processes, and the consequences of degradation of these processes for human welfare and environmental well-being. Building upon a theoretical foundation, the course will tackle issues in resource ecology and management, notably forests, agriculture and wild resources within the broader context of sustainability, biodiversity conservation and poverty alleviation or economic development. Case studies from tropical and temperate regions will be used to explore these issues. Dealing with ecological and economic uncertainty, and how this affects decision making, will be discussed. Strategies for conservation and management of terrestrial ecosystems will give consideration to landscape ecology, protected area systems, and community management, paying particular attention to alternative livelihood options and marketing strategies of common pool resources.

No Script


Abstract

Concepts will be explained step-by-step through a set of case studies, and applied in lab by the students. The following principal steps are used when coping with natural hazard-risks. At each step, students will learn and apply the following skills:
- Risk analysis - What can happen?
  - Characterize the processes and environmental measures that lead to a natural hazard and integrate modeling results of these processes.
  - Identify threats to human life and assets exposed to natural hazards and estimate possible drawbacks or damages.
- Risk assessment - What are the acceptable levels of risk?
  - Apply principles to determine acceptable risks to human life and assets in order to identify locations which should receive added protection.
  - Explain causes for conflicts between risk perception and risk analysis.
- Risk management - What steps should be taken to manage risks?
  - Explain how various hazard mitigation approaches reduce risk.
  - Describe hazard scenarios as a base for adequate dimensioning of control measures.
  - Identify the best alternative from a set of thinkable measures based on an evaluation scheme.
  - Explain the principles of risk-governance.

Content

Die Vorlesung besteht aus folgenden Blöcken:
1) Einführung ins Vorgehenskonzept (1W)
2) Risikoanalyse (6W + Exkursion) mit:
   - Systemabgrenzung
   - Gefahrenbeurteilung
   - Exposition- und Folgenanalyse
3) Risikobewertung (2W)
4) Risikomanagement (2W + Exkursion)
5) Abschlussbesprechung (1W)

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<thead>
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<tr>
<td>101-0437-00L</td>
<td>Traffic Engineering</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>M. Menendez</td>
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<tr>
<td></td>
<td>Fundamentals of traffic flow theory and operations.</td>
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<tr>
<td>Abstract</td>
<td>The objective of this course is to fully understand the fundamentals of traffic flow theory in order to effectively manage traffic operations. By the end of this course students should be able to apply basic techniques to model different aspects of urban and inter-urban traffic performance, including congestion.</td>
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<tr>
<td>Objective</td>
<td>The course utilizes case studies to teach how a future natural hazards-specialist should analyze, assess and manage risks.</td>
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<tr>
<td>Content</td>
<td>Introduction to fundamentals of traffic flow theory and operations. Includes understanding of traffic data collection and processing techniques, as well as data analysis, and traffic modeling.</td>
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<tr>
<td>Lecture notes</td>
<td>The lecture notes and additional handouts will be provided during the lectures.</td>
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<tr>
<td>Literature</td>
<td>Additional literature recommendations will be provided during the lectures.</td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Verkehr III - Road Transport Systems 6th Sem. BSc (101-0415-00L) Special permission from the instructor can be requested if the student has not taken Verkehr III</td>
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<tr>
<td>701-0963-00L</td>
<td>Energy and Mobility</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>P. J. de Haan van der Weg.</td>
</tr>
<tr>
<td></td>
<td>The lecture Energy and Transportation imparts profound knowledge of energy- and environment-related difficulties of the intersection of energy and transportation with focus on the motorized individual traffic. The students gain the ability to approach energy- and environment-related problems with special consideration of the demand side, and to evaluate possible solutions.</td>
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<tr>
<td>Abstract</td>
<td>The main objectives of this lecture are:</td>
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<td></td>
<td>(i) The students gain profound knowledge of energy- and environment-related difficulties of the intersection of energy and transportation, and learn strategies to cope with these difficulties.</td>
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<td>(ii) The students are able to approach energy- and environment-related problems with special consideration of the demand side, and to evaluate possible solutions.</td>
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<tr>
<td>Objective</td>
<td>The lecture Energy and Transportation deals with the intersection of energy and transportation with focus on the motorized individual traffic.</td>
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<tr>
<td>Content</td>
<td>Main topics are:</td>
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<tr>
<td></td>
<td>(i) Fundamentals of energy use in the transportation sector, todays present state and future developments.</td>
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<td></td>
<td>(ii) Technical potentials for the reduction of greenhouse gas (GHG) emissions and the dependence on fossil fuels: Evaluation of (a) alternative fuels, and (b) alternative propulsion systems.</td>
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<td></td>
<td>(iii) The relevance of demand on efforts to reduce GHG emissions and the dependence on fossil fuels.</td>
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<td></td>
<td>(iv) Strategies and measures for influencing the demand side.</td>
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</table>
Infrastructure Management

<table>
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<td>W</td>
<td>1 credit</td>
<td>1G</td>
<td>A. Grét-Regamey, M. J. Van Strien</td>
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<td>The aim of this course is to provide participants with an introduction to the statistical open-source software R. Students will learn how to read data from files and write data to files, and how these data can be used to plot graphs and maps. Since R is a command-line software, that is, one has to type in text commands at a prompt, rather than just clicking menus and buttons, students will also learn how to write their own functions.</td>
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<tr>
<td>Content</td>
<td>Reading data from files Creating and handling R objects such as matrices, vectors and arrays Plotting data: histograms, boxplots, scattered plots Writing data to files Reading raster and vector data Writing for- and while-loops Writing your own functions</td>
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</tr>
<tr>
<td>Lecture notes</td>
<td>Handouts of the lectures and exercises will be distributed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literature</td>
<td>&quot;Introduction to R&quot; by W. N. Venables and D. M. Smith available online at <a href="http://cran.r-project.org/doc/manuals/R-intro.pdf">http://cran.r-project.org/doc/manuals/R-intro.pdf</a></td>
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<tr>
<td>Prerequisites / notice</td>
<td>The course will be held in English and no prior knowledge on R is required.</td>
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</tbody>
</table>

| 101-0579-00L | Infrastructure Maintenance Processes | W    | 3 credits | 2G    | B. T. Adey |
| Abstract     | This course provides an introduction to: - how to model the changes in infrastructure objects over time, - how to monitor these changes and assess the benefits of monitoring, - how to intervene to improve infrastructure performance and assess the benefits of interventions, and - how to model the changes in stakeholders interests over time. |
| Objective    | to provide the basic information and tools to be used to make decisions with respect to existing infrastructure |
| Content      | Deterioration - manifest and latent processes, - modeling Monitoring - non-destructive and destructive techniques, - evaluation of benefits of monitoring Intervention - types of intervention, - evaluation of benefits of intervention Benefits - modeling of stakeholder benefits over time |
| Lecture notes| All necessary materials (e.g. transparencies and hand-outs) will be handed out at the beginning of each class. |
| Literature   | Appropriate reading material will be assigned when necessary. |

| 101-0187-00L | Structural Reliability and Risk Analysis | W    | 3 credits | 2G    | B. Sudret |
| Abstract     | Structural reliability aims at quantifying the probability of failure of systems due to uncertainties in their design, manufacturing and environmental conditions. Risk analysis combines this information with the consequences of failure in view of optimal decision making. The course presents the underlying probabilistic modelling and computational methods for reliability and risk assessment. |
| Objective    | The goal of this course is to provide the students with a thorough understanding of the key concepts behind structural reliability and risk analysis. After this course the students will have refreshed their knowledge of probability theory and statistics to model uncertainties in view of engineering applications. They will be able to analyze the reliability of a structure and to use risk assessment methods for decision making under uncertain conditions. They will be aware of the state-of-the-art computational methods and software in this field. |
| Content      | Engineers are confronted every day to decision making under limited amount of information and uncertain conditions. When designing new structures and systems, the design codes such as SIA or Euro-codes usually provide a framework that guarantees safety and reliability. However the level of safety is not quantified explicitly, which does not allow the analyst to properly choose between design variants and evaluate a total cost in case of failure. In contrast, the framework of risk analysis allows one to incorporate the uncertainty in decision making. |
| Prerequisites / notice | Basic course on probability theory and statistics |

| 101-0549-00L | Selected Topics on Legal Aspects in Civil Engineering | W    | 3 credits | 2G    | H. Briner, D. Trümpp |
| Abstract     | Basic knowledge in public and private law of civil engineering. Examples of the subjects treated: space management, protection of the environment, legal procedures, standards for building technology and contracts. |

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Part 1: The students shall acquire basic knowledge of the public law concerning civil engineering:
- space management, conception of buildings, protection of the environment, procedures

Part 2: The students shall acquire basic knowledge of the private law concerning civil engineering

**Content**

- **Teil 1:** Jede Lektion behandelt für ein bestimmtes Stadium des Projekts ein Thema des öffentlichen Baurechts wie Bau- und Zonenordnungen, Quartierpläne, Umweltverträglichkeitsprüfungen, Baubewilligungsverfahren etc.
- **Teil 2:** Grundzüge des privaten Baurechts wie Abnahme und Genehmigung von Bauwerken, Vollmacht des Architekten / Ingenieure zu Rechtsanweisungs handlungen namens des Bauherrn, Mängelrüge im Bauwesen, Mehrheit ersatzpflichtiger Baubeteiligter, Generalunternehmervertrag, Haftung des Baumaterialverkäufers, Bauhandwerkerpfandrecht, Grundzüge der SIA-Norm 118, Baukonsortium, technische Normen, internationale Bauverträge, Architekten / Ingenieure als Beratungsorganisationen, Aspekte des Bauzivilprozesses

**Lecture notes**
- D. Trümpy: Tafeln zu den Grundzügen des schweizerischen Bauvertragsrechts (Vorlesungsunterlage)
- H. Briner: Tafeln zu den Grundzügen des öffentlichen Raumplanungs-, Bau- und Umweltrechts (Vorlesungsunterlage)

**Literature**
- Stöckl P.; Siegenthaler Th. (Hrsg.) Die Planerverträge, Schulthess 2013
- Gauch Peter, Werkvertrag, 5. Auflage, Schulthess 2013

**Prerequisites / notice**
- Die Teilnehmer sollen stets ein Exemplar der SIA-Norm 118, der SIA-LHO 103 sowie die Gesetzesausgaben von OR und ZGB bei sich haben.

#### 3. Semester

##### Major Courses

#### Major in Transport Planning

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</table>

**Abstract**
The course presents cost benefit analysis and related evaluation methods in transport and introduces the survey methods used to derive the monetary values of non-market goods.

**Objective**
Familiarity with the essential methods of project appraisal

**Content**
- Cost-Benefit-Analysis; multi-criteria analysis; European guidelines; stated response methods; travel cost approach and others; Valuation of travel time savings; valuation of traffic safety

**Lecture notes**
- Handouts

**Literature**
- H. Briner: Tafeln zu den Grundzügen des öffentlichen Raumplanungs-, Bau- und Umweltrechts (Vorlesungsunterlage)

**Prerequisite**
- one semester in microeconomics.

**Objective**
The objective of the course is to provide graduate students with an understanding of the economic factors which give rise to urban spatial structure and the models which have been employed to study these processes. The course aims to help students develop an appreciation for the use of economic models in both positive and normative frameworks. We will assess both the history of thought regarding the role of markets in creating urban development, and we will read about modern theories of externalities and economic factors which induce agglomeration. The final section of the course will focus on transportation problems in urban areas and the use of economic models to assess public policy measures to deal with congestion and associated externalities.

**Content**
- Outline of Lectures
  - Topic 1: Why do cities exist?
  - Topic 2: The Basic Muth-Mills model
  - Topic 3: The New Economic Geography
  - Topic 4: Business demand for land and Von Thünen's model
  - Topic 5: Urban spatial structure
  - Topic 6: Land use control
  - Topic 7: City size and city growth
  - Topic 8: Traffic externalities and congestion
  - Topic 9: Public transport

**Lecture notes**
- Textbook
  - Cities, agglomeration and spatial equilibrium by E. L. Glaeser, 2008, Oxford University Press.
  - The new introduction to geographical economics, Steven Brakman, Harry Garretsen and Charles van Marrewijk, Cambridge.

**Prerequisite**
- one semester in microeconomics.

**Objective**
The objective of the course is to provide graduate students with an understanding of the economic factors which give rise to urban spatial structure and the models which have been employed to study these processes. The course aims to help students develop an appreciation for the use of economic models in both positive and normative frameworks. We will assess both the history of thought regarding the role of markets in creating urban development, and we will read about modern theories of externalities and economic factors which induce agglomeration. The final section of the course will focus on transportation problems in urban areas and the use of economic models to assess public policy measures to deal with congestion and associated externalities.

**Content**
- Outline of Lectures
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  - The new introduction to geographical economics, Steven Brakman, Harry Garretsen and Charles van Marrewijk, Cambridge.

**Prerequisite**
- one semester in microeconomics.

**Objective**
The objective of the course is to provide graduate students with an understanding of the economic factors which give rise to urban spatial structure and the models which have been employed to study these processes. The course aims to help students develop an appreciation for the use of economic models in both positive and normative frameworks. We will assess both the history of thought regarding the role of markets in creating urban development, and we will read about modern theories of externalities and economic factors which induce agglomeration. The final section of the course will focus on transportation problems in urban areas and the use of economic models to assess public policy measures to deal with congestion and associated externalities.

**Content**
- Outline of Lectures
  - Topic 1: Why do cities exist?
  - Topic 2: The Basic Muth-Mills model
  - Topic 3: The New Economic Geography
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**Lecture notes**
- Textbook
  - Cities, agglomeration and spatial equilibrium by E. L. Glaeser, 2008, Oxford University Press.
  - The new introduction to geographical economics, Steven Brakman, Harry Garretsen and Charles van Marrewijk, Cambridge.
Objective
An effective and efficient flow of goods, data, and control in and between companies contributes significantly to the value added for the customer. Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.

Content
Strategic and tactical concepts in logistics, operations, and supply chain management: Conflicts of objectives and strategies and in the entrepreneurial context; business process analysis and fundamental logistics concepts; the MRPII / ERP concept; business processes and methods; the lean / just-in-time and repetitive manufacturing; concepts for product families and one-of-a-kind production; concepts for the process industry.

Lecture notes

This book also serves as textbook for LOS II (spring term) as well as ERP and SCM software systems (autumn term). In addition powerpoint-handouts and documents for case studies.

Literature
Sales at 17.9.15, from 12:45, before and during breaks of the first lecture. see "script"

Prerequisites / notice
Due to the big number of students, about half of the students will play this game, instead of Oct. 1, at Friday afternoon, Oct. 2. Please be available. Thank you for your help in this matter.

363-0445-02L Logistics, Operations, and Supply Chain Management W 1 credit 2A P. Schönleben I (Additional Cases)

Abstract
Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.

Objective
An effective and efficient flow of goods, data, and control in and between companies contributes significantly to the value added for the customer. Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.

101-0491-00L Agent Based Modeling in Transportation W 3 credits 2G F. Ciarl, R. Waraich

Abstract
The main topics of the lecture are:
1) Introduction to the agent-based paradigm and overview on existing agent-based models in transportation, including MATSim
2) Learn how to setup MATSim for policy analysis
3) Learn about the interfaces available to enhances the software (includes Java programming)
4) Create, run and analyse a policy study

Objective
The objective of this course is to make the students familiar with agent-based models and in particular with the software MATSim. They will learn the pros and cons of this type of approach versus traditional transport models and will learn to use the simulation. They will design a policy study and run simulations to evaluate the impacts of the proposed policies.

Content
The main topics are:
1) Introduction to the agent-based paradigm and overview on existing agent-based models in transportation, including MATSim
2) Introduction of basic building blocks of simulation approaches (random numbers generation, experimental design, variance control, response surface estimation)
3) Revision of the key submodels and their parameters and concepts (value of time, Wardrop (Nash) equilibrium, etc.)
4) Learn how to setup MATSim for policy analysis
5) Create, run and analyse a policy study

Literature
Agent-based modeling in general

MATSim

Prerequisites / notice
There are no strict preconditions in terms of which lectures the students should have previously attended. However, it is expected that the students have some experience with some high level programming language (i.e. C, C++, Fortran or Java).

101-0479-00L Safety and Reliability of Railway Systems W 3 credits 3G U. A. Weidmann, O. Fink, M. Montigel

Abstract
Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.

Objective
Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.

Content
(1) Transport and administrative policy: Goals of the state related to public transports, governmental activities in public transport, regulation.
(2) Business management in public transport enterprises: goals of public transport companies, goals of the business management; management of public transport on the different management levels, business organization. (3) Marketing, advertising and pricing: fundamentals and goals; marketing strategies and concepts in public transports; marketing tools; putting marketing into action, (4) Quality control: Quality in transport systems; goals of quality management; structuring quality control measures; collecting quality data in an operating service; use of quality control systems for service optimization.

101-0449-00L Management, Marketing, Quality W 6 credits 4G U. A. Weidmann

Abstract
Transport and administrative policy, international and national regulation, business management of public transport companies, marketing, advertising and pricing; quality management

Objective
Comprehension of the transport and administrative policy as well as of the regulation of public transport companies. To develop a full understanding of the three important public transport system operations management processes: (1) Business management; (2) Marketing; (3) Quality control. The course will teach essential working techniques in each of these processes.

References to technical literature will be included in the course script. An additional list of literature will be given during the course. Lectures and network planning as well as systems dimensioning and capacity recommended.
Abstract
Railway safety policies and safety concepts, command and control technologies for railways, optimization systems, European Train Control System, reliability availability maintainability safety (RAMS) of railway systems.

Objective
The students comprehend the main principles of safety, reliability and optimization for railway systems and understand the basic concepts of command and control technologies for railways.

Content
Railway safety strategies
- Safety in public transport
- Safety relevant characteristic of railway transport
- Safety requirements for railway transport
- Safety concepts

Command and control technologies for railway systems
- protective functions
- ensure the sequence/spacing of trains
- ensure route protection
- ensure level crossing protection
- technical realization for protective functions
- European Train Control System

operational command/control systems
- dispatching
- operational control systems
- concepts of optimization

RAMS for railway systems
- accident investigation methods
- RAMS standards for railways
- risk analysis and hazard control
- RAMS methods
- design principles for availability and safety
- maintenance strategies
- Life Cycle Costs (LCC)
- Human Factor
- safety in long railway tunnels

tutorials in Railway Operation Laboratory
field trip to Siemens Wallisellen (command and control technologies)

Lecture notes
The slides will be provided in German.

Literature
Some of the tutorials will be held at the IVTs Railway Operation Laboratory. The lecture Systems Dimensioning and Capacity is recommended.

Prerequisites / notice

<table>
<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>363-0445-00L</td>
<td>Logistics, Operations and Supply Chain Management I W</td>
<td>3 credits</td>
<td>2G</td>
<td>P. Schönsleben, E. Scherer Casanova</td>
<td></td>
</tr>
</tbody>
</table>

Abstract
Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.

Objective
An effective and efficient flow of goods, data, and control in and between companies contributes significantly to the value added for the customer. Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.

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Strategic and tactical concepts in logistics, operations, and supply chain management: Conflicts of objectives and strategies and in the entrepreneurial context; business process analysis and fundamental logistics concepts; the MRP II / ERP concept: business processes and methods; the lean / just-in-time and repetitive manufacturing; concepts for product families and one-of-a-kind production; concepts for the process industry.

Lecture notes

This book also serves as textbook for LOS II (spring term) as well as ERP and SCM software systems (autumn term). In addition powerpoint-handouts and documents for case studies.

Literature
Sales at 17.9.15, from 12:45, before and during brakes of the first lecture.

Prerequisites / notice
As for the lecture of the 3rd week (BEMAD, a much-liked Business Engineering and Management Ability Development game), this lecture (of Oct. 1) will follow a specific schedule in specific rooms. The schedule will be presented at Sept. 17 during the 1st lecture.

Due to the big number of students, about half of the students will play this game, instead of Oct. 1, at Friday afternoon, Oct. 2. Please be available. Thank you for your help in this matter.

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<tbody>
<tr>
<td>363-0445-02L</td>
<td>Logistics, Operations and Supply Chain Management I (Additional Cases)</td>
<td>1 credit</td>
<td>2A</td>
<td>P. Schönsleben</td>
<td></td>
</tr>
</tbody>
</table>

Abstract
Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.

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Major in Spatial Development

Major in Landscape and Environmental Planning

<table>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>364-0517-00L</td>
<td>Urban and Spatial Economics</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>R. H. van Nieuwkoop</td>
</tr>
</tbody>
</table>
Abstract

This course explores the economic factors which influence location decisions of households and firms, and it explores theories of how these decisions induce the formation of cities. The course will cover the neoclassical models of land use, concepts from the new economic geography, zoning, and transportation and traffic congestion.

Prerequisite: one semester in microeconomics.

Objective

The objective of the course is to provide graduate students with an understanding of the economic factors which give rise to urban spatial structure and the models which have been employed to study these processes. The course aims to help students develop an appreciation for the use of economic models in both positive and normative frameworks. We will assess both the history of thought regarding the role of markets in creating urban development, and we will read about modern theories of externalities and economic factors which induce agglomeration. The final section of the course will focus on transportation problems in urban areas and the use of economic models to assess public policy measures to deal with congestion and associated externalities.

Content

Outline of Lectures

1. Why do cities exist?
2. The Basic Muth-Mills model
3. The New Economic Geography
4. Business demand for land and Von Thünen's model
5. Spatial structure
6. Land use control
7. City size and city growth
8. Traffic externalities and congestion
9. Public transport

Lecture notes

Textbook

- Cities, agglomeration and spatial equilibrium by E. L. Glaeser, 2008, Oxford University Press.
- The new introduction to geographical economics, Steven Brakman, Harry Garretsen and Charles van Marrewijk, Cambridge.

101-0258-00L River Engineering

<table>
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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>101-0258-00L</td>
<td>River Engineering</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>G. R. Bezzola</td>
</tr>
</tbody>
</table>

Abstract

Main subjects treated:
- Fundamentals (e.g. sediment sampling methods), alluvial channel hydraulics, incipient motion, bed forms, bed load and suspended load, sediment budget and morphological changes, river morphology, scour, river management concepts and selected measures (e.g. bank and bed protection works).
- A practical exercise (voluntary, unmarked) is offered to deepen the learned subjects.

Objective

The students shall
- be able to describe quantitatively the interrelation between discharge, sediment transport and channel evolution
- know the fundamentals and be able to apply the approaches and methods to treat river engineering problems associated with flood protection and river restoration

Content

The first part of the lecture treats the fundamentals required to deal with river engineering problems. Sampling methods for the river bed material and methods to calculate the discharge in alluvial rivers are presented. The process of river bed armoring and the principles of incipient motion, of bed load and suspended load transport are treated.

In the second part of the lecture the procedures to quantify the sediment budget and the morphological changes (erosion, aggradation) in river systems are explained. Furthermore, the process of natural channel formation and the different plan forms of rivers (straight, meandering, braided) are discussed. Own chapters are dedicated to the topics of bed forms, river morphology and scour.

The last part of the lecture concentrates on the design and dimensioning of river engineering works. The topics treated are the stabilization of banks and of the longitudinal profile of rivers.

Lecture notes

Autography River Engineering (in German)

The voluntary and unmarked exercise bases on field data, which are collected by the students on a river in nature. Besides the collection of fundamentals and field data, the exercise comprehends the calculation of the stage-discharge relationship, of the critical discharges at the onset of bed load transport and bed erosion and of the annual sediment load in a given river reach.
Objective

The objective of this course is to conduct a realistic traffic engineering project from beginning to end. During the process, students will also familiarize themselves with microscopic traffic simulation, and will use the simulation software for modeling and analyzing the traffic operations in reality. The emphasis is not only on building the simulation model, but also how to evaluate results. The final goal is to make valid and concrete engineering proposals based on the simulation model.

Content

In this course, students will complete a traffic engineering project with microscopic traffic simulator VISSIM. An emphasis will be on traffic signals at intersections.

Specific tasks will include:
1) Building a model with the simulator VISSIM in order to replicate and analyze the traffic conditions measured/observed.
2) Calibrating and validating the simulation model.
3) Redesigning/ extending the model to improve the traffic performance.

Lecture notes

The lecture notes and additional handouts will be provided before the lectures.

Literature

Additional literature recommendations will be provided at the lectures.

Prerequisites / notice

There are no pre-requisites for this course. The course Transport Simulation (101-0438-00 G) and previous experience with VISSIM is helpful but not mandatory. In addition, simultaneously taking the course Traffic Engineering (101-0437-00 G) is encouraged.

### Infrastructure Management

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<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<tbody>
<tr>
<td>101-0419-00L</td>
<td>Railway Construction and Maintenance</td>
<td>W</td>
<td>4 credits</td>
<td>4G</td>
<td>U. A. Weidmann, P. Güleldenapfel, M. Kohler, M. J. Manhart, further speakers</td>
</tr>
</tbody>
</table>

Abstract

Track geometry including calculation and measuring as well as related data systems; interaction between track and vehicles, vehicle dynamics, stress; track construction including special features of railway bridges and tunnels; track diagnostics and forecast; track maintenance and related methods

Objective

The lecture gives a deeper insight into track geometry, the interaction between track and vehicles as well as in construction and dimensioning of the track. Methods for the diagnosis of the state of the track and its forecast are shown. State-of-the-art maintenance strategies and technologies are presented.

Content

Track geometry including calculation and measuring as well as related data systems; interaction between track and vehicles, vehicle dynamics, stress; track construction including special features of railway bridges and tunnels; track diagnostics and forecast; track maintenance and related methods

Lecture notes

The slides will be made available.

Literature

A list with related technical literature will be handed out.

Prerequisites / notice

The lecture Railway Infrastructures (Transportation II) is recommended.

### Interdisciplinary Project Work

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
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</thead>
<tbody>
<tr>
<td>101-0489-02L</td>
<td>Interdisciplinary Project</td>
<td>O</td>
<td>12 credits</td>
<td>24A</td>
<td>B. T. Adey</td>
</tr>
</tbody>
</table>

Abstract

The course will provide an introduction to the human and computerized systems used to manage infrastructure.

Objective

Upon completion of the course, students will have the fundamental knowledge required
- to identify and model the processes used in organizations to manage infrastructure,
- to establish benchmarks that can be used to measure the performance of organizations that manage infrastructure, and
- to evaluate organizations that manage infrastructure

Content

- Introduction
- Organisation types used to manage infrastructure
- Processes used in organizations that manage infrastructure
- Methods used to evaluate organizations that manage infrastructure, including the establishment of appropriate benchmarks

Lecture notes

Appropriate reading / and study material will be handed out during the course.

Literature

Transparencies will be handed out at the beginning of each class.

### Electives

The entire course programs of ETH Zurich and University Zurich are open to the students to individual selection. The students have themselves to check whether they meet the admission requirements for a course.

### List of Electives Recommended by the Degree Programme

Students having enroled for 851-0703-03 earlier (i.e. bachelor's degree programme or as additional requirement for master's degree programme) cannot enrol for this again during master degree programme.

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<tbody>
<tr>
<td>103-0327-00L</td>
<td>History of Spatial Planning</td>
<td>W+</td>
<td>1 credit</td>
<td>1V</td>
<td>M. Koll-Schretzenmayer</td>
</tr>
</tbody>
</table>

Abstract

The course examines the patterns of cleavage, conflict, convergence of interest, and consensus that have structured spatial planning.

Objective

This course aims to provide students with knowledge of the historical background to understand the current spatial structure and to face the current challenges in spatial planning.

Social, cultural, and economic forces will be analyzed for the roles they have played in shaping the landscapes and cityscapes and the answers spatial planning had to spatial development. The course focuses on the history of planning ideas, paradigms and approaches. A link is made to current challenges in spatial planning.

Content

Die Veranstaltung gibt einen Überblick über die Geschichte der Raumplanung. Sie möchte das Verständnis für die Ideengeschichte wecken und den historischen Kontext für die gegenwärtige Raumplanung und Raumstruktur vermitteln.
Lecture notes/handouts will be available online.

A. E. Braunschweig

Appropriate reading material will be assigned when necessary.

3G+2U+2P to provide the basic information and tools to be used to make decisions with respect to existing infrastructure.

This course has the aim of deepening students' knowledge of the environmental, economic and social assessment methodologies and their various applications.

Different selected topics in hydraulic engineering will be focused on, e.g. dam safety, possible problems at reservoirs like sedimentation or natural hazards by impulse waves, the hydraulics of river flows, spillways and intake structures at dams and weirs, hydropower and ecology like fish-ecological aspects at low-head hydropower plants and eco-hydraulics like flow-vegetation interaction. Another focus will be put on typical approaches and procedures in the planning process of hydropower projects.

Appropriate reading / and study material will be handed out during the course.

Deterioration

- manifestation of latent processes,
- modeling
- non-destructive and destructive techniques,
- evaluation of monitoring techniques
- types of intervention,
- evaluation of benefits of intervention

Benefits
- modeling of stakeholder benefits over time

All necessary materials (e.g. transparencies and hand-outs) will be handed out at the beginning of each class.

External speakers will present current topics and projects in Switzerland and abroad.

The course provides an introduction to:
- ability to properly plan, conduct and interpret environmental assessment studies
- knowledge about the current state of the scientific discussion and new research developments
- ability to judge the scientific quality and reliability of environmental assessment studies, the appropriateness of inventory data and modelling, and the adequacy of life cycle impact assessment models and factors
- knowledge about the current state of the scientific discussion and new research developments
- ability to properly plan, conduct and interpret environmental assessment studies

In particular, students completing the course should have the
- ability to judge the scientific quality and reliability of environmental assessment studies, the appropriateness of inventory data and modelling, and the adequacy of life cycle impact assessment models and factors
- knowledge about the current state of the scientific discussion and new research developments
- ability to properly plan, conduct and interpret environmental assessment studies

In the course element "Implementation of...", students will learn to
- describe key sustainability problems of the current economic system and measuring units.
- describe the management system of an organisation and illustrate how to improve its sustainability management (especially planning and controlling), based on current ISO management standards and additional frameworks.
- discuss approaches to measure environmental performance measurement of an organisation, including 'organisational LCA' (Ecobalance)
- explain the pros and cons of single score env. assessment methods
- demonstrate life cycle costing from a sustainability viewpoint
- interpret stakeholder relations of an organisation
- (if time allows) describe sustainable supply chain management

External speakers will present current topics and projects in Switzerland and abroad.

The course focuses on selected topics in hydraulic engineering, water management and aquatic ecology relating to hydropower and flood protection projects.

Different selected topics in hydraulic engineering will be focused on, e.g. dam safety, possible problems at reservoirs like sedimentation or natural hazards by impulse waves, the hydraulics of river flows, spillways and intake structures at dams and weirs, hydropower and ecology like fish-ecological aspects at low-head hydropower plants and eco-hydraulics like flow-vegetation interaction. Another focus will be put on typical approaches and procedures in the planning process of hydropower projects.

Appropriate reading / and study material will be handed out during the course.

Deterioration

- manifest and latent processes,
- modeling
- non-destructive and destructive techniques,
- evaluation of monitoring techniques
- types of intervention,
- evaluation of benefits of intervention

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Appropriate reading / and study material will be handed out during the course.

Deterioration

- manifest and latent processes,
- modeling
- non-destructive and destructive techniques,
- evaluation of monitoring techniques
- types of intervention,
- evaluation of benefits of intervention

Benefits
- modeling of stakeholder benefits over time

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Appropriate reading / and study material will be handed out during the course.
Content

Part I (Advanced Environmental Assessments)
- Sustainability problems of the current economic system and its measuring units;
- The structure of a management system, and elements to integrate environmental management (ISO 14001) and social management (SA8000 as well as ISO 26000), especially into strategy development, planning, controlling and communication;
- Sustainability Opportunities and Innovation
- The concept of 'Continuous Improvement'
- Life Cycle Costing, Life Cycle Management
- Environmental performance measurement of an organisation, including 'organisational LCA' (Ecobalance), based on practical examples of companies and new concepts
- Single score env. assessment methods (Swiss ecopoints)
- Stakeholder management and sustainability oriented communication
- An intro into sustainability issues of supply chain management
Students will get small exercises related to course issues.

Part II (Implementation of Environmental and other Sustainability Goals):
- Use of adequate base maps
- Analysis of themes and application using adequate structural types
- Ability to design adequate thematic maps from statistical data.

Part III (Computer Lab): this is an exercise and software lab to apply the methods from Part I and II of this lecture.

Lecture notes

Part I: (-)
Part II: Documents will be available on Ilias
Part III Lab: (-)

Literature

This course should only be elected by students of environmental engineering with the Major in ESD, Air Quality Control and Waste Management. All other students should take the individual courses in Advanced Environmental Assessment and/or Implementation of Environmental goals (with or without exercise and lab).

Basic knowledge of environmental assessment tools is a prerequisite for this class. Students who have not yet had classwork in this topic are required to read an appropriate textbook before or at the beginning of this course (e.g. Baumann&Tillman, The Hitchhiker's Guide to LCA: An Orientation in Life Cycle Assessment Methodology and Applications, Studentlitteratur, Lund, 2004).

103-0245-01L
Thematic Cartography
W  2 credits  2G  L. Hurni

Abstract
Thematic map types (focus on quantitative information), analysis of themes and application, base maps, generalisation

Objective
Knowing of most important thematic map types.
Ability to design adequate thematic maps from statistical data.

Content
Thematic map types (focus on quantitative information)
Analysis of themes and application using adequate structural types
Use of adequate base maps
Generalisation of thematic maps
Dynamic thematic maps

Lecture notes
Will be distributed

Accompanying e-learning module

Further information at http://www.karto.ethz.ch

Prerequisites / notice
Prerequisite: Cartography Introduction

103-0227-00L
Cartography III
W  5 credits  4G  L. Hurni

Abstract
Basic methods, technologies, scripting, and systems for interactive web mapping projects and in the internet cartography

Objective
Gain knowledge about basic methods, technologies, scripting, and systems for interactive web mapping projects. Assessment of existing products regarding production methods. Definition of useful methods for Web-based map projects.

Content
- Web mapping
- Web Map Services (WMS)
- User Interface design
- Symbolisation
- Programming
- Java Script
- Debugging
- Map production using GIS data
- 3D-applications in cartography

Lecture notes
Own script and instructions will be distributed.

Literature
- Terry A. Slocum, Terry et al. (2004): Thematic Cartography and Geographic Visualization. 2nd ed. Prentice Hall, ISBN 0130351237

Prerequisites / notice
Further information at http://www.karto.ethz.ch

401-0625-01L
Applied Analysis of Variance and Experimental Design
W  5 credits  2V+1U  L. Meier

Abstract
Key concepts of experimental design. Planning and analysis of single factor experiments, block designs, full factorial and fractional designs, split-plot and strip-plot designs. Random effects and mixed effects models.

Objective
Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R.

Lecture notes see website

Literature


751-1551-00L Ressourcen- und Umweltökonomie W 3 credits 2V L. Bretschger, A. Müller

Abstract Relationship between economy and environment, market failure, external effects and public goods, contingent valuation, internalisation of externalities; economics of non-renewable resources, economics of renewable resources, cost-benefit analysis, sustainability, and international aspects of resource and environmental economics.

Objective Understanding of the basic issues and methods in resource and environmental economics; ability to solve typical problems in the field using the appropriate tools, which are concise verbal explanations, diagrams or mathematical expressions.

Topics are:
Introduction to resource and environmental economics
Importance of resource and environmental economics
Main issues of resource and environmental economics
Normative basis
Utilitarianism
Rawlsian fairness
Economic growth and environment
Externalities in the environmental sphere
Governmental internalisation of externalities
Private internalisation of externalities: the Coase theorem
Free rider problem and public goods
Types of public policy
Efficient level of pollution
Tax vs. permits
Command and Control Instruments
Empirical data on non-renewable natural resources
Optimal price development: the Hotelling-rule
Effects of exploration and Backstop-technology
Effects of different types of markets.
Biological growth function
Optimal depletion of renewable resources
Social inefficiency as result of over-use of open-access resources
Cost-benefit analysis and the environment
Measuring environmental benefit
Measuring costs
Concept of sustainability
Technological feasibility
Conflicts sustainability / optimality
Indicators of sustainability
Problem of climate change
Cost and benefit of climate change
Climate change as international ecological externality
International climate policy: Kyoto protocol
Implementation of the Kyoto protocol in Switzerland

Content Economy and natural environment, welfare concepts and market failure, external effects and public goods, measuring externalities and contingent valuation, internalising external effects and environmental policy, economics of non-renewable resources, renewable resources, cost-benefit-analysis, sustainability issues, international aspects of resource and environmental problems, selected examples and case studies.

Lecture notes The script and lecture material are provided at: https://moodle-app2.let.ethz.ch/course/view.php?id=140


363-0541-00L Systems Dynamics and Complexity W 3 credits 3G F. Schweitzer, P. Mavrodiev

Abstract Implementing solutions: project management, critical path method, quality control feedback loop.

Objective A successful participant of the course is able to:
- understand why most real problems are not simple, but require solution methods that go beyond algorithmic and mathematical approaches
- apply the problem solving cycle as a systematic approach to identify problems and their solutions
- calculate project schedules according to the critical path method
- setup and run systems dynamics models by means of the Vensim software
- identify feedback cycles and reasons for unintended systems behavior
- analyse the stability of nonlinear dynamical systems and apply this to macroeconomic dynamics
Content

Why are problems not simple? Why do some systems behave in an unintended way? How can we model and control their dynamics? The course provides answers to these questions by using a broad range of methods encompassing systems oriented management, classical systems dynamics, nonlinear dynamics and macroeconomic modeling.

The course is structured along three main tasks:

1. Finding solutions
2. Implementing solutions
3. Controlling solutions

PART 1 introduces complexity as a system immanent property that cannot be simplified. It introduces the problem solving cycle, used in systems oriented management, as an approach to structure problems and to find solutions.

PART 2 discusses selected problems of project management when implementing solutions. Methods for identifying the critical path of subtasks in a project and for calculating the allocation of resources are provided. The role of quality control as an additional feedback loop and the consequences of small changes are discussed.

PART 3, by far the largest part of the course, provides more insight into the dynamics of existing systems. Examples come from biology (population dynamics), management (inventory modeling, technology adoption, production systems) and economics (supply and demand, investment and consumption). For systems dynamics models, the software program VENSIM is used to evaluate the dynamics. For economic models analytical approaches, also used in nonlinear dynamics and control theory, are applied. These together provide a systematic understanding of the role of feedback loops and instabilities in the dynamics of systems. Emphasis is on oscillating phenomena, such as business cycles and other life cycles.

Lecture notes

Weekly self-study tasks are used to apply the concepts introduced in the lectures and to come to grips with the software program VENSIM. The lecture slides are provided as handouts - including notes and literature sources - to registered students only. All material is to be found on the Moodle platform. More details during the first lecture.

Prerequisites / notice

Self-study tasks (discussion exercises, Vensim exercises), are provided as home work. Weekly exercise sessions (45 min) are used to discuss selected solutions. Regular participation in the exercises is an efficient way to understand the concepts relevant for the final exam.

Objective

At the end of the course students should:

Know:
- Function, purpose and algorithm of a selected number of transdisciplinary methods

Understand:
- Functional application in case studies and other problem oriented projects

Be able to reflect on:
- Potential, limits, and necessity of transdisciplinary methods

Be prepared for:
- Transdisciplinary Case Study 2016
- Overview of the technical characteristics of railway systems

Content

The lecture is structured as follows:

- Overview of concepts and methods of inter-/transdisciplinary integration of knowledge, values and interests (approx. 20%)
- Analysis of a selected number of transdisciplinary methods focusing problem framing, problem analysis, and impact (approx. 50%)
- Practical application of the methods in a broader project setting (approx. 30%)

Lecture notes

Handouts are provided by the lecturers

Literature

Selected scientific articles and book-chapters

Prerequisites / notice

This course is recommended for students participating in the Transdisciplinary Case Study 2016.

401-3901-00L Mathematical Optimization

Abstract

Mathematical treatment of diverse optimization techniques.

Objective

Advanced optimization theory and algorithms.

Content

1. Linear optimization: The geometry of linear programming, the simplex method for solving linear programming problems, Farkas’ Lemma and infeasibility certificates, duality theory of linear programming.


3. Integer optimization: Ties between linear and integer optimization, total unimodularity, complexity theory, cutting plane theory.

4. Combinatorial optimization: Network flow problems, structural results and algorithms for matroids, matchings and, more generally, independence systems.

401-3901-00L Mathematical Optimization

Abstract

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Objective

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Content

1. Linear optimization: The geometry of linear programming, the simplex method for solving linear programming problems, Farkas’ Lemma and infeasibility certificates, duality theory of linear programming.


3. Integer optimization: Ties between linear and integer optimization, total unimodularity, complexity theory, cutting plane theory.

4. Combinatorial optimization: Network flow problems, structural results and algorithms for matroids, matchings and, more generally, independence systems.

227-0523-00L Railway Systems I

Abstract

Basic characteristics of railway vehicles and their interfaces with the railway infrastructure:
- Transportation tasks and vehicle types
- Running dynamics
- Mechanical part of rail vehicles
- Brakes
- Traction chain and auxiliary supply
- Railway power supply
- Signalling systems
- Traffic control and maintenance

Objective

- Overview of the technical characteristics of railway systems
- Understanding tasks and opportunities of engineers working in an environment which has strong economical and political boundaries
- Insight into the activities of the railway vehicle industry and railway operators in Switzerland
- Motivation of young engineers to start a career in the railway industry or with railway operators
Introduction to Law for Civil Engineering
G. Hertig
Script will be distributed during the lecture.

S. Scherler
Within the scope of the lecture “Traffic Law / Traffic Commercial Law”, besides an introduction into the legal basis of the national and international traffic, the main interest will be laid on actual political and economical questions and problems with respect to traffic (e.g. financing of traffic, road pricing, rail reform, air traffic vs. environment law etc.). With practical exercises and subsequent detailed reviews themes and subjects of special interest to participants are being treated more thoroughly.

Lecture notes
Script will be distributed during the lecture.

Further information is available at http://www.hertig.ethz.ch/courses.htm
Environmental Management  W  2 credits  2G  R. Züst

Abstract
An environmental management system has the objective to continuously improve the environmental performance of the activities, products and services of a company. The company has to introduce different management procedures. The goal of this lecture is to provide basics and specific procedure to implement the environmental dimension in the planning and decision making processes of an organisation.

Objective
Overview on environmental management and environmental management systems, general methods and principles.

Content
Introduction to environmental management / environmental management systems, energy and material flows; economical and ecological problems in industry; characterisation of an enterprise (incl. management handbook); structure and contents of an environmental management system; overview on the ISO 14001 ff. series; methods for environmental evaluation and assessment; integrated management systems; planning methodology and life-cycle-design; planning example

Lecture notes
Information about environmental management and environmental management systems will be provided by a CD or mail.

Literature
A list with literatures and links will be provided

Prerequisites / notice
Delivery of a case study, worked out in groups. Language: Teaching in English on request.

Fundamentals of Natural Hazards Management  W  3 credits  3G  H. R. Heinemann, B. Krummenacher, S. Löw

Abstract
Risks to life and human assets result when settlement areas and infrastructure overlap regions where natural hazard processes occur. This course utilizes case studies to teach how a future natural hazards-specialist should analyze, assess and manage risks.

Objective
Concepts will be explained step-by-step through a set of case studies, and applied in lab by the students. The following principal steps are used when coping with natural hazard-risks. At each step, students will learn and apply the following skills:
- Risk analysis - What can happen?
  - Characterize the processes and environmental measures that lead to a natural hazard and integrate modeling results of these processes.
  - Identify threats to human life and assets exposed to natural hazards and estimate possible drawbacks or damages.
- Risk assessment - What are the acceptable levels of risk?
  - Apply principles to determine acceptable risks to human life and assets in order to identify locations which should receive added protection.
  - Explain causes for conflicts between risk perception and risk analysis.
- Risk management - What steps should be taken to manage risks?
  - Explain how various hazard mitigation approaches reduce risk.
  - Describe hazard scenarios as a base for adequate dimensioning of control measures.
  - Identify the best alternative from a set of thinkable measures based on an evaluation scheme.
  - Explain the principles of risk-governance.

Content
Die Vorlesung besteht aus folgenden Blöcken:
1)   Einführung ins Vorgehenskonzept (1W)
2)   Risikoanalyse (6W + Exkursion) mit:
  - Systemabgrenzung
  - Gefahrenbeurteilung
  - Expositions- und Folgenanalyse
3)   Risikobewertung (2W)
4)   Risikomanagement (2W + Exkursion)
5)   Abschlussbesprechung (1W)

Electives ETH Zurich

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-BAUG.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Master Thesis

Number  Title  Type  ECTS  Hours  Lecturers
103-0010-00L  Master's Thesis  O  24 credits  47D  Supervisors

Abstract
Before starting the Master's thesis, students must have a. obtained the Bachelor's degree;
b. fulfilled all specified admission conditions, if any;
c. acquired at least 90 credits in the Master's programme, including 12 credits in the area of the interdisciplinary project.

Objective
The Master Programme concludes with the Master Thesis, which has to be done in one of the chosen Majors and has to be completed within 16 weeks. The Master Thesis is supervised by a professor and shall attest the students ability to work independently and to produce scientifically structured work.

Content
The topics of the Master Thesis are published by the professors. The Topic can be set also in consultation between the student and the professor.

Spatial Development and Infrastructure Systems Master - Key for Type

O  Compulsory  E-  Recommended, not eligible for credits
W+  Eligible for credits and recommended  Z  Courses outside the curriculum
W  Eligible for credits  Dr  Suitable for doctorate
### Key for Hours

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

**ECTS**
- European Credit Transfer and Accumulation System
- Special students and auditors need special permission from the lecturers.
Computational Science and Engineering Bachelor

First Year Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0231-10L</td>
<td>Analysis I</td>
<td>O</td>
<td>8 credits</td>
<td>7G</td>
<td>A. Iozzi</td>
</tr>
<tr>
<td>Abstract</td>
<td>Calculus of one variable: Real and complex numbers, vectors, functions, limits, sequences, series, power series, differentiation and integration in one variable, introduction to ordinary differential equations</td>
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<tr>
<td>Objective</td>
<td>Einführung in die Grundlagen der Analysis</td>
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<tr>
<td>Lecture notes</td>
<td>Christian Blatter: Ingenieur-Analysis (Kapitel 1-3)</td>
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<tr>
<td>401-0151-00L</td>
<td>Linear Algebra</td>
<td>O</td>
<td>4 credits</td>
<td>3G+2U</td>
<td>V. C. Gradinaru</td>
</tr>
<tr>
<td>Abstract</td>
<td>Contents: Linear systems - the Gaussian algorithm, matrices - LU decomposition, determinants, vector spaces, least squares - QR decomposition, linear maps, eigenvalue problem, normal forms - singular value decomposition; numerical aspects; introduction to MATLAB.</td>
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<tr>
<td>Objective</td>
<td>Einführung in die Lineare Algebra für Ingenieure unter Berücksichtigung numerischer Aspekte</td>
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<tr>
<td>Lecture notes</td>
<td>K. Nipp / D. Stoffer, Lineare Algebra, vdf Hochschulverlag, 5. Auflage 2002</td>
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<tr>
<td>Literature</td>
<td>K. Nipp / D. Stoffer, Lineare Algebra, vdf Hochschulverlag, 5. Auflage 2002</td>
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<tr>
<td>252-0023-00L</td>
<td>Discrete Mathematics</td>
<td>O</td>
<td>8 credits</td>
<td>5V+2U</td>
<td>U. Maurer</td>
</tr>
<tr>
<td>Abstract</td>
<td>Content: Mathematical reasoning and proofs, abstraction. Sets, relations (e.g. equivalence and order relations), functions, combinatorics, (un-)countability, graph theory, number theory, algebra (groups, rings, fields, polynomials, subalgebras, morphisms), logic (propositional and predicate logic, proof calculi).</td>
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<tr>
<td>Objective</td>
<td>The primary goals of this course are (1) to introduce the most important concepts of discrete mathematics, (2) to understand and appreciate the role of abstraction and mathematical proofs, and (3) to discuss a number of applications, e.g. in cryptography, coding theory, and algorithm theory.</td>
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<tr>
<td>Content</td>
<td>See course description.</td>
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<tr>
<td>Lecture notes</td>
<td>available (in english)</td>
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<tr>
<td>Literature</td>
<td>Bjarne Stroustrup: Einführung in die Programmierung mit C++, Pearson Studium, 2010</td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>From AS 2013, an admission to the exam does not any more formally require an attending of the recitation sessions. Handing in solutions to the weekly exercise sheets is thus not mandatory, but we strongly recommend it.</td>
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<tr>
<td>Examination</td>
<td>Examination is a one hour-long written test.</td>
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<tr>
<td>252-0835-00L</td>
<td>Computer Science I</td>
<td>O</td>
<td>4 credits</td>
<td>2V+2U</td>
<td>F. O. Friedrich</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course covers the fundamental concepts of computer programming with a focus on systematic algorithmic problem solving. Taught language is C++. No programming experience is required.</td>
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<tr>
<td>Objective</td>
<td>Primary educational objective is to learn programming with C++. When successfully attended the course, students have a good command of the mechanisms to construct a program. They know the fundamental control and data structures and understand how an algorithmic problem is mapped to a computer program. They have an idea of what happens &quot;behind the scenes&quot; when a program is translated and executed. Secondary goals are an algorithmic computational thinking, understanding the possibilities and limits of programming and to impart the way of thinking of a computer scientist.</td>
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<tr>
<td>Content</td>
<td>The course covers fundamental data types, expressions and statements, (Limits of) computer arithmetic, control statements, functions, arrays, structural types and pointers. The part on object orientation deals with classes, inheritance and polymorph, simple dynamic data types are introduced as examples. In general, the concepts provided in the course are motivated and illustrated with algorithms and applications.</td>
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<tr>
<td>Lecture notes</td>
<td>A script written in English will be provided during the semester. The script and slides will be made available for download on the course web page.</td>
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<tr>
<td>Literature</td>
<td>Download course material.</td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>From AS 2013, an admission to the exam does not any more formally require an attending of the recitation sessions. Handing in solutions to the weekly exercise sheets is thus not mandatory, but we strongly recommend it.</td>
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</tr>
<tr>
<td>227-0003-00L</td>
<td>Digital Circuits</td>
<td>O</td>
<td>4 credits</td>
<td>2V+2U</td>
<td>G. Tröster</td>
</tr>
<tr>
<td>Abstract</td>
<td>Digital and analogue signals and their representation. Combinational and sequential circuits and systems, boolean algebra, K-maps. Finite state machines. Memory and computing building blocks in CMOS technology, programmable logic circuits.</td>
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<tr>
<td>Objective</td>
<td>Provide basic knowledge and methods to understand and to design digital circuits and systems.</td>
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</tr>
<tr>
<td>Content</td>
<td>Digital and analogue signals and their representation. Boolean Algebra, circuit analysis and synthesis, the MOS transistor, CMOS logic, static and dynamic behaviour, tristate logic, Karnaugh-Maps, hazards, binary number systems, coding. Combinational and sequential circuits and systems (boolean algebra, K-maps, etc.). Memory building blocks and memory structures, programmable logic circuits. Finite state machines, architecture of microprocessors.</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes for all lessons, assignments and solutions.</td>
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</tr>
<tr>
<td>Prerequisites / notice</td>
<td>No special prerequisites</td>
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</table>

Basic Courses

Block G1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0353-00L</td>
<td>Analysis III</td>
<td>O</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>P. S. Jossen</td>
</tr>
<tr>
<td>Abstract</td>
<td>In this lecture we treat problems in applied analysis. The focus lies on the simplest cases of three fundamental types of partial differential equations of second order: the Laplace equation, the heat equation and the wave equation.</td>
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</tbody>
</table>
### Content

1.) Klassifizierung von PDE's  
- linear, quasilinear, nicht-linear  
- elliptisch, parabolisch, hyperbolisch

2.) Quasilineare PDE  
- Methode der Charakteristiken (Beispiele)

3.) Elliptische PDE  
- Bsp: Laplace-Gleichung  
- Harmonische Funktionen, Maximumsprinzip, Mittelwerts-Formel.  
- Methode der Variablenseparation.

4.) Parabolische PDE  
- Bsp: Wärmeleitungsgleichung  
- Bsp: Inverse Wärmeleitungsgleichung  
- Methode der Variablenseparation

5.) Hyperbolische PDE  
- Bsp: Wellengleichung  
- Formel von d'Alembert in (1+1)-Dimensionen  
- Methode der Variablenseparation

6.) Green'sche Funktionen  
- Rechnen mit der Dirac-Deltafunktion  
- Idee der Green'schen Funktionen (Beispiele)

7.) Ausblick auf numerische Methoden  
- 5-Punkt-Diskretisierung des Laplace-Operators (Beispiele)

### Literature


Zusätzliche Literatur:  
Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, Kap. 8, 11, 16 (sehr gutes Buch, als Referenz zu benutzen)  
Norbert Hungerbühler, "Einführung in die partiellen Differentialgleichungen", vdf Hochschulverlag AG an der ETH Zürich.  
G. Felder:Partielle Differentialgleichungen.  
http://www.math.ethz.ch/u/felder/Teaching/PDG

### Prerequisites / notice

Prerequisites: Analysis I and II, Fourier series (Komplexe Analysis)

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**Block G2**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0603-00L</td>
<td>Stochastics (Probability and Statistics)</td>
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</tbody>
</table>

Abstract  
This class covers the following concepts: random variables, probability, discrete and continuous distributions, joint and conditional probabilities and distributions, the law of large numbers, the central limit theorem, descriptive statistics, statistical inference, inference for normally distributed data, point estimation, and two-sample tests.

Objective  
Knowledge of the basic principles and statistics.

Content  
Introduction to probability theory, some basic principles from mathematical statistics and basic methods for applied statistics.

Lecture notes  
Lecture notes

Literature  
Lecture notes
Information Systems for Engineers

**Abstract**

Foundations of information systems from a user's viewpoint. The focus is on structured data: relational databases, the data language SQL, designing relational databases. Additional topics: Information Retrieval (searching documents), and estimating their relevance and authority with respect to free-text queries; XML as a format for data exchange; Characteristics and processing of "Big Data"

**Objective**

Following the course should enable students to

1. answer non-trivial queries on existing relational databases by formulating (entry-level) SQL statements, as well as to add new database content and to update or delete existing content,

2. formalize facts as perceived in the real world in terms of the entity-relationship model, and derive a set of normalized relations (tables) which define the structure of a relational database

3. explain how a database management system (DBMS) essentially works and what kind of services it provides

4. understand how a web search engine such as Google basically works

5. know and apply the core concepts to structure and query XML-documents

6. list the characteristics of "Big Data" and know the basics of processing "Big Data"

**Content**

Die Lehrveranstaltung vermittelt Grundlagen und Konzepte von Informationssystemen aus der Sicht eines Anwenders.

Im Zentrum stehen relationale Datenbanksysteme, die Abfrage- und Datenmanipulationssprache SQL, sowie der Entwurf bzw. die Strukturierung relationaler Datenbanken. Dieser Stoff wird auch in praktischen Übungen vertieft.

Weitere Themen sind der Umgang mit unstrukturierten und semistrukturierten Daten, die Integration von Daten aus verschiedenen autonomen Informationssystemen, sowie eine Übersicht der Architektur von Datenbanksystemen.

Inhalt:
1. Einleitung,
2. Das Relationenmodell,
3. Die Abfrage- und Datenmanipulationssprache SQL,
4. Entwurf relationaler Datenbanken mit Hilfe von Entity-Relationship Diagrammen. Grundideen der Normalisierung von Relationen,
5. Architektur relationaler Datenbanksysteme,
6. Information Retrieval: Suche von (Text-)Dokumenten. Indexierung, Stopwort-Elimination und Stemming. Boole'sches Retrieval und das Verkörperm-Modell,
8. Modellierung semi-strukturierter Daten mit XML und einfache Anfragen mit XPath und XQuery,
9. Zugriff auf SQL-Datenbanken aus Programmen. Transaktionen,

**Literature**

Vorlesungsunterlagen (PowerPoint Folien, teilweise auch zusätzlicher Text) werden auf der Web-Site publiziert. Der Kauf eines Buches wird nicht vorausgesetzt.


Als englischsprachiges Werk kann z.B.


empfohlen werden (Umfang: 1349 Seiten).

**Prerequisites / notice**

Voraussetzung:
Elementare Kenntnisse von Mengenlehre und logischen Ausdrücken.

**401-0647-00L**

Introduction to Mathematical Optimization

**Abstract**

Introduction to basic techniques and problems of mathematical optimization.

**Objective**

The goal is to get a good understanding of some of the most important mathematical optimization techniques used to solve linear programs and basic combinatorial optimization problems.

**Content**

Topics covered in this course include:
- Linear programming (simplex method, duality theory, shadow prices, ...).
- Basic combinatorial optimization problems (spanning trees, network flows, knapsack problem, ...).

**Literature**

Information about relevant literature will be given in the lecture.

This course is meant for students who did not already attend the course "Mathematical Optimization", which is a more advance lecture covering similar topics and more.

**Prerequisites / notice**

**Block G3**

All course units within Block G3 are offered in the spring semester.

**Block G4**

Students that enrol for the second year in the CSE Bachelor Programme and whose first year examination did not involve the subject "Physics I" will instead take the "Physics I and II" (402-0043-00L and 402-0044-00L) courses with performance assessment as a yearly course.

**402-0043-00L**

Physics I

**Abstract**

Introduction to the concepts and tools in physics with the help of demonstration experiments: mechanics of point-like and ridged bodies, periodic motion and mechanical waves.

**Objective**

The concepts and tools in physics, as well as the methods of an experimental science are taught. The student should learn to identify, communicate and solve physical problems in his/her own field of science.

**Content**

Mechanics (motion, Newton's laws, work and energy, conservation of momentum, rotation, gravitation, fluids)
Periodic Motion and Waves (periodic motion, mechanical waves, acoustics).

**Lecture notes**

The lecture follows the book "Physics" by Paul A. Tipler.
Literature
Prerequisites / notice
Prerequisites: Mathematics I & II

Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
</table>

Abstract
This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.

Objective
Introduction to HPC for scientists and engineers
Fundamental of:
1. Parallel Computing Architectures
2. MultiCores
3. ManyCores

Content
Programming models and languages:
1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)

Computers and methods:
1. Hardware and architectures
2. Libraries
3. Particles: N-body solvers
4. Fields: PDEs
5. Stochastics: Monte Carlo

Lecture notes
http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1
Class notes, handouts

Fields of Specialization

Astrophysics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-7851-00L</td>
<td>Theoretical Astrophysics (University of Zurich)</td>
<td>W</td>
<td>10 credits</td>
<td>4V+2U</td>
<td>R. Teyssier</td>
</tr>
</tbody>
</table>

Abstract
Radiative processes in the interstellar medium; stellar structure and evolution; supernovae; white dwarfs; neutron stars; black holes; planet formation

Literature
(1) "Formation of stars" (S. Stahler and F. Palla - Wiley editions, this is the book on which about half of the classes will be based and photocopies will be organized during first lecture)
(2) "Radiative processes in astrophysics" (R. Ribycki and A. Lightman)
(3) "The Physics of Stars" (A.C. Phillips)
(4) "Black Holes, White Dwarfs and Neutron Stars: The physics of compact objects" (S. Shapiro and S.A. Teukolski), Additionally PowerPoint slides will be prepared by the lecturer on these and extra topics (e.g. planet formation).

Prerequisites / notice
Prerequisites: Elementary atomic physics, thermodynamics, mechanics, fluid dynamics.

Physics of the Atmosphere

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-0023-00L</td>
<td>Atmosphere</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>H. Wernli, T. Peter</td>
</tr>
</tbody>
</table>

Abstract
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

Objective
Understanding of basic physical and chemical processes in the atmosphere. Understanding of mechanisms of and interactions between: weather - climate, atmosphere - ocean - continents, troposphere - stratosphere. Understanding of environmentally relevant structures and processes on vastly differing scales. Basis for the modelling of complex interrelations in the atmosphere.

Content
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

Lecture notes
Written information will be supplied.

Literature

Chemistry

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>529-0004-00L</td>
<td>Computer Simulation in Chemistry, Biology and Physics</td>
<td>W</td>
<td>7 credits</td>
<td>4G</td>
<td>P. H. Hünenerberger</td>
</tr>
</tbody>
</table>

Abstract
Molecular models, Force fields, Boundary conditions, Electrostatic interactions, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

For more information: www.csms.ethz.ch/education/CSCBP

Objective
Introduction to computer simulation of (bio)molecular systems, development of skills to carry out and interpret computer simulations of biomolecular systems.

Content
Molecular models, Force fields, Spatial boundary conditions, Calculation of Coulomb forces, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.
### Fluid Dynamics

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<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0103-00L</td>
<td>Fluid Dynamics II</td>
<td>W</td>
<td>3</td>
<td>2+1</td>
<td>P. Jenny</td>
</tr>
<tr>
<td><strong>Objective</strong></td>
<td>Expand basic knowledge of fluid dynamics. Concepts, phenomena and quantitative description of irrotational (potential), rotational, and one-dimensional compressible flows.</td>
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<tr>
<td><strong>Content</strong></td>
<td>Two-dimensional irrotational (potential) flows: stream function and potential, complex notation, singularity method, unsteady flow, aerodynamic concepts. Vorticity dynamics: vorticity and circulation, vorticity equation, vortex theorems of Helmholtz and Kelvin. Compressible flows: isentropic flow along stream tube, normal and oblique shocks, Laval nozzle, Prandtl-Meyer expansion, viscous effects.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Lecture notes are available (in German). (See also info on literature below.)</td>
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</tr>
<tr>
<td><strong>Literature</strong></td>
<td>Relevant chapters (corresponding to lecture notes) from the textbook</td>
<td></td>
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</table>

### Systems and Control

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-0103-00L</td>
<td>Control Systems</td>
<td>W</td>
<td>6</td>
<td>2+2</td>
<td>M. Morari, F. Dörfel</td>
</tr>
<tr>
<td><strong>Lecture notes</strong></td>
<td>Slides can be downloaded from the course website. A printed version with additional content is offered via SPOD (student print on demand) for a fee (ca. 10-15 CHF).</td>
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<tr>
<td><strong>Prerequisites / notice</strong></td>
<td>Prerequisites: Signal and Systems Theory II.</td>
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<tr>
<td></td>
<td>MATLAB is used for system analysis and simulation.</td>
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### Robotics

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<tr>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0601-00L</td>
<td>Theory of Robotics and Mechatronics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>P. Korb, S. Stoeter, B. Nelson</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>This course provides an introduction and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. Its a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.</td>
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<tr>
<td><strong>Objective</strong></td>
<td>Robotics is often viewed from three perspectives: perception (sensing), manipulation (affecting changes in the world), and cognition (intelligence). Robotic systems integrate aspects of all three of these areas. This course provides an introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. This course is a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.</td>
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<tr>
<td><strong>Content</strong></td>
<td>An introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control.</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Lecture notes, problem set with solutions.</td>
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</table>
151-0851-00L  
**Einführung in die rechnergestützte Simulation physikalischer Probleme. Anhand einfacher Modelle aus der klassischen Mechanik,**

We will provide an overview on how to kinematically and dynamically model typical robotic systems such as robot arms, legged robots, rotary wing systems, or fixed wing.

**Objective**  
The primary objective of this course is that the student deepens an applied understanding of how to model the most common robotic systems. The student receives a solid background in kinematics, dynamics, and rotations of multi-body systems. On the basis of state of the art applications, he/she will learn all necessary tools to work in the field of design or control of robotic systems.

**Content**  
The course consists of three parts: First, we will refresh and deepen the student's knowledge in kinematics, dynamics, and rotations of multi-body systems. In this context, the learning material will build upon the courses for mechanics and dynamics available at ETH, with the particular focus on their application to robotic systems. The goal is to foster the conceptual understanding of similarities and differences among the various types of robots. In the second part, we will apply the learned material to classical robotic arms as well as legged systems and discuss kinematic constraints and interaction forces. In the third part, focus is put on modeling fixed wing aircraft, along with related design and control concepts. In this context, we also touch aerodynamics and flight mechanics to an extent typically required in robotics. The last part finally covers different helicopter types, with a focus on quadrotors and the coaxial configuration which we see today in many UAV applications. Case studies on all main topics provide the link to real applications and to the state of the art in robotics.

**Prerequisites / notice**  
The contents of the following ETH Bachelor lectures or equivalent are assumed to be known: Mechanics and Dynamics, Control, Basics in Fluid Dynamics.

### Physics

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<tr>
<th>Number</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>402-0809-00L</td>
<td>Introduction to Computational Physics</td>
<td>W</td>
<td>8</td>
<td>2V+2U</td>
<td>H. J. Herrmann</td>
</tr>
</tbody>
</table>

**Abstract**  
This course offers an introduction to computer simulation methods for physics problems and their implementation on PCs and super computers: classical equations of motion, partial differential equations (wave equation, diffusion equation, Maxwell’s equation), Monte Carlo simulations, percolation, phase transitions.

**Content**  

**Prerequisites / notice**  
Lecture and exercise lessons in English, exams in German or in English

### Computational Finance

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-3913-01L</td>
<td>Mathematical Foundations for Finance</td>
<td>W</td>
<td>4</td>
<td>3V+2U</td>
<td>E. W. Farkas, M. Schweizer</td>
</tr>
</tbody>
</table>

**Abstract**  
First introduction to main modelling ideas and mathematical tools from mathematical finance.

**Objective**  
This course gives a first introduction to the main modelling ideas and mathematical tools from mathematical finance. It aims at a double audience: mathematicians who want to learn the modelling ideas and concepts for finance, and non-mathematicians who need an introduction to the main tools from stochastics used in mathematical finance. The main emphasis will be on ideas, but important results will be given with (sometimes partial) proofs.

**Content**  
Topics to be covered include:
- financial market models in finite discrete time
- absence of arbitrage and martingale measures
- valuation and hedging in complete markets
- basics about Brownian motion
- stochastic integration
- stochastic calculus: Itô’s formula, Girsanov transformation, Itô’s representation theorem
- Black-Scholes formula

**Literature**  
Lecture notes will be sold at the beginning of the course.

**Prerequisites / notice**  
Prerequisites: Results and facts from probability theory as in the book "Probability Essentials" by J. Jacod and P. Protter will be used freely. Especially participants without a direct mathematics background are strongly advised to familiarise themselves with those tools before (or very quickly during) the course. (A possible alternative to the above English textbook are the (German) lecture notes for the standard course "Wahrscheinlichkeitsrechnung").

For those who are not sure about their background, we suggest to look at the exercises in Chapters 8, 9, 22-25, 28 of the Jacod/Protter book. If these pose problems, you will have a hard time during the course. So be prepared.

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-4657-00L</td>
<td>Numerical Analysis of Stochastic Ordinary Differential Equations</td>
<td>W</td>
<td>6</td>
<td>3V+1U</td>
<td>A. Jentzen</td>
</tr>
</tbody>
</table>

**Abstract**  
Course on numerical approximations of stochastic ordinary differential equations driven by Wiener processes. These equations have several applications, for example in financial option valuation. This course also contains an introduction to random number generation and Monte Carlo methods for random variables.

**Objective**  
The aim of this course is to enable the students to carry out simulations and their mathematical convergence analysis for stochastic models originating from applications such as mathematical finance. For this the course teaches a decent knowledge of the different numerical methods, their underlying ideas, convergence properties and implementation issues.

**Content**  
- Generation of random numbers
- Monte Carlo methods for the numerical integration of random variables
- Stochastic processes and Brownian motion
- Stochastic ordinary differential equations (SODEs)
- Numerical approximations of SODEs
- Multilevel Monte Carlo methods for SODEs
- Applications to computational finance: Option valuation

**Lecture notes**  
Lecture Notes will be available.
Literature

P. Glassermann:
Monte Carlo Methods in Financial Engineering.

P. E. Kloeden and E. Platen:
Numerical Solution of Stochastic Differential Equations.

Prerequisites / notice

Prerequisites:

Mandatory: Probability and measure theory, basic numerical analysis and basics of MATLAB programming.

a) mandatory courses:
Elementary Probability, Probability Theory I.

b) recommended courses:
Stochastic Processes.

Electromagnetics

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-2037-00L</td>
<td>Physical Modelling and Simulation</td>
<td>W</td>
<td>5 credits</td>
<td>4G</td>
<td>C. Hafner, J. Leuthold, J. Smajic</td>
</tr>
</tbody>
</table>

Abstract
Physical modelling plays an important role in the analysis and design of new structures, especially for micro and nano devices where fabrication and measurement are difficult. After the fundamentals of electromagnetics, mechanics, and thermodynamics, an introduction to the main concepts and most widely used codes for physical modelling is given and commercial codes are applied.

Objective
Basic knowledge of the fundamental equations and effects of electromagnetics, mechanics, and thermodynamics. Knowledge of the main concepts of numerical methods for physical modelling and simulation. Ability 1) to select appropriate software, 2) to apply it for solving given problems, 3) to validate the results, 4) to interactively improve the models until sufficiently accurate results are obtained.

Content
Since the fabrication and characterization of micro- and nanostructures is difficult, expensive, and time-consuming, numerical modelling drastically reduced the design process. Although many commercial software packages are available, it is important to know the drawbacks and difficulties of the numerical methods behind them and to be able to validate the results obtained with such packages.

First, an introduction to the fundamental equations and effects of electromagnetics, mechanics, and thermodynamics is given. This is important for understanding the problems to be analyzed and for validating results obtained from software packages. After this, the main concepts of numerical methods and of the most widely used codes for physical modelling are outlined and compared, which is essential for the adequate selection of software for solving given problems. After this, prominent commercial software packages are applied to various types of problems, ranging from electrodynamics to multiphysics. For becoming able to select appropriate software and to validate the results obtained, different commercial software packages will be used and compared during the exercises in form of small projects.

Geophysics

Recommended combinations:
- Subject 1 + Subject 2
- Subject 1 + Subject 3
- Subject 2 + Subject 3
- Subject 3 + Subject 4
- Subject 5 + Subject 6
- Subject 5 + Subject 4

Geophysics: Subject 1

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<tr>
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<tbody>
<tr>
<td>651-4007-00L</td>
<td>Continuum Mechanics</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>T. Gerya</td>
</tr>
</tbody>
</table>

Abstract
In this course, students learn crucial partial differential equations (conservation laws) that are applicable to any continuum including the Earth's mantle, core, atmosphere and ocean. The course will provide step-by-step introduction into the mathematical structure, physical meaning and analytical solutions of the equations. The course has a particular focus on solid Earth applications.

Objective
The goal of this course is to learn and understand few principal partial differential equations (conservation laws) that are applicable for analysing and modelling of any continuum including the Earth's mantle, core, atmosphere and ocean. By the end of the course, students should be able to write, explain and analyse the equations and apply them for simple analytical cases. Numerical solving of these equations will be discussed in the Numerical Modelling I and II course running in parallel.
A provisional week-by-week schedule (subject to change) is as follows:

Week 1: The continuity equation

Week 2: Density and gravity

Week 3: Stress and strain

Week 4: The momentum equation

Week 5: Viscous rheology of rocks

Week 6: The heat conservation equation

Week 7: Elasticity and plasticity

GRADING will be based on homeworks (30%) and oral exams (70%).
Exam questions: http://www.erdw.ethz.ch/people/geophysics/tgerya/EXAM_QUESTIONS

Lecture notes
Script is available by request to taras.gerya@erdw.ethz.ch

Exam questions: http://www.erdw.ethz.ch/people/geophysics/tgerya/EXAM_QUESTIONS

Literature
Taras Gerya Introduction to Numerical Geodynamic Modelling Cambridge University Press, 2010

Geophysics: Subject 2

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<tr>
<th>Number</th>
<th>Title</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4241-00L</td>
<td>Numerical Modelling I and II: Theory and Applications</td>
<td>W</td>
<td>6 credits</td>
<td>4G</td>
<td>T. Gerya</td>
</tr>
</tbody>
</table>

Abstract
In this 13-week sequence, students learn how to write programs from scratch to solve partial differential equations that are useful for Earth science applications. Programming will be done in MATLAB and will use the finite-difference method and marker-in-cell technique. The course will emphasise a hands-on learning approach rather than extensive theory.

Objective
The goal of this course is for students to learn how to program numerical applications from scratch. By the end of the course, students should be able to write state-of-the-art MATLAB codes that solve systems of partial-differential equations relevant to Earth and Planetary Science applications using finite-difference method and marker-in-cell technique. Applications include Poisson equation, buoyancy driven variable viscosity flow, heat diffusion and advection, and state-of-the-art thermomechanical code programming. The emphasis will be on commonality, i.e., using a similar approach to solve different applications, and modularity, i.e., re-use of code in different programs. The course will emphasise a hands-on learning approach rather than extensive theory, and will begin with an introduction to programming in MATLAB.

Content
A provisional week-by-week schedule (subject to change) is as follows:

Week 1: Introduction to the finite difference approximation to differential equations. Introduction to programming in Matlab. Solving of 1D Poisson equation.
Week 5: Conservative finite differences for the momentum equation. "Free slip" and "no slip" boundary conditions. Solving momentum and continuity equations in case of variable viscosity using pressure-velocity formulation with staggered grid.
Week 7: Advection in 2-D with Marker-in-cell method. Combining flow calculation and advection for buoyancy driven flow.
Week 8: "Free surface" boundary condition and "sticky air" approach. Free surface stabilization. Runge-Kutta schemes.
Week 9: Solving 2D heat conservation equation in case of constant thermal conductivity with explicit and implicit approaches.
Week 10: Solving 2D heat conservation equation in case of variable thermal conductivity with implicit approach. Temperature advection with markers. Creating thermomechanical code by combining mechanical solution for 2D buoyancy driven flow with heat diffusion and advection based on marker-in-cell approach.
Week 11: Subgrid diffusion of temperature. Implementing subgrid diffusion to the thermomechanical code.
Week 12: Implementation of radioactive, adiabatic and shear heating to the thermomechanical code.
Week 13: Implementation of temperature-, pressure- and strain rate-dependent viscosity, temperature- and pressure-dependent density and temperature-dependent thermal conductivity to the thermomechanical code. Final project description.

GRADING will be based on weekly programming homeworks (50%) and a term project (50%) to develop an application of their choice to a more advanced level.
### Geophysics: Subject 3
**Offered in the spring semester**

#### Literature
- Taras Gerya, Introduction to Numerical Geodynamic Modelling, Cambridge University Press 2010

### Geophysics: Subject 4
**Offered in the spring semester**

#### Literature

### Geophysics: Subject 5
**Offered in the spring semester**

#### Number
- 651-4014-00L

#### Title
- Seismic Tomography

#### Abstract
- Seismic tomography is the science of interpreting seismic measurements (seismograms) to derive information about the structure of the Earth. The subject of this course is the formal relationship existing between a seismic measurement and the nature of the Earth, or of certain regions of the Earth, and the ways to use it, to gain information about the Earth.

#### Literature

### Biology
**Offered in the spring semester**

#### Number
- 636-0007-00L

#### Title
- Computational Systems Biology

#### Abstract
- Study of fundamental concepts, models and computational methods for the analysis of complex biological networks. Topics: Systems approaches in biology, biology and reaction network fundamentals, modeling and simulation approaches (topological, probabilistic, stoichiometric, qualitative, linear / nonlinear ODEs, stochastic), and systems analysis (complexity reduction, stability, identification).

#### Literature

### Electives

#### Number
- 151-0113-00L

#### Title
- Applied Fluid Dynamics

#### Abstract
- The methods of fluid dynamics play an important role in the description of a chain of events, involving the release, spreading and dilution of dangerous fluids in the environment. Tunnel ventilation systems and strategies are studied, which must meet severe requirements during normal operation and in emergency situations (tunnel fires etc.).

#### Objective
- Generally applicable methods in fluid dynamics and gas dynamics are illustrated and practiced using selected current examples.

#### Content
- Often experts fall back on the methodology of fluid dynamics when involved in the construction of environmentally friendly processing and incineration facilities, as well as when choosing safe transport and storage options for dangerous materials. As a result of accidents, but also in normal operations, dangerous gases and liquids may escape and be transported further by wind or flowing water. There are many possible forms that the resulting damage may take, including fire and explosion when flammable substances are mixed. The topics covered include: Emissions of liquids and gases from containers and pipelines, evaporation from pools and vaporization of gases kept under pressure, the spread and dilution of waste gas plumes in the wind, deflagration and detonation of flammable gases, fires/balls in gases held under pressure, pollution and exhaust gases in tunnels (tunnel fires etc.).

#### Lecture notes
- not available

#### Prerequisites
- Requirements: successful attendance at lectures “Fluidodynamik I und II”, “Thermodynamik I und II”

#### Number
- 151-0709-00L

#### Title
- Stochastic Methods for Engineers and Natural Scientists

#### Abstract
- The course provides an introduction into stochastic methods that are applicable for example for the description and modeling of turbulent and subsurface flows. Moreover, mathematical techniques are presented that are used to quantify uncertainty in various engineering applications.

#### Objective
- By the end of the course you should be able to mathematically describe random quantities and their effect on physical systems. Moreover, you should be able to develop basic stochastic models of such systems.

### Data
- Data: 06.02.2019 13:00
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The goal of the lecture is to provide the students with the fundamentals of the non linear Finite Element Method (FEM). The lecture focuses on the principles of the nonlinear Finite-Element-Method based on explicit and implicit formulations. Typical applications of the nonlinear Finite-Element-Methods are simulations of:

- Crash
- Collapse of structures
- Materials in Biomechanics (soft materials)
- General forming processes

Special attention will be paid to the modeling of the nonlinear material behavior, thermo-mechanical processes and processes with large plastic deformations. The ability to independently create a virtual model which describes the complex non linear systems will be acquired through accompanying exercises. These will include the Matlab programming of important model components such as constitutive equations.

- Fundamentals of continuum mechanics to characterize large plastic deformations
- Elasto-plastic material models
- Updated-Lagrange (UL), Euler and combined Euler-Lagrange (ALE) approaches
- FEM implementation of constitutive equations
- Element formulations
- Implicit and explicit FEM methods
- FEM formulations of coupled thermo-mechanical problems
- Modeling of tool contact and the influence of friction
- Solvers and convergence
- Modeling of crack propagation
- Introduction of advanced FE-Methods

Prerequisites:
- Introduction to Finite Elements and Sparse Linear System Solving

Lecture notes
- Introduction to Finite Elements and Sparse Linear System Solving
- Detailed lecture notes will be provided.

Literature
- Some textbooks related to the material covered in the course:

Prerequisites / notice
- If we will have a large number of students, two dates for the exercises will be offered.

Yes
I. THE FINITE ELEMENT METHOD

(1) Introduction, model problems.
(2) 1D problems. Piecewise polynomials in 1D.
(3) 2D problems. Triangulations. Piecewise polynomials in 2D.
(4) Variational formulations. Galerkin finite element method.
(5) Implementation aspects.

II. DIRECT SOLUTION METHODS

(6) LU and Cholesky decomposition.
(7) Sparse matrices.
(8) Fill-reducing orderings.

III. ITERATIVE SOLUTION METHODS

(9) Stationary iterative methods, preconditioning.
(10) Preconditioned conjugate gradient method (PCG).
(11) Incomplete factorization preconditioning.
(12) Multigrid preconditioning.
(13) Nonsymmetric problems (GMRES, BiCGstab).
(14) Indefinite problems (SYMMLQ, MINRES).

Literature


Prerequisites / notice

Prerequisites: Linear Algebra, Analysis, Computational Science.
The exercises are made with Matlab.

Abstract

Scientific databases share many aspects with classical DBs, but have additional specific aspects. We will review Relational DBs, Object Oriented DBs, Knowledge DBs, textual DBs and the Semantic Web. All these topics will be studied from the point of view of the scientific applications (Bioinformatics, Physics, Chemistry, Health, Engineering) A toy SDB will be used for exercises.

Objective

The goals of this course are to:
(a) Familiarize the students with how existing DBs can be used for scientific applications.
(b) Recognize the areas where SciDBs differ and require additional features compared to classical DBs.
(c) Be able to understand more easily SciDBs, improve existing ones or design/create new ones.
(d) Familiarize the students with at least two examples of SciDBs.
### Content

1) Introduction, Statement of the problem, course structure, exercises, why Scientific DBs (SDBs) do not fit exactly the classical DB area.
   - Efficiency issues and how they differ from classical DB.

2) Relational DB used for scientific data, pros/cons
   - Introduction to RDB, limitations of the model, basics of SQL, handling of metadata, examples of scientific use of RDBs.

3) Object Oriented DB.
   - Rich/structured objects are very appealing in SDB. OODB primitives and environments. OODB searching, Space and access time efficiency of OODBs.

4) Knowledge bases, key-value stores, ontologies, workflow-based architectures. WASA.

5) MapReduce / Hadoop

6) Storing and sharing mathematical objects, Open Math, its relation with OODB and Knowledge bases. Also the problem of chemical formula representation.

7) SGML and XML, human-readable databases, genomic databases.
   - Advantages of human-readable databases (the huge initial success of genomic databases).


9) An ideal scenario (and the design of a toy system with most of the desired features for exploration and exercises).


11) Functional testing, Verifiers, Consistency, Short-circuit testing, Recovery and Automatic recovery, Backup (incremental) methods.

12) Performance and space issues, various uses of compression, concurrency control. Hardware issues, clusters, Cloud computing, Crowd-sourcing.

13) Guest speaker: Ioannis Xenarios (UniProtKB/Swiss-Prot).

### Literature

Several papers and online articles will be made available. There is no single textbook for this course.

A significant amount of material will be delivered in the lectures making lecture attendance highly recommended.

| 263-3010-00L | Big Data | W 6 credits | 3V+1U+1A | T. Hofmann
|--------------|----------|-------------|----------|------------------|

**Does not take place this semester.**

**Abstract**

One of the key challenges of the information society is to turn data into information, information into knowledge, and knowledge into value. To turn data into value in this way involves collecting large volumes of data, possibly from many and diverse data sources, processing the data fast, and applying complex operations to the data.

**Objective**

To turn data into value in this way involves collecting large volumes of data, possibly from many and diverse data sources, processing the data fast, and applying complex operations to the data. This combination of requirements is typically referred to as Big Data and it has led to a completely new way to do business (e.g., develop new products and business models) and do science (sometimes referred to as data-driven science or the “fourth paradigm”). Unfortunately, big data grows faster than our ability to process the data so that new architectures and approaches for processing Big Data are needed.

**Content**

The goal of this course is to give an overview of Big Data technologies. All aspects are covered: data formats and models, programming languages, optimization techniques, systems, and applications.

**Literature**

Papers from scientific conferences and journals. References will be given as part of the course material during the semester.

| 263-2800-00L | Design of Parallel and High-Performance Computing | W 7 credits | 3V+2U+1A | T. Hofel, M. Püschel
|--------------|--------------------------------------------------|-------------|----------|------------------|

**Abstract**

Advanced topics in parallel / concurrent programming.

**Objective**

Understand concurrency paradigms and models from a higher perspective and acquire skills for designing, structuring and developing possibly large concurrent software systems. Become able to distinguish parallelism in problem space and in machine space. Become familiar with important technical concepts and with concurrency folklore.

| 227-0102-00L | Discrete Event Systems | W 6 credits | 4G | L. Thiele, L. Vanbever, R. Wattenhofer
|--------------|-----------------------|-------------|----------|------------------|

**Abstract**

Introduction to discrete event systems. We start out by studying popular models of discrete event systems. In the second part of the course we analyze discrete event systems from an average-case and from a worst-case perspective. Topics include: Automata and Languages, Specification Models, Stochastic Discrete Event Systems, Worst-Case Event Systems, Verification, Network Calculus.

**Objective**

Over the past few decades the rapid evolution of computing, communication, and information technologies has brought about the proliferation of new dynamic systems. A significant part of activity in these systems is governed by operational rules designed by humans. The dynamics of these systems are characterized by asynchronous occurrences of discrete events, some controlled (e.g. hitting a keyboard key, sending a message), some not (e.g. spontaneous failure, packet loss).

The mathematical arsenal centered around differential equations that has been employed in systems engineering to model and study processes governed by the laws of nature is often inadequate or inappropriate for discrete event systems. The challenge is to develop new modeling frameworks, analysis techniques, design tools, testing methods, and optimization processes for this new generation of systems.

In this lecture we give an introduction to discrete event systems. We start out the course by studying popular models of discrete event systems, such as automata and Petri nets. In the second part of the course we analyze discrete event systems. We first examine discrete event systems from an average-case perspective: we model discrete events as stochastic processes, and then apply Markov chains and queueing theory for an understanding of the typical behavior of a system. In the last part of the course we analyze discrete event systems from a worst-case perspective using the theory of online algorithms and adversarial queueing.
Abstract
Context recognition in mobile communication systems like mobile phone and wearable computer will be studied using advanced methods from sensor data fusion, pattern recognition, statistics, data mining and machine learning. Context comprises the behavior of individuals and of groups, their activities as well as the local and social environment.

Objective
Future mobile systems will act as personal and cooperative assistant by providing the appropriate information and services. The systems consist of a smart phone which communicates with sensors on-body and in the environment. Context comprises user's behavior, his activities, his local and social environment.

In the data path from the sensor level to signal segmentation to the classification of the context, advanced methods of signal processing, pattern recognition and machine learning will be applied. Sensor data generated by crowdsourcing methods are integrated. The validation using MATLAB is followed by implementation and testing on a smart phone.

Context recognition as the crucial function of mobile systems is the main focus of the course. Using MatLab the participants implement and verify the discussed methods also using a smart phone.

Content
The next generation of mobile communication systems are integrated in our clothes and act as personal and cooperative assistant providing information we need just now (see www.wearable.ethz.ch). Context recognition - what is the situation of the user, his activity, his environment, how is he doing, what are his needs - as the central functionality of mobile systems constitutes the focus of the course.

The main topics of the course include
Sensor nets, sensor signal processing, data fusion, time series (segmentation, similarity measures), supervised learning (Bayes Decision Theory, Decision Trees, Random Forest, kNN-Methods, Support Vector Machine, Hidden Markov Models, Adaboost), clustering (k-means, dbscan, topic models) Crowdsourcing.

The exercises show concrete design problems like motion and gesture recognition using distributed sensors, detection of activity patterns and identification of the local environment.

Presentations of the PhD students and the visit at the Wearable Computing Lab introduce in current research topics and international research projects.

Language: german/english (depending on the participants)
Lecture notes
Lecture notes for all lessons, assignments and solutions.
http://www.ife.ee.ethz.ch/education/wearable_systems_1
Literature
Literature will be announced during the lessons.
Prerequisites / notice
No special prerequisites
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.
### Content
The lecture covers topics in physically-based modeling, such as particle systems, mass-spring models, finite difference and finite element methods. These approaches are used to represent and simulate deformable objects or fluids with applications in animated movies, 3D games and medical systems. Furthermore, the lecture covers topics such as rigid body dynamics, collision detection, and character animation.

### Prerequisites / notice
Fundamentals of calculus and physics, basic concepts of algorithms and data structures, basic programming skills in C++. Knowledge on numerical mathematics as well as ordinary and partial differential equations is an asset, but not required.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Type</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3611-00L</td>
<td>Advanced Topics in Computational Statistics</td>
<td>4</td>
<td>W</td>
<td>M. H. Maathuis, M. Mächler</td>
</tr>
<tr>
<td>401-3627-00L</td>
<td>High-Dimensional Statistics</td>
<td>4</td>
<td>W</td>
<td>P. L. Bühlmann</td>
</tr>
<tr>
<td>401-4623-00L</td>
<td>Time Series Analysis</td>
<td>6</td>
<td>W</td>
<td>not available</td>
</tr>
<tr>
<td>401-3901-00L</td>
<td>Mathematical Optimization</td>
<td>11</td>
<td>W</td>
<td>R. Weismantel</td>
</tr>
<tr>
<td>402-0867-00L</td>
<td>Programming Techniques for Scientific Simulations II</td>
<td>6</td>
<td>W</td>
<td>M. Troyer</td>
</tr>
<tr>
<td>402-2203-01L</td>
<td>Classical Mechanics</td>
<td>7</td>
<td>W</td>
<td>C. Anastasiou</td>
</tr>
<tr>
<td>401-7855-00L</td>
<td>Computational Astrophysics (University of Zurich)</td>
<td>6</td>
<td>W</td>
<td>L. M. Mayer</td>
</tr>
</tbody>
</table>

### Objective
Students learn the theoretical foundations of the selected methods, as well as practical skills to apply these methods and to interpret their outcomes.

### Content
The course is roughly divided in three parts: (1) Supervised learning via (variations of) nearest neighbor methods, (2) the EM algorithm and clustering, (3) handling missing data and graphical models.

### Lecture notes
A list of references will be distributed during the course.

### Prerequisites / notice
We assume a solid background in mathematics, an introductory lecture in probability and statistics, and at least one more advanced course in statistics.

### Objective
Knowledge of methods and basic theory for high-dimensional statistical inference

### Content
Lasso and Group Lasso for high-dimensional linear and generalized linear models; Additive models and many smooth univariate functions; Non-convex loss functions and l1-regularization; Stability selection, multiple testing and construction of p-values; Undirected graphical modeling

### Literature
Objective: Acquire knowledge of main methodologies for computer-based models of astrophysical systems, the physical equations behind them, and train such knowledge with simple examples of computer programs.

Content:
1. Integration of ODE, Hamiltonians and Symplectic integration techniques, time adaptivity, time reversibility
2. Large-N gravity calculation, collisionless N-body systems and their simulation
3. Fast Fourier Transform and spectral methods in general
4. Eulerian Hydrodynamics: Upwinding, Riemann solvers, Limiters
5. Lagrangian Hydrodynamics: The SPH method
6. Resolution and instabilities in Hydrodynamics
7. Initial Conditions: Cosmological Simulations and Astrophysical Disks
8. Physical Approximations and Methods for Radiative Transfer in Astrophysics

Literature:
- Galactic Dynamics (Binney & Tremaine, Princeton University Press), Computer Simulation using Particles (Hockney & Eastwood CRC press), Targeted journal reviews on computational methods for astrophysical fluids (SPH, AMR, moving mesh)
- Some knowledge of UNIX, scripting languages (see www.physik.uzh.ch/lectures/informatik/python/ as an example), some prior experience programming, knowledge of C, C++ beneficial

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Prerequisites</th>
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<tbody>
<tr>
<td>227-1033-00L</td>
<td>Neuromorphic Engineering I</td>
<td>6 credits</td>
<td>Some knowledge of UNIX, scripting languages (as an example), some prior experience programming, knowledge of C, C++ beneficial</td>
</tr>
</tbody>
</table>

Abstract: This course covers analog circuits with emphasis on neuromorphic engineering: MOS transistors in CMOS technology, static circuits, dynamic circuits, systems (silicon neuron, silicon retina, silicon cochlea) with an introduction to multi-chip systems. The lectures are accompanied by weekly laboratory sessions.

Objective: Understanding the characteristics of neuromorphic circuit elements.

Content: Neuromorphic circuits are inspired by the organizing principles of biological neural circuits. Their computational primitives are based on physics of semiconductor devices. Neuromorphic architectures often rely on collective computation in parallel networks. Adaptation, learning and memory are implemented locally within the individual computational elements. Transistors are often operated in weak inversion (below threshold), where they exhibit exponential I-V characteristics and low currents. These properties lead to the feasibility of high-density, low-power implementations of functions that are computationally intensive in other paradigms. Application domains of neuromorphic circuits include silicon retinas and cochleas for machine vision and audition, real-time emulations of networks of biological neurons, and the development of autonomous robotic systems. This course covers devices in CMOS technology (MOS transistor below and above threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, transconductance amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina and cochlea) and an introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory sessions on the characterization of neuromorphic circuits, from elementary devices to systems.

Prerequisites / notice: Particular: The course is highly recommended for those who intend to take the spring semester course 'Neuromorphic Engineering II', that teaches the conception, simulation, and physical layout of such circuits with chip design tools.

<table>
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<tr>
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<tr>
<td>227-1037-00L</td>
<td>Introduction to Neuroinformatics</td>
<td>6 credits</td>
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</tbody>
</table>

Abstract: The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.

Objective: Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monocrucies of physics, maths, computer science, engineering, biology, psychology, and even philosophy and history, to discover the enchantments and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions.

Content: This course considers the structure and function of biological neural networks at different levels. The function of neural networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and to explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the processes of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.

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<tr>
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<th>Credits</th>
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<tbody>
<tr>
<td>327-1201-00L</td>
<td>Transport Phenomena I</td>
<td>4 credits</td>
</tr>
</tbody>
</table>

Abstract: Phnomolenological approach to “Transport Phenomena” based on balance equations supplemented by thermodynamic considerations to formulate the undetermined fluxes in the local species mass, momentum, and energy balance equations; fundamentals, applications, and simulations.

Objective: The teaching goals of this course are on five different levels:
1. Deep understanding of fundamentals: local balance equations, constitutive equations for fluxes, entropy balance, interfaces, idea of dimensionless numbers, ... 
2. Ability to use the fundamental concepts in applications
3. Insight into the role of boundary conditions
4. Knowledge of a number of applications
5. Flavor of numerical techniques: finite elements, finite differences, lattice Boltzmann, Brownian dynamics, ...

Content: Approach to Transport Phenomena
- Diffusion Equation
- Brownian Dynamics
- Refreshing Topics in Equilibrium Thermodynamics
- Balance Equations
- Forces and Fluxes
- Measuring Transport Coefficients
- Pressure-Driven Flows
- Heat Exchangers
- Complex Fluids

Lecture notes: A detailed manuscript is provided; this manuscript will be developed into a book entitled “A Modern Course in Transport Phenomena” by David C. Venerus and Hans Christian Öttinger.
This course lies in the intersection between Computer Science and Molecular Biology. The main purpose is to study computational techniques, algorithms and data structures used to solve problems in computational biology. Topics: basic biology, dynamics of large-scale atmospheric flow. Students have basic knowledge on atmospheric turbulence and theoretical as well as practical approaches to treat Planetary Boundary Layer flows. They are familiar with the relevant processes (turbulent transport, forcing within, and typical states of the Planetary Boundary Layer). Idealized concepts are known as well as their adaptations under real surface conditions (as for example over complex topography).

### Additional Electives from the Fields of Specialization (CSE Master)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>651-4053-05L</td>
<td>Boundary Layer Meteorology</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>M. Rotach, P. Calanca</td>
</tr>
<tr>
<td>701-1221-00L</td>
<td>Dynamics of Large-Scale Atmospheric Flow</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>H. Wernli, S. Pfahl</td>
</tr>
<tr>
<td>252-0523-00L</td>
<td>Computational Biology</td>
<td>W</td>
<td>6</td>
<td>3V+2U</td>
<td>G. H. Gonnet</td>
</tr>
<tr>
<td>529-0003-00L</td>
<td>Advanced Quantum Chemistry</td>
<td>W</td>
<td>7</td>
<td>3G</td>
<td>M. Reiher, S. Knecht</td>
</tr>
</tbody>
</table>

**Abstract**

The Planetary Boundary Layer (PBL) constitutes the interface between the atmosphere and the Earth's surface. Theory on transport processes in the PBL and their dynamics is provided. This course treats theoretical background and idealized concepts. These are contrasted to real world applications and current research issues. Overall goals of this course are given below. Focus is on the theoretical background and idealized concepts.

**Objective**

- Introduction
- Turbulence
- Statistical treatment of turbulence, turbulent transport
- Conservation equations in a turbulent flow
- Closure problem and closure assumptions
- Scaling and similarity theory
- Spectral characteristics
- Concepts for non-ideal boundary layer conditions

**Content**

- Various topics related to boundary layer meteorology
- Theoretical background and idealized concepts

**Lecture notes**


**Prerequisites / notice**

Umwelt-Fluiddynamik (701-0479-00L) (environment fluid dynamics) or equivalent and basic knowledge in atmospheric science
The aim of the course is to provide an in-depth knowledge of theory and method development in theoretical chemistry. It will be shown that this is necessary in order to be able to solve actual chemical problems on a computer with quantum chemical methods.

The relativistic re-derivation of all concepts known from (nonrelativistic) quantum mechanics and quantum-chemistry lectures will finally explain the form of all operators in the molecular Hamiltonian - usually postulated rather than deduced. From this, we derive operators needed for molecular spectroscopy (like those required by magnetic resonance spectroscopy). Implications of other assumptions in standard non-relativistic quantum chemistry shall be analyzed and understood, too. Examples are the Born-Oppenheimer approximation and the expansion of the electronic wave function in a set of pre-defined many-electron basis functions (Slater determinants). Overcoming these concepts, which are so natural to the theory of chemistry, will provide deeper insights into many-particle quantum mechanics. Also revisiting the workhorse of quantum chemistry, namely density functional theory, with an emphasis on open-shell electronic structures (radicals, transition-metal complexes) will contribute to this endeavor. It will be shown how these insights allow us to make more accurate predictions in chemistry in practice - at the frontier of research in theoretical chemistry.

151-0105-00L Quantitative Flow Visualization W 4 credits 2V+1U T. Rösgen
Objective
Introduction to modern imaging techniques and post processing algorithms with special emphasis on flow analysis and visualization.
Understanding of hardware and software requirements and solutions.
Content
Development of basic programming skills for (generic) imaging applications.
Fundamentals of optics, flow visualization and electronic image acquisition.
Frequently used mage processing techniques (filtering, correlation processing, FFTs, color space transforms).
Frequently used image analysis algorithms are presented in detail and programmed during the exercises.
Lecture notes are available
Prerequisites / notice
Strongly recommended (preparatory) courses are: quantum mechanics and quantum chemistry

151-0109-00L Turbulent Flows W 4 credits 2V+1U P. Jenny
Abstract
Laminar and turbulent flows, instability and origin of turbulence - Statistical description: averaging, turbulent energy, dissipation, closure problem - Scalings. Homogeneous isotropic turbulence, correlations, Fourier representation, energy spectrum - Free turbulence: wake, jet, mixing layer - Wall turbulence. Channel and boundary layer - Computation and modelling of turbulent flows
Objective
Basic physical phenomena of turbulent flows, quantitative and statistical description, basic and averaged equations, principles of turbulent flow computation and elements of turbulence modelling
Content
Laminar and turbulent flows, instability and origin of turbulence - Statistical description: averaging, turbulent energy, dissipation, closure problem - Scalings. Homogeneous isotropic turbulence, correlations, Fourier representation, energy spectrum - Free turbulence: wake, jet, mixing layer - Wall turbulence. Channel and boundary layer - Computation and modelling of turbulent flows
Lecture notes are available
Literature

151-0207-00L Theory and Modeling of Reactive Flows W 4 credits 3G C. E. Frouzakis, I. Mantzaras
Abstract
Theory of combustion with numerical applications. The course first reviews the governing equations and combustion chemistry, setting the ground for the analysis of homogeneous gas-phase mixtures, laminar diffusion and premixed flames. Catalytic combustion and its coupling with homogeneous combustion are dealt in detail, and turbulent combustion modeling approaches are presented. Available numerical codes will be used for modeling.
Objective
The analysis of realistic reactive flow systems necessitates the use of detailed computer models that can be constructed starting from first principles i.e. thermodynamics, fluid mechanics, chemical kinetics, and heat and mass transport. In this course, the focus will be on combustion theory and modeling. The reacting flow governing equations and the combustion chemistry are firstly reviewed, setting the ground for the analysis of homogeneous gas-phase mixtures, laminar diffusion and premixed flames. Heterogeneous (catalytic) combustion, an area of increased importance in the last years, will be dealt in detail along with its coupling with homogeneous combustion. Finally, approaches for the modeling of turbulent combustion will be presented. Available numerical codes will be used to compute the above described phenomena. Familiarity with numerical methods for the solution of partial differential equations is expected.

Central element of the course is the completion of a lattice Boltzmann code (using the framework specifically designed for this course).

The course will also include a review of topics of current interest in various fields of fluid dynamics, such as multiphase flows, reactive flows, microflows among others.

Optionally, we offer an option to complete a project of student's choice as an alternative to the oral exam. Samples of projects completed by previous students will be made available.

The course builds upon three parts:
I. Elementary kinetic theory and lattice Boltzmann simulations introduced on simple examples.
II. Theoretical basis of statistical mechanics and kinetic equations.
III. Lattice Boltzmann method for real-world applications.

The content of the course includes:
1. Background: Elements of statistical mechanics and kinetic theory:
   Particle's distribution function, Liouville equation, entropy, ensembles; Kinetic theory: Boltzmann equation for rarefied gas, H-theorem, hydrodynamic limit and derivation of Navier-Stokes equations, Chapman-Enskog method, Grad method, boundary conditions; mean-field interactions, Vlasov equation;
   Kinetic models: BGK model, generalized BGK model for mixtures, chemical reactions and other fluids.
2. Basics of the Lattice Boltzmann Method and Simulations:
   Minimal kinetic models: lattice Boltzmann method for single-component fluid, discretization of velocity space, time-space discretization, boundary conditions, forcing, thermal models, mixtures.
3. Hands on:
   Development of the basic lattice Boltzmann code and its validation on standard benchmarks (Taylor-Green vortex, lid-driven cavity flow etc).
4. Practical issues of LBM for fluid dynamics simulations:
   Lattice Boltzmann simulations of turbulent flows; numerical stability and accuracy.
5. Microflow:
   Rarefaction effects in moderately dilute gases; Boundary conditions, exact solutions to Couette and Poiseuille flows; micro-channel simulations.
6. Advanced lattice Boltzmann methods:
   Entropic lattice Boltzmann scheme, subgrid simulations at high Reynolds numbers; Boundary conditions for complex geometries.
7. Introduction to LB models beyond hydrodynamics:
   Relativistic fluid dynamics; flows with phase transitions.

Lecture notes
Lecture notes on the theoretical parts of the course will be made available. Selected original and review papers are provided for some of the lectures on advanced topics.
Handouts and basic code framework for implementation of the lattice Boltzmann models will be provided.

Prerequisites / notice
The course addresses mainly graduate students (MSc/Ph D) but BSc students can also attend.

263-5902-00L
Abstract
The goal of this course is to provide students with a good understanding of computer vision and image analysis techniques. The main concepts and techniques will be studied in depth and practical algorithms and approaches will be discussed and explored through the exercises.
Objective

The objectives of this course are:

1. To introduce the fundamental problems of computer vision.
2. To introduce the main concepts and techniques used to solve those.
3. To enable participants to implement solutions for reasonably complex problems.
4. To enable participants to make sense of the computer vision literature.

Content

Camera models and calibration, invariant features, Multiple-view geometry, Model fitting, Stereo Matching, Segmentation, 2D Shape matching, Shape from Silhouettes, Optical flow, Structure from motion, Tracking, Object recognition, Object category recognition

Prerequisites / notice

It is recommended that students have taken the Visual Computing lecture or a similar course introducing basic image processing concepts before taking this course.

636-0017-00L Molecular Evolution, Phylogenetics and Phylodynamics

Abstract

The aim of the course is to provide up-to-date knowledge on how we can obtain an understanding of the evolution and population dynamics of organisms based on their genetic sequencing data, employing key concepts from molecular evolution, phylogenetics and phylodynamics. Throughout the course, we tie the models and methods closely with applications, mainly in the field of epidemiology and evolution.

Objective

Attendees will learn what information is contained in genetic sequencing data and how this information is extracted from the sequencing data. The main concepts introduced are:

* models in molecular evolution
* phylogenetic & phylodynamic inference
* maximum likelihood and Bayesian statistics
* stochastic processes

Attendees will apply these concepts to a number of applications yielding biological insight into:

* epidemiology
* pathogen evolution
* macroevolution of species

Content

The course consists of three parts. We first introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Second, we employ these evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand and quantify the population dynamic processes (such as transmission in epidemiology or speciation & extinction in macroevolution) based on a phylogeny. Throughout the class, the models and methods are illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution provide insight into the evolution and ecology of different species clades.

Lecture notes

Slides of the lecture will be available online.

Literature

The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:

* Yang, Z. 2006. Computational Molecular Evolution.
* Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST.

Prerequisites / notice

Basic knowledge in linear algebra, analysis, and statistics.

Case Studies

Number Title Type ECTS Hours Lecturers

401-3667-65L Case Studies Seminar (Autumn Semester 2015) W 3 credits 2S V. C. Gradinaru, R. Hiptmair, M. Reiher

Abstract

In the CSE Case Studies Seminar invited speakers from ETH, from other universities as well as from industry give a talk on an applied topic. Beside of attending the scientific talks students are asked to give short presentations (10 minutes) on a published paper out of a list.

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-MATH:

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UEH

Bachelor Thesis

Number Title Type ECTS Hours Lecturers

401-2000-00L Scientific Works in Mathematics O 0 credits E. Kowalski

Target audience:

Third year Bachelor students;
Master students who cannot document to have received an adequate training in working scientifically.

Mandatory for all Bachelor and Master students with matriculation in the autumn semester 2014 or later.
Optional for Bachelor and Master students with matriculation until or before the spring semester 2014.
Example: You matriculated in the autumn semester 2013 into the first semester of the Bachelor programme, are now in the third year and plan to matriculate in the autumn semester 2016 into the first semester of the Master programme. In this case, you don't need "Scientific Works in Mathematics" in order to complete the Bachelor degree, but for the Master degree you will need it. In this case, we recommend that you register for "Scientific Works in Mathematics" in the autumn semester 2015 or spring semester 2016.

Directive

https://www.ethz.ch/content/dam/ethz/common/docs/weis
Abstract
Introduction to scientific writing for students with focus on publication standards and ethical issues, especially in the case of citations (references to works of others.)

Objective
Learn the basic standards of scientific works in mathematics.

Content
- Types of mathematical works
- Publication standards in pure and applied mathematics
- Data handling
- Ethical issues
- Citation guidelines

Lecture notes
Moodle of the Mathematics Library: https://moodle-app2.let.ethz.ch/course/view.php?id=519

Prerequisites / notice
This course is completed by the optional course "Recherchieren in der Mathematik" (held in German) by the Mathematics Library. For more details see: http://www.math.ethz.ch/library/services/schulungen

401-3990-01L Bachelor's Thesis ☑
No direct enrolment to this course unit in myStudies. Please fill in the online application form.
Requirements and application form under www.math.ethz.ch/intranet/students/study-administration/theses.html
(Afterwards the enrolment will be done by the Study Administration.)

Abstract
The BSc thesis concludes the curriculum. In their BSc thesis, students should demonstrate their ability to carry out independent, structured scientific work. The purpose of the BSc thesis is to deepen knowledge in a certain subject and to bring students into closer contact with applications in an existing computational group. The BSc thesis requires approximately 160 hours of work.

Objective
In their BSc thesis students should demonstrate their ability to carry out independent, structured scientific work. The purpose is to deepen knowledge in a certain subject and to enable students to collaborate in an existing scientific group to take a computational approach to problems encountered in applications.

Prerequisites / notice
The supervisor responsible for the Bachelor thesis defines the task and determines the start and the submission date. The Bachelor thesis concludes with a written report. The Bachelor thesis is graded.

Colloquia

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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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Abstract
Research colloquium

Computational Science and Engineering Bachelor - Key for Type

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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
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<tr>
<td>W</td>
<td>Eligible for credits</td>
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<td>Suitable for doctorate</td>
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Key for Hours

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<th>Type</th>
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<tr>
<td>V</td>
<td>lecture</td>
<td>practical/laboratory course</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>independent project</td>
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<tr>
<td>U</td>
<td>exercise</td>
<td>diploma thesis</td>
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<tr>
<td>S</td>
<td>seminar</td>
<td>revision course / private study</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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</table>

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Educational Science

General course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

### Courses

<table>
<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
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<tbody>
<tr>
<td>851-0240-22L</td>
<td>Coping with Psychosocial Demands of Teaching (EW4 W DZ)</td>
<td>N</td>
<td>2</td>
<td>3S</td>
<td>A. Deiglmayr, P. Greutmann, S. Hofer</td>
</tr>
</tbody>
</table>

The successful participation in EW1 ("Human Learning") and EW2 ("Designing Learning Environments for School") is recommended, but not a mandatory prerequisite.

**Abstract**

In this class, students will learn concepts and skills for coping with psychosocial demands of teaching.

**Objective**

Students possess theoretical knowledge and practical competences to be able to cope with the psychosocial demands of teaching.

1. They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents).
2. They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions).

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<th>ECTS</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>851-0242-06L</td>
<td>Cognitively Activating Instructions in MINT Subjects</td>
<td>W</td>
<td>2</td>
<td>2S</td>
<td>R. Schumacher</td>
</tr>
</tbody>
</table>

Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).

**Abstract**

This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of the ETH Zurich. In the first meeting, the mission of the MINT Learning Center will be communicated. Furthermore, in groups of two, the students will intensively work on, refine and optimize a teaching unit following a goal set in advance.

**Objective**

- Get to know cognitively activating instructions in MINT subjects
- Get information about recent literature on learning and instruction

**Prerequisites / notice**

Für eine reibungslose Semesterplanung wird um frühe Anmeldung und persönliches Erscheinen zum ersten Lehrveranstaltungstermin gebeten.

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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>851-0242-07L</td>
<td>Human Intelligence</td>
<td>W</td>
<td>1</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner, B. Rütsche</td>
</tr>
</tbody>
</table>

Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).

**Abstract**

The focus will be on the book "Intelligenz: Grosse Unterschiede und ihre Folgen" by Stern and Neubauer. Participation at the first meeting is obligatory. It is required that all participants read the complete book. Furthermore, in two meetings of 90 minutes, concept papers developed in small groups (5 - 10 students) will be discussed.

**Objective**

- Understanding of research methods used in the empirical human sciences
- Getting to know intelligence tests
- Understanding findings relevant for education

see Educational Science TC

### Subject Didactics and Professional Training

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<tr>
<th>Number</th>
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<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>401-9908-00L</td>
<td>Teaching Internship Including Examination Lessons</td>
<td>W</td>
<td>6</td>
<td>13P</td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
</tbody>
</table>

Only for students who enrolled from HS 2011 on into TC.

The teaching internship can just be visited if all other courses of TC are completed.

Repetition of the teaching internship is excluded even if the examination lessons are to be repeated.
Mentored Work Specialised Courses in the Respective Subject

The unit "Subject Didactics of Computer Science I" addresses key contributions of computer science to general education. The course deals with the thoughtful choice of educational contents for computer science classes, which takes into account its comprehensibility for different age groups as well as didactic approaches suitable for a successful knowledge transfer.

The students know various teaching methods as well as their advantages and disadvantages. They can handle inhomogeneous prior knowledge of the learners inside a class. Besides holding classes, the students do care about the individual pupil support.

Objective
- Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are assessed as Examination Lessons.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils' work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Content


Prerequisites / notice
- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Literature

Further Subject Didactics

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-9902-00L</td>
<td>Mentored Work Specialised Courses in the Respective Subject with an Educational Focus CSE</td>
<td>O</td>
<td>2</td>
<td>4A</td>
<td>J. Hromkovic, G. Serafini</td>
</tr>
</tbody>
</table>
Objective: The aim is for the students
- to familiarise themselves with a new topic by obtaining material and studying the sources, so that they can selectively extend their specialist competence in this way.
- to independently develop a text on the topic, with special focus on its mathematical comprehensibility in respect of the level of knowledge of the targeted readership.
- To try out different options for specialist further training in their profession.

Content:
Thematic Schwerpunkte:

Lernformen:

Literature:
Die Literatur ist themenspezifisch. Sie muss je nach Situation selber beschafft werden oder wird zur Verfügung gestellt.

Prerequisites / notice:
Die Arbeit sollte vor Beginn des Praktikums abgeschlossen werden.

263-2800-00L Design of Parallel and High-Performance Computing
Objective: Advanced topics in parallel / concurrent programming.
Understand concurrency paradigms and models from a higher perspective and acquire skills for designing, structuring and developing possibly large concurrent software systems. Become able to distinguish parallelism in problem space and in machine space. Become familiar with important technical concepts and with concurrency folklore.

252-0341-01L Information Retrieval
Objective: Introduction to information retrieval with a focus on text documents and images. Main topics comprise extraction of characteristic features from documents, index structures, retrieval models, search algorithms, benchmarking, and feedback mechanisms. Searching the web, images and XML collections demonstrate recent applications of information retrieval and their implementation.

252-0535-00L Machine Learning
Objective: Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensable to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.

252-1407-00L Algorithmic Game Theory
Objective: Game theory provides a formal model to study the behavior and interaction of self-interested users and programs in large-scale distributed computer systems without central control. The course discusses algorithmic aspects of game theory.

Lecture notes:
No lecture notes, but slides will be made available on the course webpage.

Literature:

Prerequisites / notice:
Solid basic knowledge in analysis, statistics and numerical methods for CSE. Experience in programming for solving the project tasks.
The Internet is a typical example of a large-scale distributed computer system without central control, with users that are typically only interested in their own good. For instance, they are interested in getting high bandwidth for themselves, but don't care about others, and the same is true for computational load or download rates. Game theory provides a particularly well-suited model for the behaviour and interaction of such selfish users and programs. Classical game theory dates back to the 1930s and typically does not consider algorithmic aspects at all. Only a few years back, algorithms and game theory have been considered together, in an attempt to reconcile selfish behavior of independent agents with the common good.

This course discusses algorithmic aspects of game-theoretic models, with a focus on recent algorithmic and mathematical developments. Rather than giving an overview of such developments, the course aims to study selected important topics in depth.

Outline:
- Introduction to classical game theoretic concepts.
- Existence of stable solutions (equilibria), algorithms for computing equilibria, computational complexity.
- The cost difference between an optimum under central control and an equilibrium under selfish agents, known as the "price of anarchy".
- Auction-like mechanisms and algorithms that "direct" the actions of selfish agents into a certain desired equilibrium situation.
- Selected current research topics of Algorithmic Game Theory, such as Web-Search Based Keyword Auctions, or Information Cascading in Social Networks

Lecture notes
No lecture notes.

Literature
"Game Theory and Strategy", Philip D. Straffin, The Mathematical Association of America, 5th printing, 2004

Prerequisites / notice
Several copies of both books are available in the Computer Science library.

Audience: Although this is a Computer Science course, we encourage the participation from all students who are interested in this topic.

Requirements: You should enjoy precise mathematical reasoning. You need to have passed a course on algorithms and complexity. No knowledge of game theory is required.

252-0417-00L Randomized Algorithms and Probabilistic Methods W 7 credits 3V+2U+1A A. Steger

Abstract
Las Vegas & Monte Carlo algorithms; inequalities of Markov, Chebyshev, Chernoff; negative correlation; Markov chains: convergence, rapidly mixing; generating functions; Examples include: min cut, median, balls and bins, routing in hypercubes, 3SAT, card shuffling, random walks

Objective
After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.

Content
Randomized Algorithms are algorithms that "flip coins" to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.

Lecture notes
Yes.

Literature

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
This course covers some of the fundamental concepts of computer graphics, namely 3D object representations and generation of photorealistic images from digital representations of 3D scenes.

At the end of the course the students will be able to build a rendering system. The students will study the basic principles of rendering and image synthesis. In addition, the course is intended to stimulate the students' curiosity to explore the field of computer graphics in subsequent courses or on their own.

This course covers fundamental concepts of modern computer graphics. Students will learn about 3D object modeling and representation, texture mapping and ray-tracing, we will move on to acceleration structures, the physics of light transport, appearance modeling and global illumination principles and algorithms. We will end with an overview of modern image-based image synthesis techniques, covering topics such as lightfields and depth-image based rendering.

The programming assignments will be in C++. This will not be taught in the class.

This course acquaints students with core knowledge in computer graphics, image processing, multimedia and computer vision. The course forms a basis for the specialization track Visual Computing of the CS master program at ETH.

In theoretical and practical homework assignments students will learn to apply and implement the presented concepts and algorithms.

A scriptum will be handed out for a part of the course. Copies of the slides will be available for download. We will also provide a detailed list of references and textbooks.


This course covers fundamental concepts of modern computer graphics. Students will learn about 3D object representations and the details of how to generate photorealistic images from digital representations of 3D scenes. Starting with an introduction to 3D shape modeling and representation, texture mapping and ray-tracing, we will move on to acceleration structures, the physics of light transport, appearance modeling and global illumination principles and algorithms.

Topics covered in the lecture include:
- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non-parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

No lecture notes, but slides will be made available on the course webpage.


Solid basic knowledge in analysis, statistics and numerical methods for CSE. Experience in programming for solving the project tasks.
Dynamics of Large-Scale Atmospheric Flow

M. Rotach
E. M. Fischer

- John H. Seinfeld and Spyros N. Pandis, Atmospheric Chemistry and Physics: From Air Pollution to Climate Change, Wiley, New York,

Written information will be supplied.

Abstract

Radiative processes in the interstellar medium; stellar structure and evolution; supernovae; white dwarfs; neutron stars; black holes; planet formation

Literature

1 "Formation of stars" (S. Stahler and F. Palla - Wiley editions, this is the book on which about half of the classes will be based and photocopies will be organized during first lecture)
2 "Radiative processes in astrophysics" (R. Ribycki and A. Lightman)
3 "The Physics of Stars" (A.C. Phillips)
Additionally PowerPoint slides will be prepared by the lecturer on these and extra topics (e.g. planet formation).

Prerequisites / notice

Prerequisites: Elementary atomic physics, thermodynamics, mechanics, fluid dynamics.

Introduction to astrophysics (preferred but not obligatory).

Astrophysics

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<th>Title</th>
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<tbody>
<tr>
<td>401-7851-00L</td>
<td>Theoretical Astrophysics (University of Zurich)</td>
<td>W</td>
<td>10 credits</td>
<td>4V+2U</td>
<td>R. Teyssier</td>
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</tbody>
</table>

Mind the enrolment deadlines at UZH:

http://www.uzh.ch/studies/application/mobilitaet_en.html

Physics of the Atmosphere

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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-0023-00L</td>
<td>Atmosphere</td>
<td>W</td>
<td>3 credits</td>
<td>2V</td>
<td>H. Wernli, T. Peter</td>
</tr>
</tbody>
</table>

Abstract

Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

Objective

Understanding of basic physical and chemical processes in the atmosphere. Understanding of mechanisms of and interactions between: weather - climate, atmosphere - ocean - continents, troposphere - stratosphere. Understanding of environmentally relevant structures and processes on vastly differing scales. Basis for the modelling of complex interrelations in the atmosphere.

Content

Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

Lecture notes

Written information will be supplied.

Literature


Boundary Layer Meteorology

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<tr>
<td>651-4053-05L</td>
<td>Boundary Layer Meteorology</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>M. Rotach, P. Calanca</td>
</tr>
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</table>

Abstract

The Planetary Boundary Layer (PBL) constitutes the interface between the atmosphere and the Earth's surface. Theory on transport processes in the PBL and their dynamics is provided. This course treats theoretical background and idealized concepts. These are contrasted to real world applications and current research issues.

Objective

Overall goals of this course are given below. Focus is on the theoretical background and idealised concepts. Students have basic knowledge on atmospheric turbulence and theoretical as well as practical approaches to treat Planetary Boundary Layer flows. They are familiar with the relevant processes (turbulent transport, forcing) within, and typical states of the Planetary Boundary Layer. Idealized concepts are known as well as their adaptations under real surface conditions (as for example over complex topography).

Content

- Introduction
- Turbulence
- Statistical tratment of turbulence, turbulent transport
- Conservation equations in a turbulent flow
- Closure problem and closure assumptions
- Scaling and similarity theory
- Spectral characteristics
- Concepts for non-ideal boundary layer conditions available (i.e. in English)

Lecture notes


Dynamics of Large-Scale Atmospheric Flow

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<tbody>
<tr>
<td>701-1221-00L</td>
<td>Dynamics of Large-Scale Atmospheric Flow</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>H. Wernli, S. Pfahl</td>
</tr>
</tbody>
</table>

Abstract

Understanding the dynamics of large-scale atmospheric flow

Objective

Dynamical Meteorology is concerned with the dynamic processes of the earth's atmosphere. The fundamental equations of motion in the atmosphere will be discussed along with the dynamics and interactions of synoptic system - i.e. the low and high pressure systems that determine our weather. The motion of such systems can be understood in terms of quasi-geostrophic theory. The lecture course provides a derivation of the mathematical basis along with some interpretations and applications of the concept.

Lecture notes

Dynamics of large-scale atmospheric flow


Chemistry

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0004-00L</td>
<td>Computer Simulation in Chemistry, Biology and</td>
<td>W</td>
<td>7 credits</td>
<td>4G</td>
<td>P. H. Hünenberger</td>
</tr>
</tbody>
</table>

Seminar in Physics of the Atmosphere for CSE

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-5930-00L</td>
<td>Seminar in Physics of the Atmosphere for CSE</td>
<td>W</td>
<td>4 credits</td>
<td>2S</td>
<td>E. M. Fischer, C. Schär</td>
</tr>
</tbody>
</table>

Abstract

The students of this course are provided with an introduction into presentation techniques (talks and posters) and practice this knowledge by making an oral presentation about a classical or recent scientific publication.
Molecular models, Force fields, Boundary conditions, Electrostatic interactions, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

For more information: www.csms.ethz.ch/education/CSCBP

Introduction to computer simulation of (bio)molecular systems, development of skills to carry out and interpret computer simulations of biomolecular systems.

Molecular models, Force fields, Spatial boundary conditions, Calculation of Coulomb forces, Molecular dynamics, Analysis of trajectories, Quantum-mechanical simulation, Structure refinement, Application to real systems. Exercises: Analysis of papers on computer simulation, Molecular simulation in practice, Validation of molecular dynamics simulation.

Available (copies of powerpoint slides distributed before each lecture)

Since the exercises on the computer do convey and test essentially different skills as those being conveyed during the lectures and tested at the oral exam, the results of the exercises are taken into account when evaluating the results of the exam.

This course lies in the intersection between Computer Science and Molecular Biology. The main purpose is to study computational techniques, algorithms and data structures which are usually applied to solve problems in Molecular Biology and Biochemistry. The following topics are likely to be covered: Introduction, mathematical models of evolution, protein and DNA sequence alignment and its meaning, phylogenetic tree construction, multiple sequence alignments, secondary structure prediction, molecular dynamics, threading, role of bioinformatics in drug design, etc. From the computer science point of view we concentrate our attention in practical solutions for the above problems. Biological knowledge is an asset but not a prerequisite.

1) Introductory lecture: basics of quantum mechanics and quantum chemistry
2) Relativistic re-derivation of all concepts known from (nonrelativistic) quantum mechanics and quantum-chemistry lectures will finally explain the form of all operators in the molecular Hamiltonian - usually postulated rather than deduced. From this, we derive operators needed for molecular spectroscopy (like those required by magnetic resonance spectroscopy), Implications of other assumptions in standard non-relativistic quantum chemistry shall be analyzed and understood, too. Examples are the Born-Oppenheimer approximation and the expansion of the electronic wave function in a set of pre-defined many-electron basis functions (Slater determinants). Overcoming these concepts, which are so natural to the theory of chemistry, will provide deeper insights into many-particle quantum mechanics. Also revisiting the workhorse of quantum chemistry, namely density functional theory, with an emphasis on open-shell electronic structures (radicals, transition-metal complexes) will contribute to this endeavor. It will be shown how these insights allow us to make more accurate predictions in chemistry in practice - at the frontier of research in theoretical chemistry.

Advanced, but fundamental topics central to the understanding of theory in chemistry and for solving actual chemical problems with a computer. Examples are:
- Operators derived from principles of relativistic quantum mechanics
- Relativistic effects + methods of relativistic quantum chemistry
- Open-shell molecules + spin-density functional theory
- New electron-correlation theories

The aim of the course is to provide an in-depth knowledge of theory and method development in theoretical chemistry. It will be shown that this is necessary in order to be able to solve actual chemical problems on a computer with quantum chemical methods.

2) F. Schwabli: Quantenmechanik für Fortgeschrittene (QM II), Springer-Verlag, 1997
3) R. McWeeny: Methods of Molecular Quantum Mechanics, Academic Press, 1992
8) Note also the standard textbooks:
A) S. Szabo, N.S. Ostlund. ;Dover Publications
B) I. N. Levine, Quantum Chemistry, Pearson

Study of computational techniques, algorithms and data structures used to solve problems in computational biology. Topics: basic biology, molecular models, Force fields, Spatial boundary conditions, character, parsimony and statistical models, Markov models, microarrays, dynamic programming, maximum likelihood and specialized DNA and protein analysis.

Familiarize the students with the basic concepts of molecular biology and the models and algorithms used to understand, classify and predict behaviour of living organism. This course is at the most basic level, where the main issues, mostly of molecular sequences, are studied.

This course lies in the intersection between Computer Science and Molecular Biology. The main purpose is to study computational techniques, algorithms and data structures which are usually applied to solve problems in Molecular Biology and Biochemistry. The following topics are likely to be covered: Introduction, mathematical models of evolution, protein and DNA sequence alignment and its meaning, phylogenetic tree construction, multiple sequence alignments, secondary structure prediction, molecular dynamics, threading, role of bioinformatics in drug design, etc. From the computer science point of view we concentrate our attention in practical solutions for the above problems. Biological knowledge is an asset but not a prerequisite.

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- New electron-correlation theories

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Data: 06.02.2019 13:00 Autumn Semester 2015 Page 1225 of 1434
### Fluid Dynamics

**One of the course units**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-0103-00L</td>
<td>Fluid Dynamics II</td>
<td>O</td>
<td>3</td>
<td>2V+1U</td>
<td>P. Jenny</td>
</tr>
<tr>
<td>Objective</td>
<td>Expand basic knowledge of fluid dynamics. Concepts, phenomena and quantitative description of irrotational (potential), rotational, and one-dimensional compressible flows.</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes are available (in German).</td>
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<tr>
<td>Prerequisites</td>
<td>Analysis II, Knowledge of Fluid Dynamics I, thermodynamics of ideal gas</td>
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<tr>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-0109-00L</td>
<td>Turbulent Flows</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>P. Jenny</td>
</tr>
<tr>
<td>Abstract</td>
<td>Basic physical phenomena of turbulent flows, quantitative and statistical description, basic and averaged equations, principles of turbulent flow computation and elements of turbulence modelling</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes are available</td>
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<tbody>
<tr>
<td>151-0182-00L</td>
<td>Fundamentals of CFD Methods</td>
<td>W*</td>
<td>4</td>
<td>3G</td>
<td>A. Haselbacher</td>
</tr>
<tr>
<td>Abstract</td>
<td>This course is focused on providing students with the knowledge and understanding required to develop simple computational fluid dynamics (CFD) codes to solve the incompressible Navier-Stokes equations and to critically assess the results produced by CFD codes. As part of the course, students will write their own codes and verify and validate them systematically.</td>
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<tr>
<td>Prerequisites</td>
<td>Prior knowledge of fluid dynamics, applied mathematics, basic numerical methods, and programming in Fortran and/or C++ (knowledge of MATLAB is &quot;not&quot; sufficient).</td>
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<th>ECTS</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0105-00L</td>
<td>Quantitative Flow Visualization</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>T. Rösgen</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course provides an introduction to digital image analysis in modern flow diagnostics. Different techniques which are discussed include image velocimetry, laser induced fluorescence, liquid crystal thermography and interferometry. The physical foundations and measurement configurations are explained. Image analysis algorithms are presented in detail and programmed during the exercises.</td>
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</table>
Introduction to modern imaging techniques and post processing algorithms with special emphasis on flow analysis and visualization.

Understanding of hardware and software requirements and solutions.

Development of basic programming skills for (generic) imaging applications.

Introduction to modern imaging techniques and post processing algorithms with special emphasis on flow analysis and visualization.

Understanding of hardware and software requirements and solutions.

Development of basic programming skills for (generic) imaging applications.
Systems and Control

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>227-0103-00L</td>
<td>Control Systems</td>
<td>W</td>
<td>6</td>
<td>2V+2U</td>
<td>M. Morari, F. Dörfler</td>
</tr>
<tr>
<td></td>
<td>Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.</td>
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<td></td>
<td>Objective</td>
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<tr>
<td></td>
<td>Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.</td>
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<tr>
<td></td>
<td>Content</td>
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<tr>
<td></td>
<td>Lecture notes</td>
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<td></td>
<td>Slides can be downloaded from the course website. A printed version with additional content is offered via SPOD (student print on demand) for a fee (ca. 10-15 CHF).</td>
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<td></td>
<td>Literature</td>
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<td></td>
<td>Prerequisites / notice</td>
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<tr>
<td></td>
<td>Prerequisites: Signal and Systems Theory II.</td>
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<tr>
<td></td>
<td>MATLAB is used for system analysis and simulation.</td>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>227-0045-00L</td>
<td>Signals and Systems I</td>
<td>W</td>
<td>4</td>
<td>2V+2U</td>
<td>H. Bölcskei</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
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<tr>
<td></td>
<td>Introduction to mathematical signal processing and system theory.</td>
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<td></td>
<td>Content</td>
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<tr>
<td></td>
<td>Lecture notes</td>
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<tr>
<td></td>
<td>Lecture notes, problem set with solutions.</td>
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<td>Prerequisites / notice</td>
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<td></td>
<td>Prerequisites: Control systems (227-0216-00 or equivalent) and sufficient mathematical maturity.</td>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0575-01L</td>
<td>Signals and Systems</td>
<td>W</td>
<td>4</td>
<td>4G</td>
<td>R. D’Andrea</td>
</tr>
<tr>
<td></td>
<td>Signals arise in most engineering applications. They contain information about the behavior of physical systems. Systems respond to signals and produce other signals. In this course, we explore how signals can be represented and manipulated, and their effects on systems. We further explore how we can discover basic system properties by exciting a system with various types of signals.</td>
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<tr>
<td></td>
<td>Objective</td>
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<tr>
<td></td>
<td>Master the basics of signals and systems. Apply this knowledge to problems in the homework assignments and programming exercises.</td>
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<tr>
<td></td>
<td>Content</td>
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<tr>
<td></td>
<td>Lecture notes</td>
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<tr>
<td></td>
<td>Lecture notes available on course website.</td>
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<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>401-5850-00L</td>
<td>Seminar in Systems and Control for CSE</td>
<td>W</td>
<td>4</td>
<td>2S</td>
<td>J. Lygeros</td>
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<tr>
<td></td>
<td>Enlarged knowledge and practical abilities in fundamentals and applications of Computational Fluid Dynamics</td>
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Robotics

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0601-00L</td>
<td>Theory of Robotics and Mechatronics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>P. Korba, S. Stoeter, B. Nelson</td>
</tr>
</tbody>
</table>
This course provides an introduction and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. Its a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.

Robotics is often viewed from three perspectives: perception (sensing), manipulation (affecting changes in the world), and cognition (intelligence). Robotic systems integrate aspects of all three of these areas. This course provides an introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. This course is a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.

An introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control.

The course will be taught in English.

Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensible to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.

The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:
- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

Computer vision and image analysis techniques. The main concepts and techniques will be studied in depth and practical algorithms and approaches will be discussed and explored through the exercises.

The objectives of this course are:
1. To introduce the fundamental problems of computer vision.
2. To introduce the main concepts and techniques used to solve those.
3. To enable participants to implement solutions for reasonably complex problems.
4. To enable participants to make sense of the computer vision literature.

The goal of this course is to provide students with a good understanding of computer vision and image analysis techniques. The main concepts and techniques will be studied in depth and practical algorithms and approaches will be discussed and explored through the exercises.

Introduction to Dynamic Programming and Optimal Control.

Covers the fundamental concepts of Dynamic Programming & Optimal Control.

Dynamic Programming Algorithm; Deterministic Systems and Shortest Path Problems; Infinite Horizon Problems, Bellman Equation; Deterministic Continuous-Time Optimal Control.


Knowledge of advanced calculus, introductory probability theory, and matrix-vector algebra.

We will provide an overview on how to kinematically and dynamically model typical robotic systems such as robot arms, legged robots, rotary wing systems, or fixed wing.

The primary objective of this course is that the student deepens an applied understanding of how to model the most common robotic systems. The student receives a solid background in kinematics, dynamics, and rotations of multi-body systems. On the basis of state of the art applications, he/she will learn all necessary tools to work in the field of design or control of robotic systems.
The students are familiar with the challenges of the fascinating and interdisciplinary field of Robotics and Mechatronics. They are

Mathematical Foundations for Finance
A. Soluyanov

Abstract
This course provides an opportunity to familiarize yourself with the advanced topics of robotics and mechatronics research. The study plan has to be discussed with the lecturer based on your specific interests and/or the relevant seminar series such as the IRIS's Robotics Seminars and BiRONZ lectures, for example.

Objective
The students are familiar with the challenges of the fascinating and interdisciplinary field of Robotics and Mechatronics. They are introduced in the basics of independent non-experimental scientific research and are able to summarize and to present the results efficiently.

Content
This 4 ECTS course requires each student to discuss a study plan with the lecturer and select minimum 10 relevant scientific publications to read through, or attend 5-10 lectures of the public robotics oriented seminars (e.g. Public robotics seminars such as the IRIS's Robotics Seminars http://www.iris.ethz.ch/iris/series/, and BiRONZ lectures http://www.birl.ethz.ch/bironz/index are good examples). At the end of semester, the results should be presented in an oral presentation and summarized in a report, which takes the discussion of the presentation into account.

Physics
For the field of specialization 'Physics' basic knowledge in quantum mechanics is required.

Number Title Type ECTS Hours Lecturers
402-0809-00L Introduction to Computational Physics W 8 credits 2V+2U H. J. Herrmann

Abstract
This course offers an introduction to computer simulation methods for physics problems and their implementation on PCs and super computers: classical equations of motion, partial differential equations (wave equation, diffusion equation, Maxwell's equation), Monte Carlo simulations, percolation, phase transitions.

Content

Prerequisites / notice
Lecture and exercise lessons in english, exams in German or in English

402-0205-00L Quantum Mechanics I W 10 credits 3V+2U G. Blatter

Abstract
Introduction to non-relativistic single-particle quantum mechanics. In particular, the basic concepts of quantum mechanics, such as the quantisation of classical systems, wave functions and the description of observables as operators on a Hilbert space, and the formulation of symmetries will be discussed. Basic phenomena will be analysed and illustrated by generic examples.

Objective
Introduction to single-particle quantum mechanics. Familiarity with basic ideas and concepts (quantisation, operator formalism, Dirac notation, symmetries, perturbation theory) and generic examples and applications (bound states, tunneling, scattering states, in one- and three-dimensional settings). Ability to solve simple problems.

Content
Keywords: Schrödinger equation, basic formalism of quantum mechanics (states, operators, commutators, measuring process), symmetries (translations, rotations), quantum mechanics in one dimension, spherically symmetric problems in three dimensions, scattering theory, density matrices, Schrödinger-, Heisenberg-, Dirac-pictures, time reversal, perturbation theory, variational techniques, spin, addition of angular momenta, relation between OMs and classical physics.

Lecture notes
Deutsch

401-5810-00L Seminar in Physics for CSE W 4 credits 2S A. Soluyanov

Abstract
In this seminar the students present a talk on an advanced topic in modern theoretical or computational physics.

Computational Finance

Number Title Type ECTS Hours Lecturers
401-3913-01L Mathematical Foundations for Finance W 4 credits 3V+2U E. W. Farkas, M. Schweizer

Abstract
First introduction to modern modelling ideas and mathematical tools from mathematical finance

Objective
This course gives a first introduction to the main modelling ideas and mathematical tools from mathematical finance. It aims at a double audience: mathematicians who want to learn the modelling ideas and concepts for finance, and non-mathematicians who need an introduction to the main tools from stochastics used in mathematical finance. The main emphasis will be on ideas, but important results will be given with (sometimes partial) proofs.

Content
Topics to be covered include
- financial market models in finite discrete time
- absence of arbitrage and martingale measures
- valuation and hedging in complete markets
- basics about Brownian motion
- stochastic integration
- stochastic calculus; Itô’s formula, Girsanov transformation, Itô’s representation theorem
- Black-Scholes formula

Lecture notes
Lecture notes will be sold at the beginning of the course.

Literature
Lecture notes will be sold at the beginning of the course. Additional (background) references are given there.

Prerequisites / notice
Prerequisites: Results and facts from probability theory as in the book "Probability Essentials" by J. Jacod and P. Protter will be used freely. Especially participants without a direct mathematics background are strongly advised to familiarise themselves with those tools before (or very quickly during) the course. (A possible alternative to the above English textbook are the (German) lecture notes for the standard course "Wahrscheinlichkeitstheorie".)

For those who are not sure about their background, we suggest to look at the exercises in Chapters 8, 9, 22-25, 28 of the Jacod/Protter book. If these pose problems, you will have a hard time during the course. So be prepared.

401-4657-00L Numerical Analysis of Stochastic Ordinary Differential Equations W 6 credits 3V+1U A. Jentzen
Alternative course title: "Computational Methods for Quantitative Finance: Monte Carlo and Sampling Methods"

Abstract
Course on numerical approximations of stochastic ordinary differential equations driven by Wiener processes. These equations have several applications, for example in financial option valuation. This course also contains an introduction to random number generation and Monte Carlo methods for random variables.

Objective
The aim of this course is to enable the students to carry out simulations and their mathematical convergence analysis for stochastic models originating from applications such as mathematical finance. For this the course teaches a decent knowledge of the different numerical methods, their underlying ideas, convergence properties and implementation issues.

Content
Generation of random numbers
Monte Carlo methods for the numerical integration of random variables
Stochastic processes and Brownian motion
Stochastic ordinary differential equations (SODEs)
Numerical approximations of SODEs
Multilevel Monte Carlo methods for SODEs
Applications to computational finance: Option valuation

Lecture notes
Lecture Notes will be available.

Literature
P. Glasserman:
Monte Carlo Methods in Financial Engineering.

P. E. Kloeden and E. Platen:
Numerical Solution of Stochastic Differential Equations.

Prerequisites / notice
Prerequisites:
Mandatory: Probability and measure theory, basic numerical analysis and basics of MATLAB programming.

a) mandatory courses:
Elementary Probability,
Probability Theory I.

b) recommended courses:
Stochastic Processes.

401-8905-00L Financial Engineering (University of Zurich) W 4.5 credits 3G University lecturers

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: MFOEC103

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Abstract
This lecture is intended for students who would like to learn more on equity derivatives modelling and pricing.

Objective
Quantitative models for European option pricing (including stochastic volatility and jump models), volatility and variance derivatives, American and exotic options.

Content
After introducing fundamental concepts of mathematical finance including no-arbitrage, portfolio replication and risk-neutral measure, we will present the main models that can be used for pricing and hedging European options e.g. Black-Scholes model, stochastic and jump-diffusion models, and highlight their assumptions and limitations. We will cover several types of derivatives such as European and American options, Barrier options and Variance Swaps. Basic knowledge in probability theory and stochastic calculus is required. Besides attending class, we strongly encourage students to stay informed on financial matters, especially by reading daily financial newspapers such as the Financial Times or the Wall Street Journal.

Lecture notes
Script.

Prerequisites / notice
Basic knowledge of probability theory and stochastic calculus.
Asset Pricing.

401-5820-00L Seminar in Computational Finance for CSE W 4 credits 2S D. Würtz

Abstract
The seminar establishes a guided self-study of original articles and advanced textbooks from the area of financial engineering. After an individual discussion with the seminar instructor each participant will deliver a 40 minutes talk (in English). Attendance during the entire semester is mandatory.

Objective

Content
Die Themen stammen aus den Gebieten Finanzmarktanalysen, Bewertung von Finanzmarktinstrumenten, Risiko Management, Portfolio Optimierung, Monte Carlo Methoden.

Literature
Papiere und Unterlagen werden in der ersten Semesterwoche verteilt.

Prerequisites / notice
Bei Fragen wenden Sie sich bitte an: PD Dr. Diethelm Wuertz: wuertz@phys.ethz.ch

Electromagnetics

Number Title Type ECTS Hours Lecturers
227-2037-00L Physical Modelling and Simulation W 5 credits 4G C. Hafner, J. Leuthold, J. Smajic

Abstract
Physical modelling plays an important role in the analysis and design of new structures, especially for micro and nano devices where fabrication and measurement are difficult. After the fundamentals of electromagnetics, mechanics, and thermodynamics, an introduction to the main concepts and most widely used codes for physical modelling is given and commercial codes are applied.
The path of an analog signal in the transmitter to the digital world in a communication link and back to the analog world at the receiver is

**Chapter 1: Introduction:** Analog/Digital conversion, The communication channel, Shannon channel capacity, Capacity requirements.

The goal of this course is to learn and understand few principal partial differential equations (conservation laws) that are applicable for

Various topics of electromagnetics, including electromagnetic theory, computational electromagnetics, electromagnetic wave propagation, applications from statics to optics. Traditional problems such as antennas, electromagnetic scattering, waveguides, resonators, etc. as well as modern topics such as photonic crystals, metamaterials, plasmonics, etc. are considered.

**Knowledge of the fundamentals of electromagnetic theory, development and application of numerical methods for solving Maxwell equations, analysis and optimal design of electromagnetic structures**

#### Geophysics

**Recommended combinations:**

Subject 1 + Subject 2
Subject 1 + Subject 3
Subject 2 + Subject 3
Subject 2 + Subject 4
Subject 5 + Subject 6
Subject 5 + Subject 4

#### Geophysics: Subject 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4007-00L</td>
<td>Continuum Mechanics</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>T. Gerya</td>
</tr>
</tbody>
</table>

In this course, students learn crucial partial differential equations (conservation laws) that are applicable to any continuum including the Earth’s mantle, core, atmosphere and ocean. The course will provide step-by-step introduction into the mathematical structure, physical meaning and analytical solutions of the equations. The course has a particular focus on solid Earth applications.

The goal of this course is to learn and understand few principal partial differential equations (conservation laws) that are applicable for analysing and modelling of any continuum including the Earth’s mantle, core, atmosphere and ocean. By the end of the course, students should be able to write, explain and analyse the equations and apply them for simple analytical cases. Numerical solving of these equations will be discussed in the Numerical Modelling I and II course running in parallel.
In this 13-week sequence, students learn how to write programs from scratch to solve partial differential equations that are useful for Earth science applications. Programming will be done in MATLAB and will use the finite-difference method and marker-in-cell technique. The course will emphasise a hands-on learning approach rather than extensive theory, and will begin with an introduction to programming in MATLAB. The course will emphasise a hands-on learning approach rather than extensive theory.

Week 1: The continuity equation
Theory: Definition of a geological media as a continuum. Field variables used for the representation of a continuum. Methods for definition of the field variables. Eulerian and Lagrangian points of view. Continuity equation in Eulerian and Lagrangian forms and their derivation.
Exercise: Computing the divergence of velocity field.

Week 2: Density and gravity
Exercise: Computing density, thermal expansion and compressibility from an equation of state.

Week 3: Stress and strain
Exercise: Analysing strain rate tensor for solid body rotation.

Week 4: The momentum equation

Week 5: Viscous rheology of rocks
Theory: Solid-state creep of minerals and rocks as the major mechanism of deformation of the Earth's interior. Dislocation and diffusion creep mechanisms. Rheological equations for minerals and rocks. Effective viscosity and its dependence on temperature, pressure and strain rate. Formulation of the effective viscosity from empirical flow laws.
Exercise: Deriving viscous rheological equations for computing effective viscosities from empirical flow laws.

Week 6: The heat conservation equation
Exercise: steady temperature profile in case of channel flow.

Week 7: Elasticity and plasticity

GRADING will be based on homeworks (30%) and oral exams (70%).
Exam questions: http://www.erdw.ethz.ch/people/geophysics/tgerya/EXAMQUESTIONS

Lecture notes
Script is available by request to taras.gerya@erdw.ethz.ch

Literature
Taras Gerya Introduction to Numerical Geodynamic Modelling Cambridge University Press, 2010

Geophysics: Subject 2

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>651-4241-00L</td>
<td>Numerical Modelling I and II: Theory and Applications</td>
<td>W</td>
<td>6 credits</td>
<td>4G</td>
<td>T. Gerya</td>
</tr>
</tbody>
</table>

Abstract
In this 13-week sequence, students learn how to write programs from scratch to solve partial differential equations that are useful for Earth science applications. Programming will be done in MATLAB and will use the finite-difference method and marker-in-cell technique. The course will emphasise a hands-on learning approach rather than extensive theory.

Objective
The goal of this course is for students to learn how to program numerical applications from scratch. By the end of the course, students should be able to write state-of-the-art MATLAB codes that solve systems of partial differential equations relevant to Earth and Planetary Science applications using finite-difference method and marker-in-cell technique. Applications include Poisson equation, buoyancy driven variable viscosity flow, heat diffusion and advection, and state-of-the-art thermomechanical code programming. The emphasis will be on commonality, i.e., using a similar approach to solve different applications, and modularity, i.e., re-use of code in different programs. The course will emphasise a hands-on learning approach rather than extensive theory, and will begin with an introduction to programming in MATLAB.

Content
A provisional week-by-week schedule (subject to change) is as follows:

Week 1: Introduction to the finite difference approximation to differential equations. Introduction to programming in MatLab. Solving of 1D Poisson equation.
Week 3: Solving momentum and continuity equations in case of constant viscosity with stream function/vorticity formulation.
Weeks 5: Conservative finite differences for the momentum equation. "Free slip" and "no slip" boundary conditions. Solving momentum and continuity equations in case of variable viscosity using pressure-velocity formulation with staggered grid.
Week 7: Advection in 2-D with Marker-in-cell method. Combining flow calculation and advection for buoyancy driven flow.
Week 8: "Free surface" boundary condition and "sticky air" approach. Free surface stabilization. Runge-Kutta schemes.
Week 9: Solving 2D heat conservation equation in case of constant thermal conductivity with explicit and implicit approaches.
Week 10: Solving 2D heat conservation equation in case of variable thermal conductivity with implicit approach. Temperature advection with markers. Creating thermomechanical code by combining mechanical solution for 2D buoyancy driven flow with heat diffusion and advection based on marker-in-cell approach.
Week 11: Subgrid diffusion of temperature. Implementing subgrid diffusion to the thermomechanical code.
Week 12: Implementation of radioactive, adiabatic and shear heating to the thermomechanical code.
Week 13: Implementation of temperature-, pressure- and strain rate-dependent viscosity, temperature- and pressure-dependent density and temperature-dependent thermal conductivity to the thermomechanical code. Final project description.

GRADING will be based on weekly programming homeworks (50%) and a term project (50%) to develop an application of their choice to a more advanced level.
The aim of this course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.

### Abstract
Seismic tomography is the science of interpreting seismic measurements (seismograms) to derive information about the structure of the Earth. The subject of this course is the formal relationship existing between a seismic measurement and the nature of the Earth, or of certain regions of the Earth, and the ways to use it to gain information about the Earth.

### Literature

### Objective
The aim of this course is to provide an introductory overview of mathematical and computational methods for the modeling, simulation and analysis of biological networks.

### Content
- Biological networks
- Systems biology
- Seismic tomography
- Inverse problem theory
- Computational methods for seismic tomography
- Linear inverse theory
- Least squares solution
- The method of least squares
- Solution of large linear inverse problems, designed for advanced math undergraduates.

### Literature
The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:
* Yang, Z. 2006. Computational Molecular Evolution.
* Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST.

### Prerequisites / notice
Basic knowledge in linear algebra, analysis, and statistics.

#### Electives

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0113-00L</td>
<td>Applied Fluid Dynamics</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>J.P. Kunsch</td>
</tr>
<tr>
<td>Abstract</td>
<td>Applied Fluid Dynamics</td>
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<tr>
<td>Objective</td>
<td>The methods of fluid dynamics play an important role in the description of a chain of events, involving the release, spreading and dilution of dangerous fluids in the environment.</td>
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<td>Content</td>
<td>Tunnel ventilation systems and strategies are studied, which must meet severe requirements during normal operation and in emergency situations (tunnel fires etc.).</td>
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<tr>
<td>Lecture notes</td>
<td>Generally applicable methods in fluid dynamics and gas dynamics are illustrated and practiced using selected current examples.</td>
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<tr>
<td>Literature</td>
<td>Often experts fall back on the methodology of fluid dynamics when involved in the construction of environmentally friendly processing and incineration facilities, as well as when choosing safe transport and storage options for dangerous materials. As a result of accidents, but also in normal operations, dangerous gases and liquids may escape and be transported further by wind or flowing water.</td>
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<tr>
<td>151-0709-00L</td>
<td>Stochastic Methods for Engineers and Natural Scientists</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>D. W. Meyer-Massetti</td>
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<tr>
<td>Objective</td>
<td>By the end of the course you should be able to mathematically describe random quantities and their effect on physical systems. Moreover, you should be able to develop basic stochastic models of such systems.</td>
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<tr>
<td>Content</td>
<td>- Probability theory, single and multiple random variables, mappings of random variables</td>
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<tr>
<td>Content</td>
<td>- Stochastic differential equations, Ito calculus, PDF evolution equations</td>
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<tr>
<td>Content</td>
<td>- Polynomial chaos and other expansion methods</td>
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<tr>
<td>Lecture notes</td>
<td>All topics are illustrated with application examples from engineering.</td>
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<tr>
<td>Literature</td>
<td>Detailed lecture notes will be provided.</td>
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<tr>
<td>151-0317-00L</td>
<td>Visualization, Simulation and Interaction - Virtual Reality II</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>A. Kunz</td>
</tr>
<tr>
<td>Objective</td>
<td>This lecture provides deeper knowledge on the possible applications of virtual reality, its basic technology, and future research fields. The goal is to provide a strong knowledge on Virtual Reality for a possible future use in business processes.</td>
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<td>Content</td>
<td>Virtual Reality can not only be used for the visualization of 3D objects, but also offers a wide application field for small and medium enterprises (SME). This could be for instance an enabling technology for net-based collaboration, the transmission of images and other data, the interaction of the human user with the digital environment, or the use of augmented reality systems.</td>
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<td>Content</td>
<td>The goal of the lecture is to provide a deeper knowledge of today’s VR environment that are used in business processes. The technical background, the algorithms, and the applied methods are explained more in detail. Finally, future tasks of VR will be discussed and an outlook on ongoing international research is given.</td>
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<td>Lecture notes</td>
<td>Introduction into Virtual Reality; basics of augmented reality; interaction with digital data, tangible user interfaces (TUI); basics of simulation; compression procedures of image-, audio-, and video signals; new materials for force feedback devices; introduction into data security; cryptography; definition of free-form surfaces; digital factory; new research fields of virtual reality</td>
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<td>Prerequisites / notice</td>
<td>The handout is available in German and English.</td>
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<tr>
<td>151-0709-00L</td>
<td>Principles of Nonlinear Finite-Element-Methods</td>
<td>W</td>
<td>5</td>
<td>2V+2U</td>
<td>N. Manopulo, B. Berisha</td>
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<tr>
<td>Objective</td>
<td>Most problems in engineering are of nonlinear nature. The nonlinearities are caused basically due to the nonlinear material behavior, contact conditions and instability of structures. The principles of the nonlinear Finite-Element-Method (FEM) will be introduced in the scope of this lecture for treating such problems.</td>
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<tr>
<td>Content</td>
<td>The goal of the lecture is to provide the students with the fundamentals of the non linear Finite Element Method (FEM). The lecture focuses on the principles of the nonlinear Finite-Element-Method based on explicit and implicit formulations. Typical applications of the nonlinear Finite-Element-Methods are simulations of:</td>
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<tr>
<td>Content</td>
<td>- Crash</td>
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<td>Content</td>
<td>- Collapse of structures</td>
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<td>Content</td>
<td>- Materials in Biomechanics (soft materials)</td>
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<tr>
<td>Content</td>
<td>- General forming processes</td>
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<tr>
<td>Special attention</td>
<td>Special attention will be paid to the modeling of the nonlinear material behavior, thermo-mechanical processes and processes with large plastic deformations. The ability to independently create a virtual model which describes the complex non linear systems will be acquired through accompanying exercises. These will include the Matlab programming of important model components such as constitutive equations</td>
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</table>
Content
- Fundamentals of continuum mechanics to characterize large plastic deformations
- Elasto-plastic material models
- Updated-Lagrange (UL), Euler and combined Euler-Lagrange (ALE) approaches
- FEM implementation of constitutive equations
- Element formulations
- Implicit and explicit FEM methods
- FEM formulations of coupled thermo-mechanical problems
- Modeling of tool contact and the influence of friction
- Solvers and convergence
- Modeling of crack propagation
- Introduction of advanced FE-Methods

Lecture notes
yes

Literature

Prerequisites / notice
If we will have a large number of students, two dates for the exercises will be offered.

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### 263-5001-00L Introduction to Finite Elements and Sparse Linear System Solving

**Abstract**
The finite element (FE) method is the method of choice for (approximately) solving partial differential equations on complicated domains. In the first third of the lecture, we give an introduction to the method. The rest of the lecture will be devoted to methods for solving the large sparse linear systems of equation that a typical for the FE method. We will consider direct and iterative methods.

**Objective**
Students will know the most important direct and iterative solvers for sparse linear systems. They will be able to determine which solver to choose in particular situations.

**Content**

I. **THE FINITE ELEMENT METHOD**
1. Introduction, model problems.
2. 1D problems. Piecewise polynomials in 1D.
3. 2D problems. Triangulations. Piecewise polynomials in 2D.
5. Implementation aspects.

II. **DIRECT SOLUTION METHODS**
6. LU and Cholesky decomposition.
7. Sparse matrices.

III. **ITERATIVE SOLUTION METHODS**
9. Stationary iterative methods, preconditioning.
11. Incomplete factorization preconditioning.
12. Multigrid preconditioning.
13. Nonsymmetric problems (GMRES, BiCGstab).

**Literature**

**Prerequisites / notice**
Prerequisites: Linear Algebra, Analysis, Computational Science.
The exercises are made with Matlab.
Content

1) - Introduction, Statement of the problem, course structure, exercises, why Scientific DBs (SDBs) do not fit exactly the classical DB area. Hierarchy: File systems, data bases, knowledge bases and variations. Efficiency issues and how they differ from classical DB.

2) - Relational DB used for scientific data, pros/cons. Introduction to RDB, limitations of the model, basics of SQL, handling of metadata, examples of scientific use of RDBs.

3) - Object Oriented DB. Rich/structured objects are very appealing in SDB. OODB primitives and environments. OODB searching, Space and access time efficiency of OODBs.

4) - Knowledge bases, key-value stores, ontologies, workflow-based architectures. WASA.

5) - MapReduce / Hadoop

6) - Storing and sharing mathematical objects, Open Math, its relation with OODB and Knowledge bases. Also the problem of chemical formula representation.

7) - SGML and XML, human-readable databases, genomic databases. Advantages of human-readable databases (the huge initial success of genomic databases).

8) - Semantic web, Resource Description Framework (RDF) triples, SparQL. An example of very flexible database for knowledge storage. Goals of the Semantic Web, discussion about its future.

9) - An ideal scenario (and the design of a toy system with most of the desired features for exploration and exercises).


11) - Functional testing, Verifiers, Consistency, Short-circuit testing. Recovery and Automatic recovery, Backup (incremental) methods.

12) - Performance and space issues, various uses of compression, concurrency control. Hardware issues, clusters, Cloud computing, Crowd-sourcing.

13) - Guest speaker: Ioannis Xenarios (UniProtKB/Swiss-Prot).

Literature

Several papers and online articles will be made available. There is no single textbook for this course.

A significant amount of material will be delivered in the lectures making lecture attendance highly recommended.

263-3010-00L Big Data W 6 credits 3V+1U+1A T. Hofmann

Does not take place this semester.

Objective

One of the key challenges of the information society is to turn data into information, information into knowledge, and knowledge into value. To turn data into value in this way involves collecting large volumes of data, possibly from many and diverse data sources, processing the data fast, and applying complex operations to the data.

Literature

Papers from scientific conferences and journals. References will be given as part of the course material during the semester.

263-2800-00L Design of Parallel and High-Performance Computing W 7 credits 3V+2U+1A T. Hoefler, M. Püschel

Abstract

Advanced topics in parallel / concurrent programming.

Objective

Understand concurrency paradigms and models from a higher perspective and acquire skills for designing, structuring and developing possibly large concurrent software systems. Become able to distinguish parallelism in problem space and in machine space. Become familiar with important technical concepts and with concurrency folklore.

227-0102-00L Discrete Event Systems W 6 credits 4G L. Thiele, L. Vanbever, R. Wattenhofer

Abstract

Introduction to discrete event systems. We start out by studying popular models of discrete event systems. In the second part of the course we analyze discrete event systems from an average-case and from a worst-case perspective. Topics include: Automata and Languages, Specification Models, Stochastic Discrete Event Systems, Worst-Case Event Systems, Verification, Network Calculus.

Objective

Over the past few decades the rapid evolution of computing, communication, and information technologies has brought about the proliferation of new dynamic systems. A significant part of activity in these systems is governed by operational rules designed by humans. The dynamics of these systems are characterized by asynchronous occurrences of discrete events, some controlled (e.g. hitting a keyboard key, sending a message), some not (e.g. spontaneous failure, packet loss).

The mathematical arsenal centered around differential equations that has been employed in systems engineering to model and study processes governed by the laws of nature is often inadequate or inappropriate for discrete event systems. The challenge is to develop new modeling frameworks, analysis techniques, design tools, testing methods, and optimization processes for this new generation of systems.

In this lecture we give an introduction to discrete event systems. We start out the course by studying popular models of discrete event systems, such as automata and Petri nets. In the second part of the course we analyze discrete event systems. We first examine discrete event systems from an average-case perspective: we model discrete events as stochastic processes, and then apply Markov chains and queuing theory for an understanding of the typical behavior of a system. In the last part of the course we analyze discrete event systems from a worst-case perspective using the theory of online algorithms and adversarial queuing.
Abstract
Context recognition in mobile communication systems like mobile phone and wearable computer will be studied using advanced methods from sensor data fusion, pattern recognition, statistics, data mining and machine learning. Context comprises the behavior of individuals and of groups, their activities as well as the local and social environment.

Objective
Future mobile systems will act as personal and cooperative assistant by providing the appropriate information and services. The systems consist of a smart phone which communicates with sensors on-body and in the environment. Context comprises user's behavior, his activities, his local and social environment.

In the data path from the sensor level to signal segmentation to the classification of the context, advanced methods of signal processing, pattern recognition and machine learning will be applied. Sensor data generated by crowdsourcing methods are integrated. The validation using MATLAB is followed by implementation and testing on a smart phone.

Context recognition as the crucial function of mobile systems is the main focus of the course. Using MatLab the participants implement and verify the discussed methods also using a smart phone.

Content
The main topics of the course include

- Sensor nets, sensor signal processing, data fusion, time series (segmentation, similarity measures), supervised learning (Bayes Decision Theory, Decision Trees, Random Forest, kNN-Methods, Support Vector Machine, Hidden Markov Models, Adaboost), clustering (k-means, dbscan, topic models)
- Crowdsourcing

The exercises show concrete design problems like motion and gesture recognition using distributed sensors, detection of activity patterns and identification of the local environment.

Presentations of the PhD students and the visit at the Wearable Computing Lab introduce in current research topics and international research projects.

Language: german/english (depending on the participants)

Lecture notes
Lecture notes for all lessons, assignments and solutions.
http://www.ife.ee.ethz.ch/education/wearable_systems_1

Literature

Prerequisites / notice
No special prerequisites
The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that are needed to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information about multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

The course language is English.

227-0417-00L Information Theory I W 6 credits 4G A. Lapidoth
Abstract
This course covers the basic concepts of information theory and of communication theory. Topics covered include the entropy rate of a source, mutual information, typical sequences, the asymptotic equi-partition property, Huffman coding, channel capacity, the channel coding theorem, the source-channel separation theorem, and feedback capacity.
Objective
The fundamentals of Information Theory including Shannon's source coding and channel coding theorems
Content
The entropy rate of a source. Typical sequences, the asymptotic equi-partition property, the source coding theorem, Huffman coding, Arithmetic coding, channel capacity, the channel coding theorem, the source-channel separation theorem, feedback capacity
Prerequisites / notice
Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C
Lecture notes
Course material Script, computer demonstrations, exercises and problem solutions
Prerequisites:

227-0427-00L Signal and Information Processing: Modeling, Filtering, Learning W 6 credits 4G H.A. Loeliger
Abstract
Fundamentals in signal processing, detection/estimation, and machine learning.
I. Linear signal representation and approximation: Hilbert spaces, LMMSE estimation, regularization and sparseness.
Objective
The course is an introduction to some basic topics in signal processing, detection/estimation theory, and machine learning.
Content
Prerequisites / notice
Lecture notes
Course material Script, computer demonstrations, exercises and problem solutions
Prerequisites:

227-0627-00L Applied Computer Architecture W 6 credits 4G A. Gunzinger
Abstract
This lecture gives an overview of the requirements and the architecture of parallel computer systems, performance, reliability and costs.
Objective
Understand the function, the design and the performance modeling of parallel computer systems.
Content
The lecture "Applied Computer Architecture" gives technical and corporate insights in the innovative Computer Systems/Architectures (CPU, GPU, FPGA, special processors) and their real implementations and applications. Often the designs have to deal with technical limits.
Which computer architecture allows the control of the over 1000 magnets at the Swiss Light Source (SLS)?
Which architecture is behind the alarm center of the Swiss Railway (SBB)?
Which computer architectures are applied for driver assistance systems?
Which computer architecture is hidden behind a professional digital audio mixing desk?
How can data volumes about 30 TB/s, produced by a proton accelerator, be processed in real time?
Can the weather forecast also be processed with GPUs?
Can weather a good computer architecture be found?
Which are the driving factors in successful computer architecture design?
Prerequisites / notice
Script and exercises sheets.
Prerequisites:
- local bachelors: course "Discrete-Time and Statistical Signal Processing" (5. Sem.)
- others: solid basics in linear algebra and probability theory

252-0237-00L Concepts of Object-Oriented Programming W 6 credits 3V+2U P. Müller
Abstract
Course that focuses on an in-depth understanding of object-oriented programming and compares designs of object-oriented programming languages. Topics include different flavors of type systems, inheritance models, encapsulation in the presence of aliasing, object and class initialization, program correctness, reflection
Objective
After this course, students will:
Have a deep understanding of advanced concepts of object-oriented programming and their support through various language features.
Be able to understand language concepts on a semantic level and be able to compare and evaluate language designs.
Be able to learn new languages more rapidly.
Be aware of many subtle problems of object-oriented programming and know how to avoid them.
Content
The main goal of this course is to convey a deep understanding of the key concepts of sequential object-oriented programming and their support in different programming languages. This is achieved by studying important challenges are addressed through language features and programming idioms. In particular, the course discusses alternative language designs by contrasting solutions in languages such as C++, C#, Eiffel, Java, Python, and Scala. The course also introduces novel ideas from research languages that may influence the design of future mainstream languages.

The topics discussed in the course include among others:
The pros and cons of different flavors of type systems (for instance, static vs. dynamic typing, nominal vs. structural, syntactic vs. behavioral typing)
The key problems of single and multiple inheritance and how different languages address them
Generic type systems, in particular, Java generics, C# generics, and C++ templates
The situations in which object-oriented programming does not provide encapsulation, and how to avoid them
The pitfalls of object initialization, exemplified by a research type system that prevents null pointer dereferencing
How to maintain the consistency of data structures

Literature
Will be announced in the lecture.
Students will be introduced to probabilistic graphical models and will learn how to apply them to problems in image analysis.

Randomized Algorithms and Probabilistic Methods
C. Schwab

Randomized Algorithms are algorithms that "flip coins" to take certain decisions. This concept extends the classical model of deterministic algorithms and has become very popular and useful within the last twenty years. In many cases, randomized algorithms are faster, simpler or just more elegant than deterministic ones. In the course, we will discuss basic principles and techniques and derive from them a number of randomized methods for problems in different areas.

Content:
- Las Vegas & Monte Carlo algorithms; inequalities of Markov, Chebyshev, Chernoff; negative correlation; Markov chains: convergence, rapidly mixing; generating functions; Examples include: min cut, median, balls and bins, routing in hypercubes, 3SAT, card shuffling, random walks.
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Literature:

**Prerequisites / notice**
Mastering at least one object-oriented programming language (this course will NOT provide an introduction to object-oriented programming): programming experience.

**252-0417-00L Randomized Algorithms and Probabilistic Methods**

| W | 7 credits | 3V+2U+1A | A. Steger |

**Abstract**
Las Vegas & Monte Carlo algorithms; inequalities of Markov, Chebyshev, Chernoff; negative correlation; Markov chains: convergence, rapidly mixing; generating functions; Examples include: min cut, median, balls and bins, routing in hypercubes, 3SAT, card shuffling, random walks.

**Objective**
After this course students will know fundamental techniques from probabilistic combinatorics for designing randomized algorithms and will be able to apply them to solve typical problems in these areas.

**Content**
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**Lecture notes**
Yes.

**Literature**

**Prerequisites / notice**
Does not take place this semester.

**252-0527-00L Probabilistic Graphical Models for Image Analysis**

| W | 4 credits | 3G |

**Abstract**
This course will focus on the algorithms for inference and learning with statistical models. We use a framework called probabilistic graphical models which include Bayesian Networks and Markov Random Fields.

**Objective**
Students will be introduced to probabilistic graphical models and will learn how to apply them to problems in image analysis and understanding. The focus will be to study various algorithms for inference and parameter learning.

**Content**
We will use examples from traditional vision problems such as image registration and image segmentation, as well as recent problems such as object recognition.

**Lecture notes**
Will be announced during the lecture.

**Literature**

**Prerequisites / notice**

**252-0546-00L Physically-Based Simulation in Computer Graphics**

| W | 4 credits | 2V+1U | B. Solenthaler, B. Thomaszewski |

**Abstract**
This lecture provides an introduction to physically-based animation in computer graphics and gives an overview of fundamental methods and algorithms. The practical exercises include three assignments which are to be solved in small groups. In an additional course project, topics from the lecture will be implemented into a 3D game or a comparable application.

**Objective**
This lecture provides an introduction to physically-based animation in computer graphics and gives an overview of fundamental methods and algorithms. The practical exercises include three assignments which are to be solved in small groups. In an additional course project, topics from the lecture will be implemented into a 3D game or a comparable application.

**Content**
The lecture covers topics in physically-based modeling, such as particle systems, mass-spring models, finite difference and finite element methods. These approaches are used to represent and simulate deformable objects or fluids with applications in animated movies, 3D games and medical systems. Furthermore, the lecture covers topics such as rigid body dynamics, collision detection, and character animation.

**Prerequisites / notice**
Fundamentals of calculus and physics, basic concepts of algorithms and data structures, basic programming skills in C++. Knowledge on numerical mathematics as well as ordinary and partial differential equations is an asset, but not required.

**Literature**
Mastering at least one object-oriented programming language (this course will NOT provide an introduction to object-oriented programming): programming experience.

**401-4655-64L Numerical Analysis of High-Dimensional Problems for Uncertainty Quantification**

| W | 6 credits | 3G | C. Schwab |

**Abstract**
In many applications of mathematics, efficient numerical methods for PDEs on high dimensional state and/or parameter spaces is required. This course provides succinct surveys of recently developed numerical methods, their computer implementation for model problems, and elements of their mathematical analysis for the efficient approximation of high- and infinite-dimensional PDE problems.

**Content**
[not necessarily in order of appearance]

1. Infinite-Dimensional Analysis
   - Probability spaces and measures,
   - Tensor Products,
   - Measures on function spaces,
   - Covariance operators,
   - PCA and KL-expansions,
   - (generalized) polynomial chaos expansions,
   - Kolmogoroff N-widths

2. Examples.
   - Parametric Approximation Problems,
   - Parametric ODEs (biochemical reaction pathways),
   - Parametric PDEs (diffusion problems with random coefficients),
   - PDEs in Parametric Domains (Scattering from random obstacles).


4. Stochastic Galerkin Methods

5. Stochastic Collocation Methods
   - Smolyak's algorithm and its generalizations; sparse, adaptive interpolation algorithms

6. Reduced Basis Methods

7. Monte Carlo Methods

8. Quasi-Monte Carlo Methods

   - Bayesian Inverse Problems
   - Shape Sensitivity Analysis of PDEs.
   - Optimal Control of parametric ODEs and PDEs.
   - Optimization of Parametric ODEs and PDEs.
Literature Books and Surveys:


Prerequisites / notice

- ETH BSc Math or equivalent
- Num. elliptic and Parabolic PDE
- Num. hyperbolic PDE
- ETH Doctoral Studies in applied mathematics or CSE.

Programming:
- MATLAB (for MSc MATH)
- Python and C/C++/MPI programming (MSc CSE).

401-3611-00L Advanced Topics in Computational Statistics W 4 credits 2V

Abstract This lecture covers selected advanced topics in computational statistics, including various classification methods, the EM algorithm, clustering, handling missing data, and graphical modelling.

Objective Students learn the theoretical foundations of the selected methods, as well as practical skills to apply these methods and to interpret their outcomes.

Content The course is roughly divided in three parts: (1) Supervised learning via (variations of) nearest neighbor methods, (2) the EM algorithm and clustering, (3) handling missing data and graphical models.

Lecture notes Lecture notes.

Prerequisites / notice We assume a solid background in mathematics, an introductory lecture in probability and statistics.

401-3627-00L High-Dimensional Statistics Does not take place this semester.

Abstract “High-Dimensional Statistics” deals with modern methods and theory for statistical inference when the number of unknown parameters is of much larger order than sample size. Statistical estimation and algorithms for complex models and aspects of multiple testing will be discussed.

Objective Knowledge of methods and basic theory for high-dimensional statistical inference

Content Lasso and Group Lasso for high-dimensional linear and generalized linear models; Additive models and many smooth univariate functions; Non-convex loss functions and l1-regularization; Stability selection, multiple testing and construction of p-values; Undirected graphical modeling


Prerequisites / notice Knowledge of basic concepts in probability theory, and intermediate knowledge of statistics (e.g. a course in linear models or computational statistics).

401-4633-00L Time Series Analysis Does not take place this semester.

Abstract Statistical analysis and modeling of observations in temporal order, which exhibit dependence. Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. Implementations in the software R.

Objective Understanding of the basic models and techniques used in time series analysis and their implementation in the statistical software R.

Content This course deals with modeling and analysis of variables which change randomly in time. Their essential feature is the dependence between successive observations. Applications occur in geophysics, engineering, economics and finance. Topics covered: Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. The models and techniques are illustrated using the statistical software R.

Lecture notes Not available

Literature A list of references will be distributed during the course.

Prerequisites / notice Basic knowledge in probability and statistics

401-3901-00L Mathematical Optimization

Abstract Mathematical treatment of diverse optimization techniques.

Objective Advanced optimization theory and algorithms.
### Content

1. **Linear optimization**: The geometry of linear programming, the simplex method for solving linear programming problems, Farkas' Lemma and infeasibility certificates, duality theory of linear programming.

2. **Nonlinear optimization**: Lagrange relaxation techniques, Newton method and gradient schemes for convex optimization.

3. **Integer optimization**: Ties between linear and integer optimization, total unimodularity, complexity theory, cutting plane theory.

4. **Combinatorial optimization**: Network flow problems, structural results and algorithms for matroids, matchings and, more generally, independence systems.

### 402-0867-00L Programming Techniques for Scientific Simulations II

<table>
<thead>
<tr>
<th>W</th>
<th>6 credits</th>
<th>3G</th>
<th>M. Troyer</th>
</tr>
</thead>
</table>

#### Abstract

This course covers advanced general and C++ programming techniques relevant for scientific simulations.

#### Content

- generic algorithm and library design
- exception safety
- smart pointers and safe memory handling
- polymorphism at compile time, at run time and hybrid designs
- mixed language programs, in particular C++, C, Fortran and Python, and the Boost, Python library
- template meta programming and relevant libraries
- C++ libraries for parallel programming on distributed and shared memory machines
- Useful C++ libraries from Boost and other sources

### 402-0777-00L Particle Accelerator Physics and Modeling I

<table>
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<tr>
<th>W</th>
<th>6 credits</th>
<th>2V+1U</th>
<th>A. Adelmann</th>
</tr>
</thead>
</table>

#### Objective

You understand the building blocks of particle accelerators. Modern analysis tools allows you to model state-of-the-art particle accelerators. In some of the exercises you will be confronted with next generation machines. We will develop a Python simulation tool (AccelLEGOrator) that reflects the theory from the lecture.

#### Content

- Particle Accelerators an Overview
- Relativity for Accelerator Physicists
- Building Blocks of Particle Accelerators
- Lie Algebraic Structure of Classical Mechanics and Applications to Particle Accelerators
- Symplectic Maps & Analysis of Maps
- Particle Tracking
- Linear & Circular Machines
- Cyclotrons
- Free Electron Lasers
- Collective effects in linear approximation
- Preview of Particle Accelerator Physics and Modeling II

#### Literature

- Particle Accelerator Physics, H. Wiedemann, ISBN-13 978-3-540-49043-2, Springer

#### Prerequisites / notice

- Physics, Computational Science (RW) at BSc. Level
- This lecture is also suited for PhD. students

### 401-7855-00L Computational Astrophysics (University of Zurich)

<table>
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<tr>
<th>W</th>
<th>6 credits</th>
<th>2V</th>
<th>L. M. Mayer</th>
</tr>
</thead>
</table>

#### Notice

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: AST245

#### Literature

- Galactic Dynamics (Binney & Tremaine, Princeton University Press),
- Computer Simulation using Particles (Hockney & Eastwood CRC press),
- Targeted journal reviews on computational methods for astrophysical fluids (SPH, AMR, moving mesh)

#### Prerequisites / notice

- Some knowledge of UNIX, scripting languages (see www.physik.uzh.ch/lectures/informatik/python/ as an example), some prior experience programming, knowledge of C, C++ beneficial

### 227-1033-00L Neuromorphic Engineering I

<table>
<thead>
<tr>
<th>W</th>
<th>6 credits</th>
<th>2V+3U</th>
<th>T. Delbrück, G. Indiveri, S.C. Liu</th>
</tr>
</thead>
</table>

#### Abstract

This course covers analog circuits with emphasis on neuromorphic engineering: MOS transistors in CMOS technology, static circuits, dynamic circuits, systems (silicon neuron, silicon retina, silicon cochlea) with an introduction to multi-chip systems. The lectures are accompanied by weekly laboratory sessions.

#### Objective

Understanding the characteristics of neuromorphic circuit elements.
Neuromorphic circuits are inspired by the organizing principles of biological neural circuits. Their computational primitives are based on physics of semiconductor devices. Neuromorphic architectures often rely on collective computation in parallel networks. Adaptation, learning and memory are implemented locally within the individual computational elements. Transistors are often operated in weak inversion (below threshold), where they exhibit exponential I-V characteristics and low currents. These properties lead to the feasibility of high-density, low-power implementations of functions that are computationally intensive in other paradigms. Application domains of neuromorphic circuits include silicon retinas and cochleas for machine vision and audition, real-time emulations of networks of biological neurons, and the development of autonomous robotic systems. This course covers devices in CMOS technology (MOS transistor below and above threshold, floating-gate MOS transistor, phototransducers), static circuits (differential pair, current mirror, transconductance amplifiers, etc.), dynamic circuits (linear and nonlinear filters, adaptive circuits), systems (silicon neuron, silicon retina and cochlea) and an introduction to multi-chip systems that communicate events analogous to spikes. The lectures are accompanied by weekly laboratory sessions on the characterization of neuromorphic circuits, from elementary devices to systems.

**Content**

The course provides an introduction to the functional properties of neurons. Particularly the description of membrane electrical properties (action potentials, channels), neuronal anatomy, synaptic structures, and neuronal networks. Simple models of computation, learning, and behavior will be explained. Some artificial systems (robot, chip) are presented.

**Objective**

Understanding computation by neurons and neuronal circuits is one of the great challenges of science. Many different disciplines can contribute their tools and concepts to solving mysteries of neural computation. The goal of this introductory course is to introduce the monocultures of physics, maths, computer science, engineering, biology, psychology, and even philosophy and history, to discover the engravings and challenges that we all face in taking on this major 21st century problem and how each discipline can contribute to discovering solutions.

**Abstract**

This course considers the structure and function of biological neuronal networks at different levels. The function of neuronal networks lies fundamentally in their wiring and in the electro-chemical properties of nerve cell membranes. Thus, the biological structure of the nerve cell needs to be understood if biologically-realistic models are to be constructed. These simpler models are used to estimate the electrical current flow through dendritic cables and explore how a more complex geometry of neurons influences this current flow. The active properties of nerves are studied to understand both sensory transduction and the generation and transmission of nerve impulses along axons. The concept of local neuronal circuits arises in the context of the rules governing the formation of nerve connections and topographic projections within the nervous system. Communication between neurons in the network can be thought of as information flow across synapses, which can be modified by experience. We need an understanding of the action of inhibitory and excitatory neurotransmitters and neuromodulators, so that the dynamics and logic of synapses can be interpreted. Finally, the neural architectures of feedforward and recurrent networks will be discussed in the context of co-ordination, control, and integration of sensory and motor information in neural networks.

**Introduction to Neuroinformatics**

W 6 credits 2V+1U K. A. Martin, M. Cook, V. Mante, M. Pfeiffer

**Prerequisites / Notice**

Particular: The course is highly recommended for those who intend to take the spring semester course 'Neuromorphic Engineering II', that teaches the conception, simulation, and physical layout of such circuits with chip design tools.

**Prerequisites:** Background in basics of semiconductor physics helpful, but not required.

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Prerequisites / notice


see also Fields of Specialization

Case Studies

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<tr>
<td>401-3667-65L</td>
<td>Case Studies Seminar (Autumn Semester 2015)</td>
<td>W</td>
<td>3 credits</td>
<td>2S</td>
<td>V. C. Gradianaru, R. Hiptmair, M. Reiher</td>
</tr>
</tbody>
</table>

Abstract

In the CSE Case Studies Seminar invited speakers from ETH, from other universities as well as from industry give a talk on an applied topic. Beside of attending the scientific talks students are asked to give short presentations (10 minutes) on a published paper out of a list.

Semester Paper

There are several course units "Semester Paper" that are all equivalent. If, during your studies, you write several semester papers, choose among the different numbers in order to be able to obtain credits again.

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<td>W</td>
<td>8 credits</td>
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Abstract

Semester Papers help to deepen the students' knowledge of a specific subject area. Students are offered a selection of topics. These papers serve to develop the students' ability for independent mathematical work as well as to enhance skills in presenting mathematical results in writing.

Prerequisites / notice

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Prerequisites / notice

There are several course units "Semester Paper" that are all equivalent. If, during your studies, you write several semester papers, choose among the different numbers in order to be able to obtain credits again.

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-MATH.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses

ETH/UZH

Master Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-2000-00L</td>
<td>Scientific Works in Mathematics</td>
<td>O</td>
<td>0 credits</td>
<td></td>
<td>E. Kowalski</td>
</tr>
</tbody>
</table>

Abstract

Introduction to scientific writing for students with focus on publication standards and ethical issues, especially in the case of citations (references to works of others.)
Objective
Learn the basic standards of scientific works in mathematics.

Content
- Types of mathematical works
- Publication standards in pure and applied mathematics
- Data handling
- Ethical issues
- Citation guidelines

Lecture notes
Moodle of the Mathematics Library: https://moodle-app2.let.ethz.ch/course/view.php?id=519

Prerequisites / notice
This course is completed by the optional course "Recherchieren in der Mathematik" (held in German) by the Mathematics Library. For more details see: http://www.math.ethz.ch/library/services/schulungen

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-4990-01L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30</td>
<td>57D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Only students who fulfil the following criteria are allowed to begin with their master's thesis:

a. successful completion of the bachelor programme;
b. fulfilling of any additional requirements necessary to gain admission to the master programme.

For Programme Regulations 2014 there are additional requirements.

No direct enrolment to this course unit in myStudies.

Please fill in the online application form.

Requirements and application form under www.math.ethz.ch/intranet/students/study-administration/theses.html

(Afterwards the enrolment will be done by the Study Administration.)

Abstract
The master's thesis concludes the study programme. Thesis work should prove the students' ability to independent, structured and scientific working.

Objective
Thesis work should prove the students' ability to independent, structured and scientific working.

Colloquia

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
</table>

Abstract
Research colloquium

Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0122-AAL</td>
<td>Fluid Dynamics for CSE</td>
<td>E-</td>
<td>5</td>
<td>11R</td>
<td>T. Rösgen</td>
</tr>
</tbody>
</table>

Enrolment only for MSc students who need this course as additional admission requirement.

The course is not available for incoming exchange students.

Abstract
An introduction to the physical and mathematical foundations of fluid dynamics is given.

Topics include dimensional analysis, integral and differential conservation laws, inviscid and viscous flows, Navier-Stokes equations, boundary layers, turbulent pipe flow. Elementary solutions and examples are presented.

Objective
An introduction to the physical and mathematical principles of fluid dynamics. Fundamental terminology/principles and their application to simple problems.

Content
Phänomene, Anwendungen, Grundfragen
Dimensionsanalyse und Ähnlichkeit; kinematische Beschreibung; Erhaltungssätze (Masse, Impuls, Energie), integrale und differentielle Formulierungen; Reibungsfreie Strömungen: Euler-Gleichungen, Stromfadentheorie, Satz von Bernoulli; Reibungsbehaftete Strömungen: Navier-Stokes-Gleichungen; Grenzschichten; Turbulenz

Lecture notes
Eine erweiterte Formelsammlung zur Vorlesung wird elektronisch zur Verfügung gestellt.

Literature
Empfohlenes Buch: Fluid Mechanics, P. Kundu & I. Cohen, Elsevier

Prerequisites / notice
Performance Assessment: session examination

Allowed aids:
Textbook (free selection, list of assignments), list of formulars IFD, 8 Sheets (=4 Pages) own notes, calculator

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<th>Number</th>
<th>Title</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>406-0353-AAL</td>
<td>Analysis III</td>
<td>E-</td>
<td>4</td>
<td>9R</td>
<td>A. Iozzi</td>
</tr>
</tbody>
</table>

Enrolment only for MSc students who need this course as additional admission requirement.

Abstract
Introduction to partial differential equations. Differential equations which are important in applications are classified and solved. Elliptic, parabolic and hyperbolic differential equations are treated. The following mathematical tools are introduced: Laplace transforms, Fourier series, separation of variables, methods of characteristics.

Objective
Mathematical treatment of problems in science and engineering. To understand the properties of the different types of partial differential equations.
Laplace Transforms:
- Laplace Transform, Inverse Laplace Transform, Linearity, s-Shifting
- Transforms of Derivatives and Integrals, ODEs
- Unit Step Function, t-Shifting
- Short Impulses, Dirac's Delta Function, Partial Fractions
- Convolution, Integral Equations
- Differentiation and Integration of Transforms

Fourier Series, Integrals and Transforms:
- Fourier Series
- Functions of Any Period p=2L
- Even and Odd Functions, Half-Range Expansions
- Forced Oscillations
- Approximation by Trigonometric Polynomials
- Fourier Integral
- Fourier Cosine and Sine Transform

Partial Differential Equations:
- Basic Concepts
- Modeling: Vibrating String, Wave Equation
- Solution by separation of variables; use of Fourier series
- D'Alembert Solution of Wave Equation, Characteristics
- Heat Equation: Solution by Fourier Series
- Heat Equation: Solutions by Fourier Integrals and Transforms
- Modeling Membrane: Two Dimensional Wave Equation
- Laplacian in Polar Coordinates: Circular Membrane, Fourier-Bessel Series
- Solution of PDEs by Laplace Transform

Literature

For reference/complement of the Analysis I/II courses:
Christian Blatter: Ingenieur-Analysis (Download PDF)

Prerequisites / notice
Up-to-date information about this course can be found at:
http://www.math.ethz.ch/education/bachelor/lectures/hs2013/other/analysis3_itet
Content

The course will cover the following chapters:

1. Direct Methods for linear systems of equations
2. Interpolation
3. Iterative Methods for non-linear systems of equations
4. Krylov methods for linear systems of equations
5. Eigensolvers
6. Least Squares Techniques
7. Filtering Algorithms
8. Approximation of Functions
9. Numerical Quadrature
10. Clustering Techniques
11. Single Step Methods for ODEs
12. Stiff Integrators

Lecture notes

Comprehensive lecture materials are available upon request from the lecturer.

Literature

M. Hanke-Bourgeois "Grundlagen der Numerischen Mathematik und des wissenschaftlichen Rechnens", BG Teubner, 2002
C. Moler, "Numerical computing with MATLAB", SIAM, 2004
P. Deuflhard and A. Hohmann, "Numerische Mathematik I", DeGruyter, 2002

Prerequisites / notice

Solid knowledge about fundamental concepts and techniques from linear algebra & calculus as taught in the first year of science and engineering curricula.

252-0232-AAL Software Design

Enrolment only for MSc students who need this course as additional admission requirement.

Abstract

The course Software Design presents and discusses design patterns regularly used to solve problems in object oriented design and object oriented programming. The presented patterns are illustrated with examples from the Java libraries and are applied in a project.

Objective

The students
- know the principles of object oriented programming and can apply these.
- know the most important object oriented design patterns.
- can apply design patterns to solve design problems.
- discover in a given design the use of design patterns.

529-0483-AAL Statistical Physics and Computer Simulation

Enrolment only for MSc students who need this course as additional requirement.

Abstract

Principles and applications of statistical mechanics and equilibrium molecular dynamics, Monte Carlo simulation, Stochastic dynamics. Exercises using a MD simulation program to generate ensembles and subsequently calculate ensemble averages.

Objective

Introduction to statistical mechanics with the aid of computer simulation, development of skills to carry out statistical mechanical calculations using computers and interpret the results.

Content

Principles and applications of statistical mechanics and equilibrium molecular dynamics, Monte Carlo simulation, Stochastic dynamics. Exercises using a MD simulation program to generate ensembles and subsequently calculate ensemble averages.

Lecture notes

available

Literature

see "Course Schedule"

Prerequisites / notice

additional information will be provided in the first lecture.

Computational Science and Engineering Master - Key for Type

O Compulsory
W+ Eligible for credits and recommended
W Eligible for credits

Key for Hours

V lecture
G lecture with exercise
U exercise
S seminar
K colloquium

P practical/laboratory course
A independent project
D diploma thesis
R revision course / private study

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Robotics, Systems and Control Master

Core Courses

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<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0104-00L</td>
<td>Uncertainty Quantification for Engineering &amp; Life Sciences</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>J. Beck, P. Koumoutsakos</td>
</tr>
</tbody>
</table>

**Abstract**
Quantification of uncertainties in computational models pertaining to applications in engineering and life sciences. Exploitation of massively available data to develop computational models with quantifiable predictive capabilities. Applications of Uncertainty Quantification and Propagation to problems in mechanics, control, systems and cell biology.

**Objective**
The course will teach fundamental concept of Uncertainty Quantification and Propagation (UQ+P) for computational models of systems in Engineering and Life Sciences. Emphasis will be placed on practical and computational aspects of UQ+P including the implementation of relevant algorithms in multicore architectures.

**Content**
Topics that will be covered include: Uncertainty quantification under parametric and non-parametric modelling uncertainty, Bayesian inference with model class assessment, Markov Chain Monte Carlo simulation, prior and posterior reliability analysis.

**Lecture notes**
The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

**Literature**
1. Data Analysis: A Bayesian Tutorial by Devinderjit Sivia
2. Probability Theory: The Logic of Science by E. T. Jaynes
3. Class Notes

**Prerequisites / notice**
Fundamentals of Probability, Fundamentals of Computational Modeling

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</table>

**Abstract**
This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.

**Objective**
Introduction to HPC for scientists and engineers
Fundamental of:
1. Parallel Computing Architectures
2. MultiCores
3. ManyCores

**Content**
Programming models and languages:
1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)

Computers and methods:
1. Hardware and architectures
2. Libraries
3. Particles; N-body solvers
4. Fields: PDEs
5. Stochastics: Monte Carlo

**Lecture notes**
http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1
Class notes, handouts

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<tr>
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</thead>
<tbody>
<tr>
<td>151-0509-00L</td>
<td>Microscale Acoustofluidics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>J. Dual</td>
</tr>
</tbody>
</table>

**Abstract**
In this lecture the basics as well as practical aspects (from modelling to design and fabrication ) are described from a solid and fluid mechanics perspective with applications to microsystems and lab on a chip devices.

**Objective**
Understanding acoustofluidics, the design of devices and potential applications

**Content**
Linear and nonlinear acoustics, foundations of fluid and solid mechanics and piezoelectricity, Gorkov potential, numerical modelling, acoustic streaming, applications from ultrasonic microrobotics to surface acoustic wave devices

**Lecture notes**

**Literature**
Solid and fluid continuum mechanics. Notice: The exercise part is a mixture of presentation, lab session and hand in homework.

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<tr>
<th>Number</th>
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<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>151-0563-01L</td>
<td>Dynamic Programming and Optimal Control</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>R. D’Andrea</td>
</tr>
</tbody>
</table>

**Abstract**
Introduction to Dynamic Programming and Optimal Control.

**Objective**
Covers the fundamental concepts of Dynamic Programming & Optimal Control.

**Content**
Dynamic Programming Algorithm; Deterministic Systems and Shortest Path Problems; Infinite Horizon Problems, Bellman Equation; Deterministic Continuous-Time Optimal Control.

**Literature**

**Prerequisites / notice**
Requirements: Knowledge of advanced calculus, introductory probability theory, and matrix-vector algebra.

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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</thead>
<tbody>
<tr>
<td>151-0593-00L</td>
<td>Embedded Control Systems</td>
<td>W</td>
<td>4</td>
<td>6G</td>
<td>J. S. Freudenberg, M. Schmid Daners</td>
</tr>
</tbody>
</table>

**Abstract**
This course provides a comprehensive overview of embedded control systems. The concepts introduced are implemented and verified on a microprocessor-controlled haptic device.

**Objective**
Familiarize students with main architectural principles and concepts of embedded control systems.
An embedded system is a microprocessor used as a component in another piece of technology, such as cell phones or automobiles. In this intensive two-week block course the students are presented the principles of embedded digital control systems using a haptic device as an example for a mechatronic system. A haptic interface allows for a human to interact with a computer through the sense of touch.

Subjects covered in lectures and practical lab exercises include:
- The application of C-programming on a microprocessor
- Digital I/O and serial communication
- Quadrature decoding for wheel position sensing
- Queued analog-to-digital conversion to interface with the analog world
- Pulse width modulation
- Timer interrupts to create sampling time intervals
- System dynamics and virtual worlds with haptic feedback
- Introduction to rapid prototyping

Lecture notes

Lecture notes, lab instructions, supplemental material

Prerequisite courses are Control Systems I and Informatics I.

This course is restricted to 33 students due to limited lab infrastructure. Interested students please contact Marianne Schmid (E-Mail: schmid@idsc.mavt.ethz.ch)

After your reservation has been confirmed please register online at www.mystudies.ethz.ch.

Detailed information can be found on the course website http://www.idsc.ethz.ch/education/lectures/embedded-control-systems.html

### 151-0601-00L Theory of Robotics and Mechatronics

**Abstract**
This course provides an introduction and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. It's a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.

**Objective**
Robotics is often viewed from three perspectives: perception (sensing), manipulation (affecting changes in the world), and cognition (intelligence). Robotic systems integrate aspects of all three of these areas. This course provides an introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control. This course is a requirement for the Robotics Vertiefung and for the Masters in Mechatronics and Microsystems.

**Content**
An introduction to the theory of robotics, and covers the fundamentals of the field, including rigid motions, homogeneous transformations, forward and inverse kinematics of multiple degree of freedom manipulators, velocity kinematics, motion planning, trajectory generation, sensing, vision, and control.

**Lecture notes**
Available.

**Prerequisites / notice**
The course will be taught in English.

### 151-0604-00L Microrobotics

**Abstract**
Microrobotics is an interdisciplinary field that combines aspects of robotics, micro and nanotechnology, biomedical engineering, and materials science. The aim of this course is to expose students to the fundamentals of this emerging field. Throughout the course students are expected to submit assignments. The course concludes with an end-of-semester examination.

**Objective**
The objective of this course is to expose students to the fundamental aspects of the emerging field of microrobotics. This includes a focus on physical laws that predominate at the microscale, technologies for fabricating small devices, bio-inspired design, and applications of the field.

**Content**
Main topics of the course include:
- Scaling laws at micro/nano scales
- Electrostatics
- Electromagnetism
- Low Reynolds number flows
- Observation tools
- Materials and fabrication methods
- Applications of biomedical microrobots

**Lecture notes**
The powerpoint slides presented in the lectures will be made available in hardcopy and as pdf files. Several readings will also be made available electronically.

**Prerequisites / notice**
The course will be taught in English.

### 151-0613-00L Fundamentals of Image Processing and Computer Vision

**Abstract**
No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

**Objective**
The objective of this course is to provide the basics required to develop simple image processing and feature extraction algorithms.

**Prerequisites / notice**
Basic knowledge of Math, Physics, Probability theory, C/C++, and Matlab programming are an advantage.

### 151-0623-00L ETH Zurich Distinguished Seminar in Robotics, Systems and Controls

**Abstract**
This course consists of a series of seven lectures given by researchers who have distinguished themselves in the area of Robotics, Systems, and Controls.

**Objective**
Obtain an overview of various topics in Robotics, Systems, and Controls from leaders in the field. Please see http://www.msr.ethz.ch/education/distinguished-seminar-in-robotics--systems--controls--151-0623-0.html for a list of upcoming lectures.

**Content**
This course consists of a series of seven lectures given by researchers who have distinguished themselves in the area of Robotics, Systems, and Controls. MSc students in Robotics, Systems, and Controls are required to attend every lecture. Attendance will be monitored. If for some reason a student cannot attend one of the lectures, the student must select another ETH or University of Zurich seminar related to the field and submit a one page description of the seminar topic. Please see http://www.msr.ethz.ch/education/distinguished-seminar-in-robotics--systems--controls--151-0623-0.html for a suggestion of other lectures.
The course consists of three parts: First, we will refresh and deepen the student's knowledge in kinematics, dynamics, and rotations of multi-body systems. The student receives a solid background in kinematics, dynamics, and rotations of multi-body systems. On the basis of state of the art applications, he/she will learn all necessary tools to work in the field of design or control of robotic systems.

<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
<th>151-0851-00L</th>
<th>Robot Dynamics</th>
<th>W</th>
<th>4 credits</th>
<th>2V+1U</th>
<th>R. Siegwart, M. Hutter, K. Rudin, T. Stastry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>We will provide an overview on how to kinematically and dynamically model typical robotic systems such as robot arms, legged robots, rotary wing systems, or fixed wing.</td>
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<tr>
<td>Objective</td>
<td>The primary objective of this course is that the student deepens an applied understanding of how to model the most common robotic systems. The student receives a solid background in kinematics, dynamics, and rotations of multi-body systems. On the basis of state of the art applications, he/she will learn all necessary tools to work in the field of design or control of robotic systems.</td>
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<tr>
<td>Content</td>
<td>The course consists of three parts: First, we will refresh and deepen the student's knowledge in kinematics, dynamics, and rotations of multi-body systems. In this context, the learning material will build upon the courses for mechanics and dynamics available at ETH, with the particular focus on their application to robotic systems. The goal is to foster the conceptual understanding of similarities and differences among the various types of robots. In the second part, we will apply the learned material to classical robotic arms as well as legged systems and discuss kinematic constraints and interaction forces. In the third part, focus is put on modeling fixed wing aircraft, along with related design and control concepts. In this context, we also touch aerodynamics and flight mechanics to an extent typically required in robotics. The last part finally covers different helicopter types, with a focus on quadrotors and the coaxial configuration which we see today in many UAV applications. Case studies on all main topics provide the link to real applications and to the state of the art in robotics.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>The contents of the following ETH Bachelor lectures or equivalent are assumed to be known: Mechanics and Dynamics, Control, Basics in Fluid Dynamics.</td>
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<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
<th>151-1116-00L</th>
<th>Introduction to Aircraft and Car Aerodynamics</th>
<th>W</th>
<th>4 credits</th>
<th>3G</th>
<th>J. Wildi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Aircraft aerodynamics: Atmosphere; aerodynamic forces (lift, drag); thrust.</td>
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<tr>
<td>Content</td>
<td>An introduction to the basic principles and interrelationships of aircraft and automotive aerodynamics.</td>
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<td></td>
<td>To understand the basic relations of the origin of aerodynamic forces (i.e., lift, drag). To quantify the aerodynamic forces for basic configurations of aircraft and car components.</td>
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<tr>
<td>Literature</td>
<td>Illustration of the intrinsic problems and results using examples.</td>
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<td></td>
<td>Using experimental and theoretical methods to illustrate possibilities and limits.</td>
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<td></td>
<td>Aircraft aerodynamics: atmosphere, aerodynamic forces (ascending force: profile, wings. Resistance, residual resistance, induced resistance); thrust (overview of the propulsion system, aerodynamics of the propellers), introduction to static longitudinal stability.</td>
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<tr>
<td>Lecture notes</td>
<td>English literature covering the content of the course:</td>
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<td></td>
<td>1.) Grundlagen der Flugtechnik (Basics of flight science, script in german language)</td>
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<td></td>
<td>2.) Einführung in die Fahrzeugaerodynamik (Introduction in car aerodynamics, script in german language)</td>
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<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
<th>227-0102-00L</th>
<th>Discrete Event Systems</th>
<th>W</th>
<th>6 credits</th>
<th>4G</th>
<th>L. Thiele, L. Vanbever, R. Wattenhofer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Introduction to discrete event systems. We start out by studying popular models of discrete event systems. In the second part of the course we analyze discrete event systems from an average-case and from a worst-case perspective. Topics include: Automata and Languages, Specification Models, Stochastic Discrete Event Systems, Worst-Case Event Systems, Verification, Network Calculus.</td>
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<tr>
<td>Objective</td>
<td>Over the past few decades the rapid evolution of computing, communication, and information technologies has brought about the proliferation of new dynamic systems. A significant part of activity in these systems is governed by operational rules designed by humans. The dynamics of these systems are characterized by asynchronous occurrences of discrete events, some controlled (e.g., hitting a keyboard key, sending a message), some not (e.g., spontaneous failure, packet loss).</td>
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<td></td>
<td>The mathematical arsenal centered around differential equations that has been employed in systems engineering to model and study processes governed by the laws of nature is often inadequate or inappropriate for discrete event systems. The challenge is to develop new modeling frameworks, analysis techniques, design tools, testing methods, and optimization processes for this new generation of systems.</td>
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<td>In this lecture we give an introduction to discrete event systems. We start out the course by studying popular models of discrete event systems, such as automata and Petri nets. In the second part of the course we analyze discrete event systems. We first examine discrete event systems from an average-case perspective: we model discrete events as stochastic processes, and then apply Markov chains and queuing theory for an understanding of the typical behavior of a system. In the last part of the course we analyze discrete event systems from a worst-case perspective using the theory of online algorithms and adversarial queuing.</td>
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<tr>
<td>Content</td>
<td>1. Introduction</td>
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<td>2. Automata and Languages</td>
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<td>3. Smarter Automata</td>
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<td>4. Specification Models</td>
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<td>5. Stochastic Discrete Event Systems</td>
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<td>6. Worst-Case Event Systems</td>
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<td>7. Network Calculus</td>
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<tr>
<td>Lecture notes</td>
<td>Available</td>
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</tbody>
</table>
Linear System Theory

Study of concepts and methods for the mathematical description and analysis of dynamical systems. The concept of feedback. Design of control systems for single input - single output and multivariable systems.

F. Dörfler

Rings, fields and linear spaces, normed linear spaces and inner product spaces.

J. W. Kolar

Power Electronic Systems I


J. Lygeros

Data Networks

Basics of the switching behavior and gate drive circuits of power semiconductor devices and auxiliary circuits for minimizing the switching losses are explained. Furthermore, zero voltage switching, zero current switching, and resonant DC/DC converters are discussed in detail; the operating behavior of isolated full-bridge DC/DC converters is detailed for different secondary side rectifier topologies; high frequency loss mechanisms of magnetic components of converter circuits are explained and approximate calculation methods are presented; the concept of space vector calculus for analyzing three-phase systems is introduced; finally, phase-oriented and space vector modulation of three-phase inverter systems in the lecture Power Electronic Systems II.

Bertsekas


M. Morari

5G

Slides can be downloaded from the course website. A printed version with additional content is offered via SPOD (student print on demand) for a fee (ca. 10-15 CHF).

4G

Lecture notes and associated exercises including correct answers, simulation program for interactive self-learning including visualization/animation features.
**Course material Script, computer demonstrations, exercises and problem solutions**

R. Smith

3V+1U


**Objective**

Overview of the most important concepts of image formation, perception and analysis, and Computer Vision. Gaining own experience through practical computer and programming exercises.

**Content**

The first part of the course starts off from an overview of existing and emerging applications that need computer vision. It shows that the realm of image processing is no longer restricted to the factory floor, but is entering several fields of our daily life. First it is investigated how the parameters of the electromagnetic waves are related to our perception. Also the interaction of light with matter is considered. The most important hardware components of technical vision systems, such as cameras, optical devices and illumination sources are discussed. The course then turns to the steps that are necessary to arrive at the discrete images that serve as input to algorithms. The next part describes necessary preprocessing steps of image analysis, that enhance image quality and/or detect specific features. Linear and non-linear filters are introduced for that purpose. The course will continue by analyzing procedures allowing to extract additional types of basic information from multiple images, with motion and depth as two important examples. The estimation of image velocities (optical flow) will get due attention and methods for object tracking will be presented. Several techniques are discussed to extract three-dimensional information about objects and scenes. Finally, approaches for the recognition of specific objects as well as object classes will be discussed and analyzed.

**Lecture notes**

Course material Script, computer demonstrations, exercises and problem solutions

**Prerequisites / notice**

Prerequisites: Basic concepts of mathematical analysis and linear algebra. The computer exercises are based on Linux and C.

The course language is English.

---

**227-0526-00L**

**Power System Analysis**

R. Andersson

6 credits

3V+1U

The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the development of stationary models of the electrical network, their mathematical representation and special characteristics and solution methods of large linear and non-linear systems of equations related to electrical power networks.

**Objective**

The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the development of stationary models of the electrical network, their mathematical representation and special characteristics and solution methods of large linear and non-linear systems of equations related to electrical power networks.

**Content**

The electrical power transmission system, the energy management system, requirements of the electrical power transmission (demand oriented, operationally, economically), network planning and network operation, models of N-port network components (line, cables, shunts, transformers), the p.u. computation, computer oriented network models, linear networks (solution methods - direct, iterative), algorithms for the solution of non-linear set of equations, derived from the electrical power system (Newton-Raphson), power flow computation (problem definition, solution methods), three phase short-circuit computation, application of power flow algorithms. Introduction to power system stability.

**Lecture notes**

Lecture notes. Course is supported by WWW-teaching system.

---

**227-0689-00L**

**System Identification**

R. Smith

6 credits

3G

The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the development of stationary models of the electrical network, their mathematical representation and special characteristics and solution methods of large linear and non-linear systems of equations related to electrical power networks.

**Objective**

To provide a series of practical techniques for the development of dynamical models from experimental data, with the emphasis being on the development of models suitable for feedback control design purposes. To provide sufficient theory to enable the practitioner to understand the trade-offs between model accuracy, data quality and data quantity.

**Content**

Introduction to modeling: Black-box and grey-box models; Parametric and non-parametric models; ARX, ARMAX (etc.) models. Predictive, open-loop, black-box identification methods. Time and frequency domain methods. Subspace identification methods.

**Literature**


**Prerequisites / notice**

Closed-loop identification strategies. Trade-off between controller performance and information available for identification.


Control systems (227-0216-00L) or equivalent.

---

**227-0697-00L**

**Industrial Process Control**

G. Maier, A. Horch

6 credits

3G

The goal of this course is understanding the stationary and dynamic problems in electrical power systems. The course includes the development of stationary models of the electrical network, their mathematical representation and special characteristics and solution methods of large linear and non-linear systems of equations related to electrical power networks.

**Abstract**

Introduction to process automation and its application in process industry and power generation.

**Objective**

Knowledge of process automation and its application in industry and power generation.

**Content**

Introduction to process automation: system architecture, data handling, communication (fieldbusses), process visualization, engineering, etc. Analysis and design of open loop control problems: discrete automata, petri-nets, decision tables, drive control and object oriented function group automation philosophy, RT-UML. Engineering: Application programming in IEC61131-3 (function blocks, sequence control, structured text); Process visualization and operation; engineering integration from sensor, cabling, topology design, function, visualization, diagnosis, to documentation; Industry standards (e.g. OPC, Proflbus).

**Prerequisites**

Control systems (227-0216-00L) or equivalent.

**Lecture notes**

Slides will be available as .PDF documents, see “Learning materials” (for registered students only)

**Exercises**

Tuesday 15-16

Practical examples will illustrate some topics, especially some control software coding using industry standard programming tools based on IEC61131-3.

---

**227-0778-00L**

**Hardware/Software Codeign**

L. Thiele

6 credits

2V+2U

The course provides advanced knowledge in the design of complex computer systems, in particular embedded systems. Models and methods are discussed that are fundamental for systems that consist of software and hardware components.

**Objective**

The course provides advanced knowledge in the design of complex computer systems, in particular embedded systems. Models and methods are discussed that are fundamental for systems that consist of software and hardware components.

**Content**

The course covers the following subjects: (a) Models for describing hardware and software components (specification), (b) Hardware-Software Interfaces (instruction set, hardware and software components, reconfigurable computing, heterogeneous computer architectures, System-on-Chip), (c) Application and generic instruction sets, code generation and retargetable compilation, (d) Performance analysis and estimation techniques, (e) System design (hardware-software partitioning and design space exploration).

**Lecture notes**

Material for exercises, copies of transparencies.
Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the solid basic knowledge in analysis, statistics and numerical methods for CSE. Experience in programming for solving the project tasks.

Prerequisites / notice
Solid basic knowledge in analysis, statistics and numerical methods for

Literature
No lecture notes, but slides will be made available on the course webpage.

Content
The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

Topics covered in the lecture include:
- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

Objective
Students will be introduced to probabilistic graphical models and will learn how to apply them to problems in image analysis and understanding. The focus will be to study various algorithms for inference and parameter learning.

Abstract
This course will focus on the algorithms for inference and learning with statistical models. We use a framework called probabilistic graphical models which include Bayesian Networks and Markov Random Fields.

Literature
Will be announced during the lecture.

Objective
This course discusses algorithmic aspects of game-theoretic models, with a focus on recent algorithmic and mathematical developments. Rather than giving an overview of such developments, the course aims to study selected important topics in depth.

Outline:
- Introduction to classical game theoretic concepts.
- Existence of stable solutions (equilibria), algorithms for computing equilibria, computational complexity.
- The cost difference between an optimum under central control and an equilibrium under selfish agents, known as the "price of anarchy".
- Auction-like mechanisms and algorithms that "direct" the actions of selfish agents into a certain desired equilibrium situation.
- Selected current research topics of Algorithmic Game Theory, such as Web-Search Based Keyword Auctions, or Information Cascading in Social Networks

Content
Game theory provides a formal model to study the behavior and interaction of self-interested users and programs in large-scale distributed computer systems without central control. The course discusses algorithmic aspects of game theory.

Objective
Learning the basic concepts of game theory and mechanism design, acquiring the computational paradigm of self-interested agents, and using these concepts in the computational and algorithmic setting.

Abstract
Game theory provides a formal model to study the behavior and interaction of self-interested users and programs in large-scale distributed computer systems without central control. The course discusses algorithmic aspects of game theory.

Literature

Prerequisites / notice
No lecture notes.

252-1407-00L Algorithmic Game Theory W 7 credits 3V+2U+1A P. Widmayer

Abstract
The Internet is a typical example of a large-scale distributed computer system without central control, with users that are typically only interested in their own good. For instance, they are interested in getting high bandwidth for themselves, but don't care about others, and the same is true for computational load or download rates. Game theory provides a particularly well-suited model for the behaviour and interaction of such selfish users and programs. Classical game theory dates back to the 1950s and typically does not consider algorithmic aspects at all. Only a few years back, algorithms and game theory have been considered together, in an attempt to reconcile selfish behavior of independent agents with the common good.

This course discusses algorithmic aspects of game-theoretic models, with a focus on recent algorithmic and mathematical developments. Rather than giving an overview of such developments, the course aims to study selected important topics in depth.

Outline:
- Introduction to classical game theoretic concepts.
- Existence of stable solutions (equilibria), algorithms for computing equilibria, computational complexity.
- The cost difference between an optimum under central control and an equilibrium under selfish agents, known as the "price of anarchy".
- Auction-like mechanisms and algorithms that "direct" the actions of selfish agents into a certain desired equilibrium situation.
- Selected current research topics of Algorithmic Game Theory, such as Web-Search Based Keyword Auctions, or Information Cascading in Social Networks

Lecture notes
No lecture notes.
In this seminar, recent papers of the pattern recognition and machine learning literature are presented and discussed. Possible topics cover...

The goal of the course is that students should understand the principles of user-centred design and be able to apply these in practice.

A. Krause

The seminar "Advanced Topics in Machine Learning" familiarizes students with recent developments in pattern recognition and machine learning. Material from the books "Probabilistic Artificial Intelligence" by D. Poole and A. Mackworth, M. Jordan and S. Russell, and "Machine Learning" by T. Mitchell, as well as recent research papers are selected covering topics such as modeling, rendering, animation, real-time graphics, physical simulation, and computational photography. Each time the course is offered, a collection of research papers is selected and each student presents one paper to the class and leads a discussion about the paper and related topics.

263-5210-00L

Probabilistic Artificial Intelligence

W

4 credits

2V+1U

A. Krause

Abstract

This course introduces core modeling techniques and algorithms from statistics, optimization, planning, and control and study applications in areas such as sensor networks, robotics, and the Internet.

Objective

How can we build systems that perform well in uncertain environments and unforeseen situations? How can we develop systems that exhibit "intelligent" behavior, without prescribing explicit rules? How can we build systems that learn from experience in order to improve their performance? We will study core modeling techniques and algorithms from statistics, optimization, planning, and control and study applications in areas such as sensor networks, robotics, and the Internet. The course is designed for upper-level undergraduate and graduate students.

Content

Topics covered:
- Search (BFS, DFS, A*), constraint satisfaction and optimization
- Tutorial in logic (propositional, first-order)
- Probability
- Bayesian Networks (models, exact and approximative inference, learning) - Temporal models (Hidden Markov Models, Dynamic Bayesian Networks)
- Probabilistic planning (MDPs, POMDPs)
- Reinforcement learning
- Combining logic and probability

Prerequisites

Solid basic knowledge in statistics, algorithms and programming

263-2600-00L

Robotics Programming Laboratory

W

8 credits

7P

B. Meyer, J. W. Shin

Number of participants limited to 18.

The course is open to students of computer science, electrical engineering, and mechanical engineering background (although students from other departments will be considered).

In the Master Programme max. 10 credits can be accounted by Labs on top of the Interfocus Courses. Additional Labs will be listed on the Addendum.
Abstract
This course is a hands-on laboratory course in which participants program Thymio II robot that will play in a competition. Students will learn software engineering skills and robotics concepts and apply them in practice.

Objective
- Knowledge of basic software engineering principles and methods
- Knowledge of how software engineering applies to robotics
- Knowledge of the most common architectures, coordination and synchronization methods
- Experience in design of a small robotics system with aspects of sensing, planning and control

Content
- Software engineering tools
- Design patterns
- Software architecture
- ROS and Roboscoop
- Perception
- Mapping and localization
- Path planning and obstacle avoidance

Prerequisites / notice
Students will program Thymio II educational robot with a Carmine 1.09 RGBD camera as the sensor. Combination of lectures and a semester-long project.

263-5902-00L Computer Vision W 6 credits 3V+1U+1A M. Pollefeys, L. Van Gool
Abstract
The goal of this course is to provide students with a good understanding of computer vision and image analysis techniques. The main concepts and techniques will be studied in depth and practical algorithms and approaches will be discussed and explored through the exercises.

Objective
The objectives of this course are:
1. To introduce the fundamental problems of computer vision.
2. To introduce the main concepts and techniques used to solve those.
3. To enable participants to implement solutions for reasonably complex problems.
4. To enable participants to make sense of the computer vision literature.

Content
Camera models and calibration, invariant features, Multiple-view geometry, Model fitting, Stereo Matching, Segmentation, 2D Shape matching, Shape from Silhouettes, Optical flow, Structure from motion, Tracking, Object recognition, Object category recognition

263-1279-00L Virtual Reality in Medicine ■ W 3 credits 2V R. Riener, M. Harders
Abstract
Virtual Reality has the potential to support medical training and therapy. This lecture will derive the technical principles of multi-modal (audiovisual, haptic, tactile etc.) input devices, displays and rendering techniques. Examples are presented in the fields of surgical training, intra-operative augmentation, and rehabilitation. The lecture is accompanied by practical courses and excursions.

Objective
Provide theoretical and practical knowledge of new principles and applications of multi-modal simulation and interface technologies in medical education, therapy, and rehabilitation.

Content
Virtual Reality has the potential to provide descriptive and practical information for medical training and therapy while relieving the patient and/or the physician. Multi-modal interactions between the user and the virtual environment facilitate the generation of high-fidelity sensory impressions, by using not only visual and auditory modalities, but also kinesthetic, tactile, and even olfactory feedback. On the basis of the existing physiological constraints, this lecture will derive the technical requirements and principles of multi-modal input devices, displays, and rendering techniques. Several examples are presented that are currently being developed or already applied for surgical training, intra-operative augmentation, and rehabilitation. The lecture will be accompanied by several practical courses on graphical and haptic display devices as well as excursions to facilities equipped with large-scale VR equipment.

Target Group:
Students of other departments, faculties, courses are also welcome!

Prerequisites / notice
It is recommended that students have taken the Virtual Computing lecture or a similar course introducing basic image processing concepts before taking this course.

376-1504-00L Physical Human Robot Interaction (pHRI) ■ W 4 credits 2V+2U R. Gassert, O. Lambercy, R. Riener
Abstract
This course focuses on the emerging, interdisciplinary field of physical human-robot interaction, bringing together themes from robotics, real-time control, human factors, haptics, virtual environments, interaction design and other fields to enable the development of human-oriented robotic systems.

Objective
The objective of this course is to give an introduction to the fundamentals of physical human robot interaction, through lectures on the underlying theoretical/mechatronics aspects and application fields, in combination with a hands-on lab tutorial. The course will guide students through the design and evaluation process of such systems.

By the end of this course, you should understand the critical elements in human-robot interactions - both in terms of engineering and human factors - and use these to evaluate and de- sign safe and efficient assistive and rehabilitative robotic systems. Specifically, you should be able to:
1) identify critical human factors in physical human-robot interaction and use these to derive design requirements;
2) compare and select mechatronic components that optimally fulfill the defined design requirements;
3) derive a model of the device dynamics to guide and optimize the selection and integration of selected components into a functional system;
4) design control hardware and software and implement and test human-interactive control strategies on the physical setup;
5) characterize and optimize such systems using both engineering and psychophysical evaluation metrics;
6) investigate and optimize one aspect of the physical setup and convey and defend the gained insights in a technical presentation.
This course provides an introduction to fundamental aspects of physical human-robot interaction. After an overview of human haptic, visual and auditory sensing, neurophysiology and psychophysics, principles of human-robot interaction systems (kinematics, mechanical transmissions, robot sensors and actuators used in these systems) will be introduced. Throughout the course, students will gain knowledge of interaction control strategies including impedance/admittance and force control, haptic rendering basics and issues in device design for humans such as transparency, safety and stability analysis, safety hardware and probability. The course is organized into lectures that aim to bring students up to speed with the basics of these systems, readings on classical and current topics in physical human-robot interaction, laboratory sessions and lab visits.

Students will attend periodic laboratory sessions where they will implement the theoretical aspects learned during the lectures. Here the salient features of haptic device design and theoretical aspects will be identified and theoretical and experimental aspects are organized into labs that aim to bring students up to speed with the basics of these systems, readings on classical and current topics in physical human-robot interaction, laboratory sessions and lab visits.

Lecture notes
Will be distributed through the document repository before the lectures.
http://www.relab.ethz.ch/education/courses/phri.html

Literature


### Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-MAVT.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UVZH

### Semester Project

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>151-1014-00L</td>
<td>Semester Project Robotics, Systems and Control Only for Robotics, Systems and Control MSc.</td>
<td>O</td>
<td>8 credits</td>
<td>17A</td>
<td>Professors</td>
</tr>
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</table>

**Abstract**

The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

**Objective**

The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program.

### Internship

<table>
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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1015-00L</td>
<td>Industrial Internship Robotics, Systems and Control</td>
<td>O</td>
<td>8 credits</td>
<td>external organisers</td>
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</table>

**Abstract**

The main objective of the 12-week internship is to expose master's students to the work environment in an engineering company or in a research lab outside of the ETH domain. During this period, students have the opportunity to be involved in on-going projects at the host institution.

**Objective**

The main objective of the 12-week internship is to expose master's students to the work environment in an engineering company or in a research lab outside of the ETH domain.

### Master Thesis

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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1016-00L</td>
<td>Master's Thesis Robotics, Systems and Control Only students who fulfill the following criteria are allowed to begin with their Master Thesis: a. Successful completion of the Bachelor programme b. Any additional requirements for admission to the degree programme have been fulfilled c. Only two courses can be pending in the category “Core Courses” c. Successful completion of the Semester Project (the corresponding credits have been acquired)</td>
<td>O</td>
<td>30 credits</td>
<td>64D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

**Abstract**

Master's programs are concluded by the master's thesis. The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem. The subject of the master's thesis, as well as the project plan and roadmap, are proposed by the tutor and further elaborated with the student.

**Objective**

The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem.

### Key for Type

<table>
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<tr>
<th>Code</th>
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<th>Description</th>
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<tbody>
<tr>
<td>O</td>
<td>Compulsory</td>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
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<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
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### Key for Hours

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<th>Description</th>
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<tr>
<td>V</td>
<td>lecture</td>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
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<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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**ECTS**

European Credit Transfer and Accumulation System

- Special students and auditors need special permission from the lecturers.
## Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>860-0003-00L</td>
<td>Cornerstone Science, Technology, and Policy (Only for Science, Technology, and Policy MSc.)</td>
<td>O</td>
<td>2</td>
<td>3S</td>
<td>T. Bernauer, R. S. Abhari</td>
</tr>
</tbody>
</table>

### Abstract
This course introduces students to the MSc program in two ways. First, it provides a general introduction to the study of STP. Second, it exposes students to a variety of complex policy problems and ways and means of coming up with proposals for and assessments of policy options.

### Objective
This course introduces students to the MSc program in two ways. First, it provides a general introduction to the study of STP. Second, it exposes students to a variety of complex policy problems and ways and means of coming up with proposals for and assessments of policy options.

- Day 1: Introduction to the MSc program, getting to know each other, social event
- Day 2: Introduction to the study of Science, Technology and Policy
- Day 3: Knowledge assessment in areas marked by controversy over scientific issues
- Day 4: Challenges of urban development
- Day 5: How to achieve an energy transition?
- Day 6: Mitigating and adapting to climate change
- Day 7: Managing international water resources
- Day 8: Implications of digital society

### Content
Day 1: Introduction to the MSc program, getting to know each other, social event
Day 2: Introduction to the study of Science, Technology and Policy
Day 3: Knowledge assessment in areas marked by controversy over scientific issues
Day 4: Challenges of urban development
Day 5: How to achieve an energy transition?
Day 6: Mitigating and adapting to climate change
Day 7: Managing international water resources
Day 8: Implications of digital society

### Prerequisites / notice
Reserved for the ISTP's Master students

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>860-0001-00L</td>
<td>Public Institutions and Policy-Making Processes (Priority for ISTP MSc students.)</td>
<td>O</td>
<td>6</td>
<td>3G</td>
<td>T. Bernauer, S. Bechtold, F. Schimmelfennig</td>
</tr>
</tbody>
</table>

### Abstract
Students acquire the contextual knowledge for analyzing public policies. They learn why and how public policies and laws are developed, designed, and implemented at national and international levels.

### Objective
Public policies result from decision-making processes that take place within formal institutions of the state (parliament, government, public administration, courts). That is, policies are shaped by the characteristics of decision-making processes and the characteristics of public institutions and related actors (e.g. interest groups). In this course, students acquire the contextual knowledge for analyzing public policies.

- They learn why and how public policies and laws are developed, designed, and implemented at national and international levels.
- The course is organized in three modules. The first module (Stefan Bechtold) examines basic concepts and the role of law, law-making, and law enforcement in modern societies. The second module (Thomas Bernauer) deals with the functioning of legislatures, governments, and interest groups. The third module (Frank Schimmelfennig) focuses on the European Union and international organisations.

### Content
Schedule:
- Day 1: Introduction
- Day 2: Introduction to the study of STP
- Day 3: Knowledge assessment in areas marked by controversy over scientific issues
- Day 4: Challenges of urban development
- Day 5: How to achieve an energy transition?
- Day 6: Mitigating and adapting to climate change
- Day 7: Managing international water resources
- Day 8: Implications of digital society

### Prerequisites / notice
This is a Master level course. The course is capped at 25 students, with ISTP Master students having priority.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

### Abstract
The lectures will introduce students to the principles of quantitative policy analysis, namely the methods to predict and evaluate the social, economic, and environmental effects of alternative strategies to achieve policy objectives. A series of graded assignments will give students an opportunity for students to apply those methods to a set of case studies.

### Objective
The objectives of this course are to develop the following key skills necessary for policy analysts:
- Identifying the critical quantitative factors that are of importance to policy makers in a range of decision-making situations.
- Developing conceptual models of the types of processes and relationships governing these quantitative factors, including stock-flow dynamics, feedback loops, optimization, sources and effects of uncertainty, and agent coordination problems.
- Develop and program numerical models to simulate the processes and relationships, in order to identify policy problems and the effects of policy interventions.
- Communicate the findings from these simulations and associated analysis in a manner that makes transparent their theoretical foundation, the level and sources of uncertainty, and ultimately their applicability to the policy problem.

The course will proceed through a series of policy analysis and modeling exercises, involving real-world or hypothetical problems. The specific examples around which work will be done will concern the environment, energy, health, and natural hazards management.
This course picks up on the cornerstone course and goes into greater depth on issues covered in that course, as well as additional issues where science and technology are among the causes of societal challenges but can also help in finding solutions.

### Week 1: (no class because of ISTP cornerstone course)
- Urban development
- Energy transitions
- Climate change

### Week 2: Urban development

### Week 3: Urban development

### Week 4: Energy transitions

### Week 5: Energy transitions

### Week 6: Climate change

### Week 7: Climate change

### Week 8: International water management

### Week 9: International water management

### Week 10: Digital society

### Week 11: Digital society

### Week 12: Genetic engineering and synthetic biology

### Week 13: Minerals

### Week 14: End of semester exam

#### Course Details
- **ECTS Credits:** 6
- **Prerequisites:** Solid mathematical skills.
- **Lecturers:** D. Helbing, L. Sanders
- **Software:** Students are free to choose R, SPSS or any other statistical software for solving the assignments.
- **Assignments:** Students are free to choose R, SPSS or any other statistical software for assignments.
- **Final Grade:** A weighted average of the two groups of assignments.
- **Number of Participants:** Limited to 20.

#### Objective
- Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. Students will solve problems on the interface of policy, technology, and society. Solving assignments contributes to the final grade with a weight of one fourth. Students are assisted in solving the assignments during the exercises session. Support is provided for the analysis software Stata, but students are free to choose R, SPSS or any other statistical software to solve the assignments.

#### Content
- Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. Students will solve problems on the interface of policy, technology, and society. Solving assignments contributes to the final grade with a weight of one fourth. Students are assisted in solving the assignments during the exercises session. Support is provided for the analysis software Stata, but students are free to choose R, SPSS or any other statistical software to solve the assignments.

#### Literature

#### Electives

### Complexity and Global Systems Science
- **Prerequisites:** Solid mathematical skills.
- **Type:** W
- **ECTS Credits:** 3
- **Hours:** 2V
- **Lecturers:** D. Helbing, L. Sanders
- **Abstract:** This course discusses complex techno-socio-economic systems, their counter-intuitive behaviors, and how theoretical understanding empowers us to solve some long-standing problems that are currently bothering the world.
- **Objective:** Participants should learn to get an overview of the state of the art in the field, to present it in a well-understandable way to an interdisciplinary scientific audience, to develop models for open problems, to analyze them, and to defend their results in response to critical questions. In essence, participants should improve their scientific skills and learn to think scientifically about complex dynamical systems.
- **Content:** This course starts with a discussion of the typical and often counter-intuitive features of complex dynamical systems such as self-organization, emergence, (sudden) phase transitions at "tipping points", multi-stability, systemic instability, determinism, chaos, and turbulence. It then discusses phenomena in networked systems such as feedback, side and cascade effects, and the problem of radical uncertainty. The course progresses by demonstrating the relevance of these properties for understanding societal and, at times, global-scale problems such as traffic jams, crowds disasters, breakdowns of cooperation, crime, conflict, social unrests, political revolutions, bubbles and crashes in financial markets, epidemic spreading, and/or "tragedies of the commons" such as environmental exploitation, overfishing, or climate change. Based on this understanding, the course points to possible ways of mitigating techno-socio-economic-environmental problems, and what data science may contribute to their solution.

### Modelling and Simulating Social Systems with MATLAB (with Coding Project)
- **Prerequisites:** Math, science, technology, and policy.
- **Type:** W
- **ECTS Credits:** 6
- **Hours:** 2S+2A
- **Lecturers:** D. Helbing, O. Woolley, S. Ballelli, L. Sanders
- **Abstract:** This course picks up on the cornerstone course and goes into greater depth on issues covered in that course, as well as additional issues where science and technology are among the causes of societal challenges but can also help in finding solutions.
- **Objective:** Students will apply the methods from the lectures by solving weekly assignments using statistical software and data sets provided by the instructors. Students will solve problems on the interface of policy, technology, and society. Solving assignments contributes to the final grade with a weight of one fourth. Students are assisted in solving the assignments during the exercises session. Support is provided for the analysis software Stata, but students are free to choose R, SPSS or any other statistical software to solve the assignments.
- **Content:** This course discusses complex techno-socio-economic systems, their counter-intuitive behaviors, and how theoretical understanding empowers us to solve some long-standing problems that are currently bothering the world.
- **Objective:** Participants should learn to get an overview of the state of the art in the field, to present it in a well-understandable way to an interdisciplinary scientific audience, to develop models for open problems, to analyze them, and to defend their results in response to critical questions. In essence, participants should improve their scientific skills and learn to think scientifically about complex dynamical systems.
- **Content:** This course starts with a discussion of the typical and often counter-intuitive features of complex dynamical systems such as self-organization, emergence, (sudden) phase transitions at "tipping points", multi-stability, systemic instability, determinism, chaos, and turbulence. It then discusses phenomena in networked systems such as feedback, side and cascade effects, and the problem of radical uncertainty. The course progresses by demonstrating the relevance of these properties for understanding societal and, at times, global-scale problems such as traffic jams, crowds disasters, breakdowns of cooperation, crime, conflict, social unrests, political revolutions, bubbles and crashes in financial markets, epidemic spreading, and/or "tragedies of the commons" such as environmental exploitation, overfishing, or climate change. Based on this understanding, the course points to possible ways of mitigating techno-socio-economic-environmental problems, and what data science may contribute to their solution.
This course introduces the mathematical software package MATLAB. Students should learn to implement models of various social processes and systems, and document their skills by a seminar thesis, a short oral presentation as well as a coding project.

Objective

The students should learn how to use MATLAB as a tool to solve various scientific problems. MATLAB is an integrated environment with a high level programming language which makes it possible to quickly find numerical solutions to a wide range of scientific problems. Furthermore, it includes a rich set of tools for graphically presenting the results.

After the students have learned the basic structure of the programming language, they should be able to implement social simulation models in MATLAB and document their skills by a seminar thesis, a coding project and finally give a short oral presentation.

351-0778-01L Discovering Management (Exercises) W Dr 1 credit 1U P. Frauenfelder

Abstract

This course is offered complementary to the basis course 351-0778-00L, “Discovering Management”. The course offers additional exercises and case studies.

Objective

This course is offered to complement the course 351-0778-00L. The course offers additional exercises and case studies.

Content

The course offers additional exercises and case studies concerning:

- Strategic Management;
- Technology and Innovation Management;
- Operations and Supply Chain Management;
- Finance and Accounting;
- Marketing and Sales.

Please refer to the course website for further information on the content, credits and schedule of the module: www.dm.ethz.ch


Abstract

Discovering Management offers an introduction to the field of business management and entrepreneurship for engineers and natural scientists. The module provides an overview of the principles of management, teaches knowledge about management that is highly complementary to the students' technical knowledge, and provides a basis for advancing the knowledge of the various subjects offered at D-MTEC.

Objective

Discovering Management offers an integrated learning system, which combines in an innovate format a set of lectures, an advanced business game simulation and a set of group exercises involving industry speakers (ranging from leading venture capitalists to executives at established corporations). Unlike more traditional courses, the learning model for Discovering Management involves 'learning by doing'. While the 13 different lectures, in-class discussions and assigned readings provide the theoretical and conceptual foundations, the experiential learning outcomes result from the interrelated group activities: 1) the interactive case studies and exercises, 2) the business game simulation.

Content

The lectures for Discovering Management are designed to broaden the participant's understanding of factors driving company success, where success is understood as a broad construct including financial return, employee, customer and supplier satisfaction as well as social and ecological responsibility.

Discovering Management is designed to suit the needs and expectations of Bachelor students at all levels as well as Master and PhD students not belonging to D-MTEC. By providing an overview of Entrepreneurial Management, this course is an ideal enrichment of the standard curriculum at ETH Zurich. No prior knowledge of business or economics is required to successfully complete this course.

Prerequisites / notice

Discovering Management is designed to suit the needs and expectations of Bachelor students at all levels as well as Master and PhD students not belonging to D-MTEC. By providing an overview of Business Management, this course is an ideal enrichment of the standard curriculum at ETH Zurich. No prior knowledge of business or economics is required to successfully complete this course.

<table>
<thead>
<tr>
<th>Science, Technology, and Policy Master - Key for Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>O Compulsory E- Recommended, not eligible for credits</td>
</tr>
<tr>
<td>W+ Eligible for credits and recommended Z Courses outside the curriculum</td>
</tr>
<tr>
<td>W Eligible for credits Dr Suitable for doctorate</td>
</tr>
</tbody>
</table>

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 1260 of 1434
<table>
<thead>
<tr>
<th>Key for Hours</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

**ECTS**
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
**Educational Science**

Course offerings in the category Educational Science are listed under "Programme: Educational Science for Teaching Diploma and TC".

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0240-15L</td>
<td>Designing Educational Environments in Physical Education (EW2 Sport)</td>
<td>O</td>
<td>4 credits</td>
<td>2S</td>
<td>H. Gubelmann, R. Scharpf</td>
</tr>
<tr>
<td></td>
<td>Abstract: Students learn principles of teaching beyond classroom and regular PE-Lessons: - Planning and organizing camps and events - Teaching the &quot;Ergänzungsfach Sport&quot; - Long-term-curricula in PE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Objective: Students know - How to plan events and camps - To assess curricula critically and to use them properly - How to combine theoretical and practical issues in the 'Ergänzungsfach'</td>
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</tr>
<tr>
<td></td>
<td>Prerequisites / notice: EW2 is compulsory requirement for EW4 Sport</td>
<td></td>
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</tr>
<tr>
<td>851-0240-00L</td>
<td>Human Learning (EW1)</td>
<td>O</td>
<td>2 credits</td>
<td>2G</td>
<td>E. Stern</td>
</tr>
<tr>
<td></td>
<td>Abstract: This course looks into scientific theories and also empirical studies on human learning and relates them to the school.</td>
<td></td>
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<tr>
<td></td>
<td>Objective: Anyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.</td>
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<tr>
<td></td>
<td>Content: Thematische Schwerpunkte: - Lernen als Verhaltensänderung und als Informationsverarbeitung: Das menschliche Gedächtnis unter besonderer Berücksichtigung der Verarbeitung symbolischer Information; Lernen als Wissenskonstruktion und Kompetenzverwerbung unter besonderer Berücksichtigung des Wissenstransfers; Lernen durch Instruktion und Erklärungen: Die Rolle von Emotion und Motivation beim Lernen; Interindividuelle Unterschiede in der Lernfähigkeit und ihre Ursachen: Intelligenztheorien, Geschlechtsunterschiede bei Lernen</td>
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<tr>
<td></td>
<td>Notice: This lecture is only apt for students who intend to enrol in the programs &quot;Teaching Diploma&quot; or &quot;Teaching Certificate&quot;. It is about learning in childhood and adolescence.</td>
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<tr>
<td></td>
<td>Lecture notes: Folien werden zur Verfügung gestellt.</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Prerequisites / notice: ERW2-15L</td>
<td>1 credit</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler</td>
<td></td>
</tr>
</tbody>
</table>

**Subject Didactics in Sport**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-0203-00L</td>
<td>Mentored Work Subject Didactics Sport A</td>
<td>O</td>
<td>2 credits</td>
<td>4A</td>
<td>O. Graf</td>
</tr>
<tr>
<td></td>
<td>Simultaneous enrolment in Mentored Work Subject Didactics Sport A and B is compulsory</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

**Objective**

Planning and organization of a longer period of instruction in school.

**Content**

Connection of educational goals and instruction

**Lecture notes**

see moodle 00 - Lehrdiplom Sport

**Literature**


Hofmann Verlag Schorndorf 1997, 157-166

Hotz A., Qualitatives Bewegungslernen, Sportpädagogische Perspektiven einer kognitiv akzentuierten Bewegungslhre in Schlüsselbegriffen, Zumikon SVSS Verlag 1996;1998/2


Loosch E., Allgemeine Bewegungslhre, Limpert Verlag Wiesbaden 1999

Roth K. & K. Willemczik, Bewegungswissenschaft, Rowohlt Verlag Reinbek 1999

Röthig P. Sportwissenschaftliches Lexikon, Schorndorf Verlag 2003

Röthig P. & s. Grössing (Hrsg.) Bewegungslhre, Kursbuch 3, Wiesbaden 1990/3

**557-0204-00L**

Mentored Work Subject Didactics Sport B

*Simultaneous enrolment in Mentored Work Subject Didactics Sport A and B is compulsory.*

**Abstract**

In their mentored work on subject didactics, students put into practice the contents of the subject-didactics lectures and go into these in greater depth. Under supervision, they compile tuition materials that are conducive to learning and/or analyse and reflect on certain topics from a subject-based and pedagogical angle.

**Objective**

Planning and organization of a longer period of instruction in school.

**Content**

Connection of educational goals and instruction.

**Lecture notes**

see moodle 00 - Lehrdiplom Sport

**Literature**


Hofmann Verlag Schorndorf 1997, 157-166

Hotz A., Qualitatives Bewegungslernen, Sportpädagogische Perspektiven einer kognitiv akzentuierten Bewegungslhre in Schlüsselbegriffen, Zumikon SVSS Verlag 1996;1998/2


Loosch E., Allgemeine Bewegungslhre, Limpert Verlag Wiesbaden 1999

Roth K. & K. Willemczik, Bewegungswissenschaft, Rowohlt Verlag Reinbek 1999

Röthig P. Sportwissenschaftliches Lexikon, Schorndorf Verlag 2003

Röthig P. & s. Grössing (Hrsg.) Bewegungslhre, Kursbuch 3, Wiesbaden 1990/3

**557-0315-00L**

Sport Didactics I

*Simultaneous enrolment in Introductory Internship Sport - course 557-0210-00L - is compulsory.*

**Abstract**

Practical implementation in sports of general didactics, with the planning, implementation and evaluation of topics from all the sports-specific areas of tuition in secondary school Level II.

**Objective**

The students:

- Implement the objectives of general didactics in respect of the different types of sport at school.
- Master the planning, implementation and evaluation of topics from all the sports-specific areas of tuition.
- Gain an overview of the preparation necessary for the different requirements placed on a sports teacher at secondary school Level II.
- Try out different teaching structures, such as the lesson, teaching unit, block periods and extra units in sport in addition to those on the timetable.

**Content**

Implementation of practical sport into general teacher training with planning, execution and evaluation of the topics from all sport-specific areas of the education at this level in Section II.

**Lecture notes**

Skript unter: https://moodle-app2.let.ethz.ch/course/view.php?id=117

**Literature**

Lehrmittel Sporterziehung, ESK 1997/98.

**Prerequisites / notice**

Lehrdiplom-Studierende müssen die Fachdidaktik Sport I zusammen mit dem Einführungspraktikum Sport - LE 557-0210-00 - belegen.

**Professional Training in Sport**

*Important: You can only enrol in the courses of this category if you have not more than 12 CP left for possible additional requirements.*

**Professional Training (First Subject)**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-0210-00L</td>
<td>Introductory Internship Sport I</td>
<td>O</td>
<td>3</td>
<td>6P</td>
<td>O. Graf, R. Scharpf</td>
</tr>
</tbody>
</table>

*Simultaneous enrolment in Sport Didactics I - course 557-0315-00L - is compulsory.*

**Abstract**

During the introductory teaching practice, the students sit in on five lessons given by the teacher responsible for their teaching practice, and teach five lessons themselves. The students are given observation and reflection assignments by the teacher responsible for their teaching practice.

**Objective**

Right at the start of their training, students acquire initial experience with the observation of teaching, the establishment of concepts for teaching and the implementation of teaching. This early confrontation with the complexity of everything that teaching involves helps students decide whether they wish to and, indeed, ought to, continue with the training. It forms a basis for the subsequent pedagogical and subject-didactics training.

**Content**

Students observe and teach 5 lessons, supervised by experienced teachers.
O. Graf - Expanding the professional fields of sports tuition.
R. Scharpf see moodle 00 - Lehrdiplom Sport
Expanding sports competence in the context of out-of-school projects. Students apply their theoretical background in practice. By teaching sports lessons they improve their teaching skills and classroom management.
R. Scharpf
4G
This is a supplement to the Teaching Internship required to obtain a Teaching Diploma in Sports. It is aimed at enlarging the already acquired teaching experience. Students observe 10 lessons and teach 15 lessons independently.

Teaching Internship Sport II  ▶  W  4 credits  9P  R. Scharpf
Only for Sport Teaching Diploma students.

Abstract
This is a supplement to the Teaching Internship required to obtain a Teaching Diploma in Sports. It is aimed at enlarging the already acquired teaching experience. Students observe 10 lessons and teach 15 lessons independently.

Objective
Practice in sports teaching into special didactics with planning, execution and evaluation of the topics from all sport-specific areas of the education at this level in Section II.

Content
Teaching and observation of 50 Sports lessons, supervised by experienced teachers.

Lecture notes
Skript unter: https://moodle-app2.let.ethz.ch/course/view.php?id=117>

Literature
Disler P., Didawan-Methodische Modelle in der Ausbildung, Dissertation in 2004, 152
Loosch E., Allgemeine Bewegungslere, Limpert Verlag Wiesbaden 1999
Roth K. & K. Willecmzik, Bewegungswissenschaft, Rowohlt Verlag Reinbek 1999
Röthig P. Sportwissenschaftliches Lexikon, Schorndorf Verlag 2003
Röthig P. & s. Groossing (Hrsg.) Bewegungslere, Kursbuch 3, Wiesbaden 1990/3

Prerequisites / notice
Voraussetzung für das Unterrichtspraktikum ist ein abgeschlossenes Einführungspraktikum und die Fachdidaktik I.

Professional Exercises  ▶  O  2 credits  4G  R. Scharpf
Only for Sport Teaching Diploma students.

Abstract
- Expanding the professional fields of sports tuition.
- Application of special forms of teaching and learning in sports tuition.
- Project work in leisure-time sport and tourism.
- Application of the didactic handling skills and core competences.

Objective
Expanding sports competence in the context of out-of-school projects. Opening up new areas of activity in sport.

Data: 06.02.2019 13:00
Autumn Semester 2015
Page 1264 of 1434
Die Studierenden erfähren das Lektionsthema in der Regel eine Woche vor dem Prüfungstermin. Von der zuständigen Lehrperson erhalten sie Informationen über den Wissensstand der zu unterrichtenden Klasse und können sie vor dem Prüfungstermin besuchen.

Sie wissen um die Genderproblematik und begegnen ihr v.a. im koedukativen aber auch im seedukativen Sportunterricht mit geeigneten Maßnahmen.


Die Stundenscheibe schlägt um 6 Uhr. Die Studierenden verlassen die Klasse. Sie beenden den Unterrichtsalphabetisch. 

Professionale Training (Two Subjects in One-Step Procedure)

The programme "Teaching Diploma, Two Subjects in One-Step Procedure" will not be offered anymore since Autumn Semester 2010. Therefore new matriculations are no longer possible. The courses offered below are valid only for students who have registered before.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-0212-00L</td>
<td>Teaching Internship Sport</td>
<td>O</td>
<td>6</td>
<td></td>
<td>O. Graf</td>
</tr>
</tbody>
</table>

The hours for this course include lectures, seminars, and practical work, as well as an examination. Students must achieve a minimum passing grade.

The programme is designed for students who wish to combine two subjects in one step, allowing a more focused and comprehensive approach to their education.

Students must fulfill all requirements, including regular attendance, participation in all activities, and successful completion of examinations. Failure to meet these requirements may result in the disqualification from the programme.

Students interested in this programme are encouraged to contact the programme coordinator for further information and guidance.
Ein Skript für die aktuelle Veranstaltung wird abgegeben.

Comprehension for development and changes of sports from the ancient world to the presence. Description of sports in services of national

Students will improve their teaching skills and knowledge by instructing and observing sports lessons

compulsory part of the Teaching Diploma in Sports. Application of scientific knowledge to analyse and improve instructional and teaching skills.

Lecture notes

see moodle 00 - Lehrdipлом Sport

see moodle-app2.let.ethz.ch/auth/shibboleth/login.php

Voraussetzung für das Unterrichtspraktikum ist ein abgeschlossenes Einführungspraktikum und die Fachdidaktik I.

[

557-0207-00L Teaching Internship Including Examination Lessons W 4 credits 9P O. Graf

Sport Teaching Internship Sport ONLY for Teaching Diploma in 2 Subjects in One-Step Procedure and Sport as Second Subject.

- Repetition of the Teaching Internship is excluded even if Examination Lessons are to be repeated.

Abstract

Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as assessed as Examination Lessons.

Objective

- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils' work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Content


Die Themen für die beiden Prüfungseinstellung am Schluss des Praktikums erfahren die Studierenden in der Regel eine Woche vor dem Prüfungstermin. Sie erstellen eine Vorbereitung gemäß Anleitung und reichen sie bis am Vortrag um 12 Uhr den beiden Prüfungsexperten (Fachdidaktiker/-in, Departementsvertreter/-in) ein. Die gehaltenen Lektionen werden kriteriumsbasiert beurteilt. Die Beurteilung umfasst auch die schriftliche Vorbereitung und eine mündliche Reflexion des Kandidaten/der Kandidatin über die gehaltenen Lektionen im Rahmen eines kurzen Kolloquiums.

Lecture notes

see moodle 00 - Lehrdipлом Sport

https://moodle-app2.let.ethz.ch/auth/shibboleth/login.php


Hofmann Verlag Schorndorf 1997,157-166

Loosch E., Allgemeine Bewegungsllehre, Limpert Verlag Wiesbaden 1999

Roth K. & K. Willemczik, Bewegungswissenschaft, Rowohlt Verlag Reinbek 1999

Röthig P. Sportwissenschaftliches Lexikon, Schorndorf Verlag 2003

Röthig P. & s. Grössing (Hrsg.) Bewegungslehre, Kursbuch 3, Wiesbaden 1990/3


Literature


Teaching Diploma in 2 Subjects in One-Step Procedure: no courses from this category have to be completed.

Specialized Courses in Respective Subject with Educational Focus I

At least 6 CP's must be obtained in this category.

No number

Title History of Sports

Comprehension for development and changes of sports from the ancient world to the present. Description of sports in services of national idea, from education and health promotion from the middle of the 18th century till this day.

Understanding for the development and adaptation of sports from the ancient world to present times.

Ein Skript für die aktuelle Veranstaltung wird abgegeben.


Data: 06.02.2019 13:00 Autumn Semester 2015 Page 1266 of 1434
Sport Psychology

This lecture is intended as an introduction to sport psychology and impart knowledge on selected areas of the subject.

Students are given insight into different work areas of sport psychology. In order to understand what «sport psychology» is, it is necessary to explain the essence and tasks of sport psychology and what it relates to, and to work out an underlying basis for key topics, such as cognition and emotions. Students’ expertise is furthered by presenting and providing more in-depth treatment of additional topics of sport psychology. Selected intervention forms are intended to provide insight into applied sport psychology and ensure that mental processes and their impact in sport can be recognised. Case studies and practical exercises (e.g. objective training) are intended to prompt students to reflect to a greater extent on the forms in which sport psychology can be applied in their practice of sports and to integrate these in their teaching.

Content
Main Topics
- Introduction to sport psychology
- Cognitions in sports: mental rehearsal and mental training
- Emotions and stress
- Motivation: goal-setting in sports
- Career and career transition in elite sport
- Coach-Athlete-Interaction
- Psychological aspects of sport-injury rehabilitation
- Group dynamics in sport

Sociology of Sport

These lectures deal with the current changes in society and sport and provide an overview of the many different problems and perspectives of sport sociology.

Objective
The lectures set out to:
- present the different dimensions, functions and interrelationships of present-day sport
- provide an introduction to the central theories and models of (sport) sociology
- show how far sport reflects society and how it changes and becomes more differentiated in the process
- take current examples from newspapers, magazines and television to highlight the sociological view of sport.

Content
Sport and social change: developments and trends
The economy and the media: dependencies, consequences, scandals
Social inequalities and distinctions: gender differences and group behavior
Conflicts and politics: sports organizations, doping, violence

Pedagogical application of research projects for schools

Introduction of sports pedagogical oriented research projects. Competency to a youth friendly movement and sports education. Competent ‘pedagogical application’ of research projects in the field of movement and sport. Feed in of scientific findings to school lesson settings.

Objective
The students combine and apply general educational aims with a general and specific background of research projects.

Content
- Group dynamics in sport
- Psychological aspects of sport-injury rehabilitation
- Group dynamics in sport

Literature


A detailed program with additional references will be delivered at the beginning of the lecture.

Mentored Work Specialised Courses in the Respective Subject with an Educational Focus Sport A

Only for Sport Teaching Diploma students.

Mentored Work Specialised Courses in the Respective Subject with an Educational Focus in Sport for Teaching Diploma.

Abstract
Pedagogical application of research projects for schools
Introduction of sports pedagogical oriented research projects. Competency to a youth friendly movement and sports education. Competent ‘pedagogical application’ of research projects in the field of movement and sport. Feed in of scientific findings to school lesson settings.

Objective
The students combine and apply general educational aims with a general and specific background of research projects.

They know different educational concepts of the above mentioned, recognise its strengths and weaknesses and are able to apply concepts appropriate to the situation.

They approach the research interest of their pupils with the knowledge of sports psychology, sports sociology, sports pedagogy, and sports history.

Content
Die Studierenden wenden die Bewegungs- und Lernziele des Sportunterrichts aus den kantonalen Lehrplänen im Unterricht an und können diese begründen.

Sie interessieren sich für die Prozesse der Forschung Im Sport

Sie erlernen anhand von Projektarbeiten die didaktische Anwendung der Sportpsychologie, Sportsociologie, Sportpädagogik und Sportsprachliche Formen und dazu hierzu Konsequenz für den situativ-variabel orientierten Unterricht.

Sie setzen ihr Wissenswissen ein, um bei den Lernenden Denkprozessen anzustoßen und zu begleiten.

Lecture notes
Skript unter: https://moodle-app2.let.ethz.ch/course/view.php?id=117>

Literature
Lectureverweise erfolgen jeweils in den gewählten Fachbereichen.
Specialized Courses in Respective Subject with Educational Focus II

At least 6 CP's must be acquired in this category. Further courses must be chosen from the "Sport Practical: Major Education and Specialized Education".

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-0206-00L</td>
<td>Mentored Work Specialised Courses in the Respective Subject with an Educational Focus Sport B</td>
<td>O</td>
<td>2</td>
<td>4A</td>
<td>R. Scharpf</td>
</tr>
</tbody>
</table>

Abstract
- Refurbishment of research projects dealing with motor competencies in sport and professional scientific content related to this area.
- Competent "didactical implementation" of research content. The Fachwissenschaftliche Vertiefung II orientates itself to the guiding principles of cognitive, conditional and coordination aspects of movement.

Objective
- Connection of sport and human movement science and educational instruction.

Content
- scientific analysis of sports disciplines in order to improve instruction

Lecture notes
- Skript unter: https://moodle-app2.let.ethz.ch/course/view.php?id=117>

Prerequisites / notice
- Mentored paper in selected sports disciplines.

see Sport Teaching Diploma, Sport Practical: Major Education

Compulsory Elective Courses

At least 6 CP's must be acquired in this category. Further courses must be chosen from the "Sport Practical: Major Education and Specialized Education".

- the course 557-0215-00L "Professional Exercises" must be completed within the category Compulsory Elective Courses;
- courses from the category Compulsory Elective Courses of the Minor Subject may also be selected;
- courses from the category Specialized Courses in the Respective Subject, either of the Major or the Minor Subject, may also be selected.

see Sport Teaching Diploma, Sport Practical: Major Education

Sport Practical

The Teaching Diploma in Sport - or in Sport as major subject for a Teaching Diploma in a major and a minor subject - will only be granted to students holding a Master, Diploma or Licentiate degree in Sport. Additionally, a Sport Practical encompassing 56 CP's is required. The Sport Practical can be partly conducted during the Bachelor and Master programmes in Sport.

Assessments

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-0103-00L</td>
<td>Assessment II</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>A. Krebs, S. Nüssli, S. Schoch</td>
</tr>
</tbody>
</table>

Abstract
- The assessment II 'achievement' allows students to continue their studies in the basic subjects of athletics, fitness, swimming, ice sports and trend sports. Aim is to acquire the basic skills for the respective sports discipline.

Objective
- The assessment monitors both the physical fitness of the students and their skills in the fields of athletics and fitness, which forms the basis for a successful rounding off of the respective direction of study.

Content
- Aerobic, wesentliche Übungen zur Körperkraftigung, Gewandheit, Hochsprung, Kugelstossen und Ausdauer.

Prerequisites / notice
- Kenntnisse (Schulniveau) in den Sportfächern Fitness und Leichtathletik werden ebenso vorausgesetzt wie angemessene konditionelle Fähigkeiten.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>557-0101-00L</td>
<td>Assessment I</td>
<td>O</td>
<td>2</td>
<td>2G</td>
<td>B. Mattli Baur, M. M. Jaeggi, C. König</td>
</tr>
</tbody>
</table>

Abstract
- To acquire basic movements on various apparatuses and in acrobatics as well as to create individual and cooperative combinations according to qualitative criteria.

Objective
- The students should be able to:
  - acquire and consolidate apparatus related core movements as well as apply and create such combinations
  - utilize their own strength as well as the resulting impact in a differentiate way in order to precisely move the swinging, flying, falling and twisting body
  - gain orientation safety and equilibrium while twisting and flying

Content
- Rhythmised attainment of specific acrobatic requirements with music
- Change of positions on the trampoline respecting coordinative aspects
- Accomplishment of an Indoor Parkour


**Basic Education**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>557-0412-01L</td>
<td>Dance I&lt;br&gt;&lt;br&gt;Prerequisites: Practical course Movement Sciences I (BSc HMS) or Assessment I (BSc HST).&lt;br&gt;&lt;br&gt;Compulsory for Sport Teaching Diploma, new Programme Regulations.</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>C. König</td>
</tr>
<tr>
<td></td>
<td>Abstract&lt;br&gt;- Dance and movement comprise of expression, strength, endurance, suppleness, flexibility, rhythmic movement sequences, coordination and dance cantats with music - combined with creativity. Implementation of these aspects.</td>
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<td></td>
<td>Objective&lt;br&gt;- To arouse and stimulate the interest for dancing&lt;br&gt;- To enjoy dancing without prior knowledge and to experience the possibilities within dance from easy to hard&lt;br&gt;- To gain insight into different dance styles&lt;br&gt;- To improve one's own dance technique in framework of the topics offered: To acquire and expand personal skills and knowledge&lt;br&gt;- To expand the diversity and repertoire of movements&lt;br&gt;- To improve coordination with the help of music&lt;br&gt;- To understand music and to be able to interpret the music's character&lt;br&gt;- Dance enhances the consciousness about body and posture, helps in a holistic personality development and assists in body language: a way to express emotions</td>
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<tr>
<td></td>
<td>Content&lt;br&gt;- Kennenlernen von verschiedenen Tanzstilen: HipHop/Streetdance, Jazz, Jive (RNR), Salsa...&lt;br&gt;- Grundlagen von Techniken einzelner Tanzstile kennenlernen und verbessern&lt;br&gt;- Erarbeiten von Tanzkombinationen&lt;br&gt;- Der Tanz und die Bewegung beinhalten Ausdruck, Kraft, Ausdauer, Geschmeidigkeit, Flexibilität, rhythmische Bewegungsabläufe, Koordination und Tanzphrasen mit Musik- gepaart mit Kreativität und Lebensfreude</td>
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<tr>
<td>557-0433-00L</td>
<td>Apparatus Gymnastics and Trampoline I&lt;br&gt;&lt;br&gt;Prerequisites: Practical course Movement Sciences I (BSc HMS) or Assessment I (BSc HST).&lt;br&gt;&lt;br&gt;Compulsory for Sport Teaching Diploma, new Programme Regulations.</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>B. Mattli Baur, M. M. Jaeggi</td>
</tr>
<tr>
<td></td>
<td>Abstract&lt;br&gt;- To get to know and understand the basics of movement (core movements) and its respective actions and functions on apparatuses, on the floor and in acrobatics as well as to create individual and cooperative combinations according to qualitative criteria.</td>
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<td>Objective&lt;br&gt;- The students should be able to:&lt;br&gt;- acquire and consolidate apparatus related core movements as well as apply and create such combinations&lt;br&gt;- utilize their own strength as well as the resulting impact in a differentiate way in order to precisely move the swinging, flying, falling and twisting body&lt;br&gt;- gain orientation safety and room orientation while twisting and flying&lt;br&gt;- gain sensitivity for social competences (e.g. to assist, to observe, to advise) within a small group.&lt;br&gt;- structural relationships within rotations (turnarounds, handsprings and free somersaults)&lt;br&gt;- acrobatic cooperation in a threesome on a course of apparatuses&lt;br&gt;- core poses as motor basic training&lt;br&gt;- variety of position modifications in handstands&lt;br&gt;- core movements and combinations on parallel bars, high bar, floor and in swinging rings&lt;br&gt;- different forms of vaulting as well as springing in movements like handstands and somersaults</td>
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<tr>
<td>557-0503-01L</td>
<td>Basketball - Basics&lt;br&gt;&lt;br&gt;Prerequisites: Practical course Movement Sciences I-III (BSc HMS) or Assessment III (BSc HST).&lt;br&gt;&lt;br&gt;Compulsory for Sport Teaching Diploma, new Programme Regulations.</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>C. Schaudt</td>
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<tr>
<td></td>
<td>Abstract&lt;br&gt;- Basketball - Basics: Basic technical skills: shooting, passing, dribbling / ballhandling, related to the specific Basketball rules.&lt;br&gt;- (Pre-)tactical skills: from 1 : 0 through 3 : 3, preparing 5 : 5</td>
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<td></td>
<td>Objective&lt;br&gt;- Basics of Basketball (technical and tactical skills) up to level 3 vs. 3. With these learnings the game 5 vs. 5 can be played easily, though it is not a primary topic of this event.</td>
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<tr>
<td></td>
<td>Content&lt;br&gt;- Basic technical skills: shooting, passing, dribbling / ballhandling, related to the specific Basketball rules.&lt;br&gt;- Tactical skills: from 1 : 0 through, 3 : 3, preparing 5 : 5</td>
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<td></td>
<td>Lecture notes&lt;br&gt;- no specific script</td>
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</tbody>
</table>
### Soccer I

**Prerequisites:** Practical course Movement Sciences -III (BSc HMS) or Assessment III (BSc HST).

**Abstract**
Acquisition/consolidation basic skills for soccer.

**Objective**
Support and development the individual conditions/talent/skill and introduction of basic methods will be treated.

**Content**
- Technique:
  - Dribble, short passport play, get the ball under control, shot,
  - Individual tactics:
    - offensive/defensive 1vs1; keep ball in own rows
  - various contests in support of different techniques and tactics

**Literature**
- Bucher, Walter (Hrsg.) 1020 Spiel- und Übungsformen im Kinderfußball, 7. unveränderte Auflage 2011, Hofmann-Verlag, Schorndorf

**Prerequisites / notice**
1. Prerequisites:
   - Small being able in soccer.
   - Readines to train.
2. After this course you can get the licence "manager for children".
   - Prerequisites: Only 1 absence from the lessons "football for children"; the book "Kinderfußball" can be bought in the course

### Floorball I

**Prerequisites:** Practical course Movement Sciences I-III (BSc HMS) or Assessment III (BSc HST).

**Abstract**
Experiencing Unihockey/Floorball as an indoor sportsgame

**Objective**
Practising unihockey to improve personal sport skills and widening personal abilities in ball sports

**Content**
- Transfer of ideas into motor movements and motor skills
- Personal improvement by practising different motor skills as moving the ball/ballcontrol, passing, shooting
- Training of personal sports abilities in ballgames
- Analysis of play-situations and corresponding motor movement
- Understanding, learning and applying the rules of the game
- Practical test of skills and in game activities at the end of the semester

**Lecture notes**
Classes are based on insights from the book "unihockey basics" by B.Beutler, M.Wolf.

**Literature**

**Prerequisites / notice**
Please bring your personal hockey stick with you to class.

### Snowsport I

**Prerequisites:** Assessment I+II (BSc HST) passed.

**Abstract**
Education in the disciplines of winter sports (ski or snowboard)

**Objective**
The students:
- experience the different winter sports
- gain an understanding of how to ski off-piste

**Content**
- To apply and vary personal technique of alpine skiing
- To apply and vary personal technique of snowboarding
- To acquire and vary personal technique of cross-country skiing
- Competition in ski-jumping, and giant slalom
- To gain an understanding in how to ski off-piste

**Prerequisites / notice**
Requirement: Assessment I + II (BSc HST)

### Trendsports

**Number of participants limited to 72.**

**Prerequisites:** Assessment II passed (BSc HST) or
Handball I
Prerequisites: Practical course Movement Sciences III (BSc HMS) or Assessment III (BSc HST).

Abstract
Learn by playing - from three-a-side to four-a-side games.
Game development takes place over the zone play of the game (2/1) or 3/2 to the game 4/4 or (6/6).

Objective
The students improve their personal skills and demonstrate the game in teams as well as groups of 4 against 4. They deepen the development of the game. They improve their personal skills with an individual emphasis on game and practice.

Content
Spielend Handball lernen - Über das Spiel zum Spiel (Vom Spiel 3/3 zum Spiel 4/4)

The introduced technical elements form the requirements for the tactically-orientated zone plays and are exclusively trained in the execution and formation steps.

The students improve their personal skills and demonstrate the game in teams as well as groups of 4 against 4. They deepen the development of the game. They improve their personal skills with an individual emphasis on game and practice.

Content
Spielend Handball lernen - Über das Spiel zum Spiel (Vom Spiel 3/3 zum Spiel 4/4)

The introduced technical elements form the requirements for the tactically-orientated zone plays and are exclusively trained in the execution and formation steps.

The students improve their personal skills and demonstrate the game in teams as well as groups of 4 against 4. They deepen the development of the game. They improve their personal skills with an individual emphasis on game and practice.

Content
Spielend Handball lernen - Über das Spiel zum Spiel (Vom Spiel 3/3 zum Spiel 4/4)

The introduced technical elements form the requirements for the tactically-orientated zone plays and are exclusively trained in the execution and formation steps.

The students improve their personal skills and demonstrate the game in teams as well as groups of 4 against 4. They deepen the development of the game. They improve their personal skills with an individual emphasis on game and practice.

Content
Spielend Handball lernen - Über das Spiel zum Spiel (Vom Spiel 3/3 zum Spiel 4/4)

The introduced technical elements form the requirements for the tactically-orientated zone plays and are exclusively trained in the execution and formation steps.

The students improve their personal skills and demonstrate the game in teams as well as groups of 4 against 4. They deepen the development of the game. They improve their personal skills with an individual emphasis on game and practice.

Content
Spielend Handball lernen - Über das Spiel zum Spiel (Vom Spiel 3/3 zum Spiel 4/4)

The introduced technical elements form the requirements for the tactically-orientated zone plays and are exclusively trained in the execution and formation steps.
557-0545-00L  Volleyball II  W  2 credits  2G  J. Albrecht
Prerequisite: Basic course completed

Abstract
To learn the game of volleyball through the interaction between individual playing positions. To achieve skills in a six-a-side game without specialization. (system 3-2-1, setter pos. 1)

Objective
- To know the chain of action for each players position in the game
- To be able to play volleyball 6 against 6 without specialization (system 3-2-1, setter position 1)

Content
- individual tactics: chain of action, attack in all 3 net positions, setting from position 1, statistical evaluation of the game
- methodical steps: planning of training session, including adaptation for stronger and weaker players, individual corrections for players

Literature
- PAPAGEORGIU/CZIMEK: "Volleyball Spielerisch Lernen"
- PAPAGEORGIU/SPITZLEY, "Volleyball Grundlagenausbildung"
- PAPAGEORGIU/SPITZLEY "Leistungsvolleyball"
- PAOLINI M.: "Volleyball from young player to champions"
- MEYNDT/BEUTELSTAHL: "Richtig Volleyball - Halle und Beach"

557-0605-00L  Snowsport II  W  2 credits  2G  P. Diabler, further lecturers
Prerequisite: basic education Snowsport I completed.

Abstract
Only for students in Human Movement Sciences and Health Sciences and Technology.

Objective
Specialization training: Acquisitions of special skills, getting to know the performance factors and training methods in the areas of Snowsports.

Content
- Snow sports (Skiing/Snowboarding):
  - To deepen and expand experience and skills in snow sports and in the personal competency of technique of the chosen snow sport.
  - To expand skills to the area of telemark and competition
- Off-piste education:
  - To acquire knowledge and experience in planning and realization of back-country skiing and consider the environment

Literature
- PAPAGEORGIU/CZIMEK: "Volleyball Spielerisch Lernen"
- PAPAGEORGIU/SPITZLEY, "Volleyball Grundlagenausbildung"
- PAPAGEORGIU/SPITZLEY "Leistungsvolleyball"
- PAOLINI M.: "Volleyball from young player to champions"
- MEYNDT/BEUTELSTAHL: "Richtig Volleyball - Halle und Beach"

557-0426-00L  Fitness II  W  2 credits  2G  C. Romano, A. Sonderegger
Prerequisites: successful completion of Basic Education in Fitness.

Abstract
A consolidation of fitness education; relevant performance factors in the training of physical fitness. Acquisition of skills, tactics, methodology in the areas of fitness and aerobics. Getting to know current and prophylactic training aspects and the training thereof.

Objective
To deepen knowledge of relevant components of physical fitness
To get to know and to enhance knowledge of actual preventative aspects of fitness training

Content
- Fittests im Fitnessbereich
- Krafttrainings- und Ausdauergeräte
- Trainingsprogramme im Fitnessbereich für Kraft, Ausdauer und Beweglichkeit
- Programmankunnpassungen bei Problemen am Bewegungsapparat
- Einführung von Personen an Fitnesstraining
- Funktionelle Anatomiekennnisse im Fitnessbereich
- Aerobics: Aufbau und Einführung von Aerobicblöcken

Lecture notes
Wird im Unterricht abgegeben

Literature
- Skript GA Fitness, GA+VA Gymnastik und Haltung
- Taschenatlas der Anatomie, Bewegungsapparat, W. Platzner, Thieme Verlag
- Optimales Training, J. Weineck, Erlangen, Spitta Verlag
- Sportbiologie, J. Weineck, Erlangen, Perimed Verlag
- Sportanatomie, J. Weineck, Erlangen, Perimed Verlag
- ASVZ Trainingslehre, erhältlich in Polybuchhandlung ETH
- Training fundiert erklärt, Jost Hegner, Ingrid Verlag

Prerequisites / notice
Prüfungsanforderungen
Praxis: Training und Einführung an Fitnessgeräten demonstrieren, Aerobicblock aufbauen können
Theorie: Fragen über Inhalte des Fitnes-Vorlesungsskripts beantworten

Lernkontrollen
Anwesenheit nach ETH Regelung
Fitnesstraining: Praktische Trainingserfahrung an Fitnessgeräten
Aerobics: Demonstrieren und aufbauen eines Aerobicblocks

557-0434-01L  Acrobatics II  W  2 credits  2G  B. Matti Baur, M. M. Jaeggi
Prerequisites: successful completion of Basic Education.

Abstract
To get to know and understand the basics of movement (core movements) and its respective actions and functions on the floor, in acrobatics and partner acrobatics as well as in Parkour to create individual and cooperative combinations according to qualitative criteria.

Objective
The students should be able to:
- acquire and consolidate core movements as well as to apply and create such combinations
- utilize their own strength as well as the resulting impact in a differentiate way in order to precisely and economically move the swinging, flying, falling and twisting body
- gain orientation safety and room orientation while twisting and flying
- gain sensitivity for social competences (e.g. to assist, to observe, to advise) within a small group
- compose and present within a group of three a creative performance
### Freerunning
- creative and cooperative composition in a threesome accompanied by music
- core movements and combinations on the floor, the tumbling-track (airtrack) and the wall
- vault springs and touching down springs (stuetz springs) to overcome obstacles in a artful way
- methodical didactical inputs

### Education Acquired Outside ETH

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>
| 557-0450-00L | Life Saving Rescue Test Plus Pool SLRG  
Only for Sport Teaching Diploma students. | O    | 2    | credits | external organisers |
|          | **Confirmation of course attendance**  
Brevet Basis Pool and  
Brevet Plus Pool SLRG. |      |      |       |                 |
|          | **External education! Credit points only for Sport Teaching Diplom**a |      |      |       |                 |
|          | **Abstract**  
Acquirement of the lifesaving rescue test I SLRG. More details: www.slrgr.ch |      |      |       |                 |
|          | **Objective**  
To recognize danger in, on and around water  
Knowledge and handling of life saving equipment  
Rescue and towing techniques  
Orientation under water  
To rescue a person  
Basis knowledge in anatomy and first aid |      |      |       |                 |
| 557-0451-00L | Samariterausweis  
Only for Sport Teaching Diploma students. | O    | 2    | credits | external organisers |
|          | **Confirmation of course attendance**  
"Samariterausweis". More information: www.samariter.ch |      |      |       |                 |
|          | **External education! Credit points only for Sport Teaching Diploma** |      |      |       |                 |
|          | **Abstract**  
|          | **Objective**  
- To be able to judge an injured person and to apply life saving actions  
- To carry out wound treatment with actual bandage  
- To list the characteristics of a sprain, strain, dislocation and to apply first-aid interventions  
- To carry out fixed bandages with common material  
- To explain the function of the cardiovascular system  
- To name the symptoms of poisoning  
- To list the signs of acute illness  
- To put together the content of a first-aid box  
- To carry out safety interventions in daily situations. |      |      |       |                 |
|          | **Content**  
* Hautverletzungen  
* Wundinfektion / Blutvergiftung  
* Stürze im Alltag (Verstauchungen, Prellungen, Quetschungen)  
* Sportverletzungen, Knochenbrüche  
* Herzkreislaufstörungen  
* Alltagskrankungen in der Familie |      |      |       |                 |

### Sport Teaching Diploma - Key for Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>O</td>
<td>Compulsory</td>
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<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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</tbody>
</table>

### Key for Hours

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<tr>
<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

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**Special students and auditors need special permission from the lecturers.**
The course shall make sure that the participants are fit to make the adequate decisions when encountering legal questions and issues in their career.

In order to achieve this goal, legal problems and issues will be presented to the participants and then discussed in class.

The course touches upon relevant topics of Contract Law (formation of contract and contract performance), Tort Law (including liability limitation), corporate law (types of corporations, formation of LLC), civil procedure (jurisdiction and applicable law, costs, when and how to engage a lawyer) and insurance law (duty to disclose relevant facts, gross negligence).

The course ‘Introduction au Droit civil’ (851-0709-00) provides an introduction to the law of Contracts and Torts in French.

The course touches upon relevant topics of Contract Law (formation of contract and contract performance), Tort Law (including liability limitation), corporate law (types of corporations, formation of LLC), civil procedure (jurisdiction and applicable law, costs, when and how to engage a lawyer) and insurance law (duty to disclose relevant facts, gross negligence).

The aim of this lecture is to give students an introductory overview of relevant topics regarding leadership research and practice, thus enabling them to gain a deeper understanding of the leadership phenomenon. Students should understand different concepts of leadership in the complex interaction between individuals, groups, organisation, context and situation. They should be informed about the evolution of the understanding of mankind in relation to working processes and its impact on organisations and the understanding of leadership theory in the past 100 years. They should grasp the concept of leadership responsibility (leadership ethics) and be able to derive consequences for leadership in practical situations. They should recognize the fundamental importance of communication in leadership situations and receive input which enables them to communicate adequately in specific situations.

The 1-hour written exam will take place during the last lecture in the semester.

The course 'Leadership I' covers the following fields: leadership basics, leadership theories and leadership styles, the concept of leadership responsibility and the role of communication in practical leadership.

The aim of this lecture is to give students an introductory overview of relevant topics regarding leadership research and practice, thus enabling them to gain a deeper understanding of the leadership phenomenon. Students should understand different concepts of leadership in the complex interaction between individuals, groups, organisation, context and situation. They should be informed about the evolution of the understanding of mankind in relation to working processes and its impact on organisations and the understanding of leadership theory in the past 100 years. They should grasp the concept of leadership responsibility (leadership ethics) and be able to derive consequences for leadership in practical situations. They should recognize the fundamental importance of communication in leadership situations and receive input which enables them to communicate adequately in specific situations.

The course introduces students to the legal process and the basics of private law.

The course 'Leadership I' covers the following fields: leadership basics, leadership theories and leadership styles, the concept of leadership responsibility and the role of communication in practical leadership.

The course 'Leadership I' covers the following fields: leadership basics, leadership theories and leadership styles, the concept of leadership responsibility and the role of communication in practical leadership.

The 1-hour written exam will take place during the last lecture in the semester.
Teaching of formal requirements of scientific work (philosophy of science with a focus on the social sciences); literature reviews and the

**Lecture notes**
via email

**Literature**
Mankiw, G. and Taylor M. (2010): Economics, Thomson Learning

**Prerequisites / notice**
Course macroeconomics in the summer term

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**853-0725-00L**

**Title:** History Part One: Europe

**Type:** O

**ECTS:** 3

**Hours:** 2V

**Lecturers:** M. Mühlheim

**Abstract**
Using concrete regional examples, this lecture offers a survey and analysis of the crucial historical transformations that engendered "modernity" in Europe from the late 18th to the mid 20th centuries.

**Objective**
At the end of this lecture course, students can: (a) highlight the most important changes in the "long nineteenth century" in Europe (b) explain their long-term effects; and (c) relate these changes to global developments.

**Content**
The thematic foci include: the economic and social consequences of the industrial revolution, the genesis of political ideologies and social movements, shifts in gender roles, colonialism and imperialism, as well as the emergence of consumerism and a "leisure society."

**Lecture notes**
Power Point Slides and handouts will be made available at https://ilias-app2.let.ethz.ch/goto.php?target=crs_85655&client_id=ilias_lda in the course of the semester.

**Literature**
Mandatory and further reading will be made available at https://ilias-app2.let.ethz.ch/goto.php?target=crs_85655&client_id=ilias_lda.

**Prerequisites / notice**

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**853-0037-00L**

**Title:** Military Psychology and Pedagogy I

**Type:** 2V+1U

**ECTS:** 4

**Lecturers:** H. Annen

**Abstract**
Examine the fundamentals of the two sciences and establish links with military life. Discuss various schools of thought in psychology and focus on content and process theories of motivation. Explore characteristics of pedagogical thinking and discuss the values of military education with reference to the young adult serving in the armed forces.

**Objective**
- Becoming acquainted with basic psychological views of human behaviour and experience
- Knowing the content and motivation and being able to transfer them to the military context
- Knowing the possibilities and limitations of military education and deriving consequences

**Content**
Overall, the objective is to become acquainted with the basics of both scientific areas and to make references to military practice. Military psychology is a branch of applied psychology; consequently selected aspects of psychological principles will be covered. Military pedagogy hasn't yet established itself firmly as an independent scientific discipline, it nevertheless can draw on a deep-seated tradition in Switzerland. Thus, the great importance that has been attached to the discussion of education in Swiss society and academia will be taken into account. Subjects:
- History of military psychology
- Psychological images of humanity (psychoanalysis, behaviourism, behavioural biology, humanistic psychology, cognitivism)
- Motivational theories
- Defence-, service-, operational- and combat motivation
- Swiss military pedagogy
- Education as defining feature of pedagogic thinking and acting

This course is completed by a compulsory one week course between terms.

**Literature**
- Stadelmann, J.: Führung unter Belastung, Huber, Frauenfeld 1998 (provided as pdf)

The lecture is supported by a virtual learning environment containing relevant documents (presentations and texts) and information to further literature.

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### Remaining Core Courses of the Bachelor Programme

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>853-0205-00L</td>
<td>Proseminar I: Political Methodology</td>
<td>O</td>
<td>3</td>
<td>2S</td>
<td>R. Huber</td>
</tr>
</tbody>
</table>

**Abstract**
Teaching of formal requirements of scientific work (philosophy of science with a focus on the social sciences); literature reviews and the basics of conducting independent research on short as well as simple topics; basics of conceptualizing research designs for politically relevant questions and hypotheses.

**Objective**
1) Understanding the goal and the basic procedures of (empirical social sciences) scientific work (philosophy of science, theory building, research design, as well as the correct employment of sources, data and literature).
2) Identification of relevant research questions.
3) Creating a common basis for a thorough and systematic analysis of these.

**Content**
Political Methodology I seeks to introduce students to the basics of scientific work and procedures in the social sciences, which in turn shall allow them - also in conjunction with Political Methodology II - to conduct work that fulfills satisfactory standards of research quality throughout their further studies.

With regard to Political Methodology I, this seminar primarily focuses on the philosophy and theory of (empirical) social sciences, its structure, and procedures. The seminar emphasizes substantive contents and ways of presenting them, research and, conceptual work. Additionally, it deals with the basis of establishing research designs with politically relevant questions and hypotheses.

**Literature**

**Prerequisites / notice**
Each student will be graded by two exercises (50% each).

1) Source analysis and acquisition: based upon a research question that will be given by the lecturer, the student shall collect a comprehensive list of the relevant literature and summarize that with her/his own words.

2) Critical analysis of sources: based upon a research article that the student chooses on her/his own, the student shall write a critical analysis of that, which mirrors frame and structure of scientific writing

Submission dates will be communicated in the first meeting.
Abstract
Beside of the most important terms of sociology, demographic changes and the related value and structure change will be analysed. The second part focuses on organizational sociology. Thirdly, the course examines to which extent armed forces can be considered as organizations like any other and to which extent they constitute a special case from an organizational and normative point of view.

Objective
Recognize and explain current changes (social change) in modern society (individualisation, pluralisation); describe demographic changes in Switzerland; explain the structures of societies; define issues and fields of research in modern military sociology and explain the foundations of organisational sociology; explain the military in terms of organisational sociology and identify specific traits of the military as an organisation.

Content
Societal change; organizations as societal phenomena; aims, structures, environments of organizations; specifics of the military as an organization; impacts of technological and societal changes on the armed forces in modern societies.

Literature
A reader with a set of texts will be handed out.

Languages
First Foreign Language

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>853-0405-00L</td>
<td>English, Part I</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>O. Gwerder</td>
</tr>
</tbody>
</table>

Abstract
Teaching is focused on the acquisition of general English in the four classical skills, i.e. speaking, listening comprehension, reading comprehension and writing. The goal is to reach level B2 or C1 depending on the linguistic proficiency of the students.

Objective
This three-semester English course should enable the participants to successfully use the English language in an international military setting.

Content
Read, analyse and write military and civilian documents
Listening comprehension using current radio or TV reports
Practise speaking through group discussions and short presentations
Systematic revision and extension of key grammar points
Systematic acquisition of general and military vocabulary

3. Semester

Remaining Core Courses of the Bachelor Programme

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>853-0015-00L</td>
<td>Conflict Research I: Causes of War in Historical Context</td>
<td>O</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>L.E. Cederman</td>
</tr>
</tbody>
</table>

Abstract
This course offers an introduction to research on causes of wars. War as a social phenomenon is covered from the pre-state world to today's state system after the end of the Cold War. Topics include state formation and collapse, nationalism, decolonization, democracy, and ethnic conflict.

Objective
Developing an understanding for causes of war and their development over the last 500 years. Knowledge of fundamental concepts in research on causes of war.

Content
You will work on the following topics:
1. Social perception: How do we perceive humans? And how do we do attributions of human behavior?
2. Social Cognition: Why and on what basis do we make social judgments?
4. Group psychology: What is a group? What happens if someone enters into a group? How do groups develop? What are the processes?
5. Prejudice in groups: What can we do about prejudice and conflicts between groups?
6. Applied social psychology: Insights in leadership psychology.

Literature
Weitere Literatur wird im Kurs bekanntgegeben.

Prerequisites / notice
Lehrangebot im Studiengang Berufsoffizier

853-0046-00L | Social Psychology of Groups ■ | O             | 3 credits | 2V    | T. Heilmann    |

Abstract
Relevant applied social psychosocial topics will be discussed.
You have got the chance
1. To learn about basic fields of social psychology.
2. To apply the lessons learned to your own (military) situation/daily life.
3. To think about daily social psychological pitfalls
4. To connect theory and application based on case studies.

Content
You will work on the following topics:
1. Social perception: How do we perceive humans? And how do we do attributions of human behavior?
2. Social Cognition: Why and on what basis do we make social judgments?
4. Group psychology: What is a group? What happens if someone enters into a group? How do groups develop? What are the processes?
5. Prejudice in groups: What can we do about prejudice and conflicts between groups?
6. Applied social psychology: Insights in leadership psychology.

Literature
Weitere Literatur wird im Kurs bekanntgegeben.

853-0047-00L | World Politics Since 1945: The History of International Relations | O             | 4 credits | 2V+1U | A. Wenger |

Abstract
This lecture series provides students with an overview of the development of international relations since the end of World War II. The first part of the series deals with the development of and changes in Cold War security policy structures. The second part deals with the period after the transformation of 1989/91; the focus here is on current issues in international security policy.

Objective
By the end of the semester, participants of the lecture should have a solid knowledge on the history and theoretical foundations of International Relations since the end of the Second World War.

Content
cf. "Diploma Supplement"

Literature
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Type</th>
<th>Credits</th>
<th>Term</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td>853-0065-00L</td>
<td>Business Administration I</td>
<td>O</td>
<td>4 credits</td>
<td>3V</td>
<td>J.P. Chardonnens</td>
</tr>
<tr>
<td>853-0063-00L</td>
<td>Military History I (with Exercises)</td>
<td>O</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>M. Olsansky</td>
</tr>
<tr>
<td>853-0082-00L</td>
<td>Strategic Studies I</td>
<td>O</td>
<td>3 credits</td>
<td>2V</td>
<td>M. Mantovani</td>
</tr>
<tr>
<td>853-0302-00L</td>
<td>European Integration: Seminar</td>
<td>O</td>
<td>4 credits</td>
<td>3S</td>
<td>F. Schimmelfennig</td>
</tr>
</tbody>
</table>

**Prerequisites / notice**
The lecture is being supported by a virtual classroom. If you have any questions, please contact Lukas Meyer; lukas.meyer@sipo.gess.ethz.ch.

**Abstract**
The course offers a foundation in accounting and financial management. It covers topics in financial accounting (recording of transactions, preparation of balance sheet and income statement, methods of using accounting information for decision-making purposes) and financial management (profitability, liquidity, capital budgeting, financing).

**Objective**
Objectives:
- Develop corporate finance thinking
- Record transactions and prepare financial statements
- Master tools and methods used for financial management

**Content**
Content:
1. Financial Accounting
   - Accounts
   - Balance sheet and income statement
   - Inventories
   - Value-added tax, prepayments and accruals
   - Provisions, depreciation,
   - Evaluation, hidden reserves

2. Financial Management
   - Financial report and -analysis
   - Profitability and capital turnover
   - Financial planning
   - Cash budget
   - Capital budgeting

**Abstract**
The lecture outlines the development of the armed forces (assets regarding manpower, technology and armament), the concepts of warfare and the actual warfare in the 19th and 20th century.

**Objective**
- Distinguish between military history as a subject and historiography as a way of describing events;
- Analyse the modern developments regarding armed forces and warfare in the context of socio-economic changes;
- Based on the approach regarding revolution in military affairs, describe the evolution of the armed forces and of warfare;
- Exemplify the issues regarding the evolution of the combat (First and Second World War, Vietnam War and Algerian War).

**Content**
The lecture first examines the bases of the science of (military) history. It focuses on how military history developed from war history, on specific similarities and differences between military history and general historiography, the different ways of dealing with history in Switzerland, Germany, France and in the Anglo-Saxon cultural area (different approaches) as well as on institutions which deal with military history such as universities, military academies, national and international commissions and associations etc.

The lecture is structured along the lines of the concept of “Military Revolution” and starts with the formation of modern, European armed forces after the Oranian Army reform in the 17th century.

Based on the “Military Revolution” approach, the lecture examines the structural changes regarding the armed forces and the development of warfare from the 18th to the 20th century. Special emphasis will be put on how the battlefield was revolutionized due to the Napoleonic wars, the industrialization in the 19th century, the First World War, the mechanization and totalization during the Second World War and the period of the Cold War.

**Literature**

**Abstract**
The lecture series, spread over two terms, deals with the leading concepts of (military) strategy and theories of war from antiquity to the present. It focuses in particular on the backgrounds of these concepts, their implementation as well as their significance for subsequent conceptual thinking.

**Objective**
The participants know the classical conceptions of strategy and war theory from antiquity to the present against their specific background. They recognize aspects, which are useful for the understanding of modern/current conflicts. They are capable of analyzing critically original texts and modern scholarly works in the field of strategic studies.

**Content**
The lecture series introduces the basic concepts of strategy and war theory and wants to present the variety of asymmetric warfare throughout history. It critically highlights in particular Sun Tzu, Machiavelli, Jomini, Clausewitz, Moltke, Mahan, Corbett, Douhet, Fuller, Liddell Hart, Swetchn, Tuchatschewsky, Mao and Che Guvvera, etc. (see program). If appropriate, a specific Swiss view is being applied.

**Literature**
A textbook with primary sources and a list of further reading are available with the lecturer or electronically on the MILAK website (Lehre und Forschung/Dozentur/Vorlesungsunterlagen).

Slides are being distributed.

**Abstract**
The seminar covers the theory, development, and core policy fields of European integration as well as structures and processes of the EU as a decision- and policy-making system.

**Objective**
The seminar is designed to help students understand the European Union as a particular kind of political system that differs both from the nation-state and from other international organizations. It imparts basic knowledge on the development, institutions, procedures, and policies of the EU and provides an introduction to major approaches to integration theory and political science research on the EU.
Participants should gain a solid understanding of current issues in international security policy as well as of the central academic debates.

Hours

Lecturers

Reader with copies of the relevant literature (see below)

1. Introduction

O. Thränert

Introduction to Constitutional Law in Security Policy

A reading list will be distributed at the beginning of the spring semester.

2VECTS

P. Sutter

The basic sources of the lectures are:

Current Issues in Security Policy

The aim of the course is to provide the participants with an overview of international security politics in a globalized world. After dealing with the major changes of the international security environment as compared to the cold war era, we will concentrate on some of the key challenges (international terrorism, proliferation of weapons of mass destruction etc.). The third part of the lecture focuses on security strategies pursued by the ‘Western’ world.

Type

Participants are expected to study the compulsory texts provided at the beginning of the semester via the online platform Moodle.

Abstract

- know any persons rights of judicial review of security measures.
- know the legal status of members of the military forces;
- know the constitutional rules to deal with a state of emergency;
- know the elements of cooperation between military and police;
- understand the actors of security policy and their position within the constitutional order;
- know the basic terms of security law;
- understand the actors of security policy and their position within the constitutional order;
- know the constitutional mandate and powers of the military and the police;
- know the elements of cooperation between military and police;
- know the constitutional rules to deal with a state of emergency;
- know the legal status of members of the military forces;
- know any persons rights of judicial review of security measures.

Content

- read, analyse and write military and civilian documents
- Listening comprehension using current radio or TV reports
- Practise speaking with group discussions and short presentations
- Systematic revision and extension of key grammar points
- Systematic acquisition of general and military vocabulary

5. Semester

Remaining Core Courses of the Bachelor Programme

Number

Title

Type

ECTS

Hours

Lecturers

853-0049-00L

Introduction to Constitutional Law in Security Policy

O

3 credits

2V

P. Sutter

This introduction into the constitutional elements of security policy includes questions of competences (separation of powers, federalism) and considerations on the constitutional mandates and powers of military, police and private actors - especially in the state of emergency. The legal status of individuals (members of the military forces; persons involved in security measures) is ventilated.

Objective

Students should:

- know the basic terms of security law;
- understand the actors of security policy and their position within the constitutional order;
- know the constitutional mandate and powers of the military and the police;
- know the elements of cooperation between military and police;
- know the constitutional rules to deal with a state of emergency;
- know the legal status of members of the military forces;
- know any persons rights of judicial review of security measures.

Content

- The knowledge and skills acquired in the second semester serve as a basis for further improvements in the areas of speaking, listening, reading and writing, which will enable students to enroll for the Cambridge exams. The goal is to reach Council of Europe (CEFR) level C1 or C2 depending on the linguistic proficiency of the students.

Objective

This three-semester English course should enable the participants to successfully use the English language in an international military setting.

Content

- read, analyse and write military and civilian documents
- Listening comprehension using current radio or TV reports
- Practise speaking with group discussions and short presentations
- Systematic revision and extension of key grammar points
- Systematic acquisition of general and military vocabulary

853-0060-00L

Current Issues in Security Policy

O

3 credits

2V

A. Wenger, O. Thränert

This course provides an overview of the development of the international system and the central security challenges since the end of the Cold War. The focus of this course will be on security issues of the post 9/11 era: new risks, arcs of crises, security strategies and core actors will be presented during the course.

Objective

Participants should gain a solid understanding of current issues in international security policy as well as of the central academic debates.

Content

- The aim of the course is to provide the participants with an overview of international security politics in a globalized world. After dealing with the major changes of the international security environment as compared to the cold war era, we will concentrate on some of the key challenges (international terrorism, proliferation of weapons of mass destruction etc.).
Abstract
This course analyzes the foundations and central challenges of Swiss foreign policy. After reviewing the history of foreign and neutrality policy conceptions since the early 20th century, the determining factors of Swiss foreign policy will be discussed, and issues such as the Ukraine crisis, Swiss-EU relations, and Switzerland and the Middle East will be examined.

Objective
Students should acquire a sound understanding of Swiss foreign policy and the relevant academic and political debates associated with it.

Content
After introducing the field of Foreign Policy Analysis, this course will first deal with the historical foundations and the conceptual development of Swiss foreign policy. The focus will be on Switzerland's different reactions to the new international orders after 1918, 1945, and 1989 as well as on the significance of the 9/11 terrorist attacks and the global financial and debt crises since 2009 for Swiss foreign policy. We will also discuss the extent to which the Ukraine crisis and the annexation of Crimea by Russia mark a watershed in the international order - and how Switzerland should respond to these challenges.

Subsequently, key determinants of Swiss foreign policy will be analyzed, with specific attention on neutrality, direct democracy, and the special case paradigm. Finally, the discussion will center on current challenges and issues such as Swiss-EU relations, the Ukraine crisis and the OSCE engagement, Switzerland's role in the UN, Swiss peacebuilding efforts, Swiss policy in the Middle East, and development cooperation.

The first hour will consist of a lecture; in the second hour, we will deepen and discuss the respective issues together with guest speakers from the Swiss foreign ministry, including Secretary of State Rossier.

Lecture notes
Students will receive a handout of slides accompanying the lectures.

Literature
A reading list will be handed out at the beginning of the semester.

Prerequisites / notice
The course will be supported by an e-learning environment.

853-0321-00L
Advanced Course II (Seminar) ■
Precondition: Successful completion of Seminar I (853-0322-00L) in spring term.

Abstract
This two-semester course is divided into several groups. A core question relating to the topic of the seminar paper is being developed (I), which will be chosen in coordination and under the guidance of the respective lecturers. Upon conclusion, the paper will be presented in class (II). Based on the qualifications obtained in the Proseminar, a high academic standard is expected.

Objective
Based on the research design prepared in part I of the seminar, candidates write a comprehensive academic term paper. The term paper should be considered as a good preparation for the BA thesis.

Content
Seminar II builds on the findings of seminar I. Within the broader framework of the overall theme of the seminar (Foreign Policies and Security Strategies of the Great Powers) and based on the approved research design of seminar I, participants write their term paper (in close consultation with the lecturer).

851-0000-00L
Learning Environments for Training: Planning, Operation, Assessment

Abstract
In this lecture practical aspects of learning environments directed to training with respect to planning, operation and assessment are introduced comprising (a) presentations about their theoretical background, (b) discussions of practical aspects and (c) practical exercises.

Objective
The participants have the knowledge and skills necessary for planning, preparing, and implementing good lessons. They apply their knowledge adaptively and based on findings from the research on learning and instruction literature.

Content
The lecture consists of two parts: Basics of Learning skills and military didactics. The first part comprises insights in teaching and learning research, performance assessment, knowledge tranfer and evaluation. Military didactics deal with specific aspects of military education: The planning of learning environments for schools and courses, the definition of learning objectives for military exercises, controlling and E-research, performance assessment, knowledge tranfer and evaluation. Military didactics deal with specific aspects of military education:

Systematic acquisition of general and military vocabulary
Systematic revision and extension of key grammar points
Practise speaking with group discussions and short presentations
Listening comprehension using current radio or TV reports

Only for Public Policy BA.

853-0404-00L
French, Part II

Abstract
Based on the knowledge and skills acquired during the first semester, speaking and discussion skills related to military situations are examined and put into practice. Attention is focused on issues such as instruction, qualification and career interviews.

Objective
This two-semester French course should enable the German speaking participants to fulfil their function as professional officers also in the German language.

Content
Read, analyse and write military and civilian documents
Listening comprehension using current radio or TV reports
Practise speaking with group discussions and short presentations
Systematic revision and extension of key grammar points
Systematic acquisition of general and military vocabulary

853-0315-00L
BA Colloquium ■

Abstract
Based on the knowledge and skills acquired during the first semester, speaking and discussion skills related to military situations are examined and put into practice. Attention is focused on issues such as instruction, qualification and career interviews.

Objective
This two-semester German course should enable the French speaking participants to fulfil their function as professional officers also in the French language.

Content
Read, analyse and write military and civilian documents
Listening comprehension using current radio or TV reports
Practise speaking with group discussions and short presentations
Systematic revision and extension of key grammar points
Systematic acquisition of general and military vocabulary

Languages

Second Foreign Language

Bachelor Colloquium and Bachelor Thesis
The program of the course is organized into 14 units of 90 minutes each. The units combine the elements of lecture (where analytical
Hours
D. Seiler Hubler
Title
Kurzüberblick über Antike bis frühe Neuzeit. Darstellung des Sports im Dienst nationaler Ideen, von Bildung und Erziehung, der
W+
2 credits
Military Business Administration II - Case Examples
2V
The Lecturer will distribute all necessary literature directly to the students by disseminating pdf files or citing links to online references.
Central aspects of Sport related pedagogy will be handled in these lectures. These aspects cover, amongst others, the subject and tasks of
History of Sports
8D
The BA Colloquium prepares students for their BA thesis with regard to content, administration, and methodology. During the colloquium,
The BA Colloquium prepares students for their BA thesis with regard to content, administration, and methodology. During the colloquium,
each student has to choose a topic for his/her BA-thesis. The students also choose their supervisors, whereas the goal is an even
distribution of the supervisors. Finally, the methodological competences which were acquired during the first four semesters will be
complemented.
Prerequisites / notice
If you have questions, please contact Prof. A. Wenger, wenger@sipo.gess.ethz.ch, 044 632 59 10.
853-0654-00L Bachelor’s Thesis W
O 10 credits 8D Lecturers
Abstract
The Bachelor Thesis completes the Bachelor program and consists of a scientific project carried out independently under the tutorship of
an ETH or MILAK lecturer in Public Policy.
Objective
The elaboration of the Bachelor Thesis should further students’ capacities to work independently, structured and scientifically.

Select Electives

Recommended Elective Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>853-0102-00L</td>
<td>Military Business Administration II - Case Examples</td>
<td>W+</td>
<td>3 credits</td>
<td>2V</td>
<td>M. M. Keupp</td>
</tr>
</tbody>
</table>

Abstract
The elective course Military Business Administration II builds on the mandatory course Military Business Administration I and adds to it. It
deals with in-depth case studies from international security and economic policy with a special emphasis on the economic and practical
relevance of these issues for the Swiss Armed Forces.

Objective
Students who are intrinsically interested in business-related issues will be provided with a big picture that transcends the micro view of
business administration. Students learn how to integrate security and resource-related issues into a global economic analysis and how to
derive relevant consequences, particularly economic ones, for Switzerland.

Content
The program of the course is organized into 14 units of 90 minutes each. The units combine the elements of lecture (where analytical
concepts are taught) and application (where these concepts as applied). Additionally, guest lecturers will hold talks on selected issues.

* Swiss economic autarchy - madness or option?
* Global resource positions and world trade: Implications for the Swiss Armed Forces I
* Global resource positions and world trade: Implications for the Swiss Armed Forces II
* Economic causes of military instability
* Aggressive emerging economies: Economic growth and rearmament
* The process of an arms deal
* Costs and financing of a military conflict
* Economic analysis of terrorism
* Economic analysis of cyberwar
* Economic analysis of the present GSOA initiative: Compulsory military service vs. voluntary militia
* Global arms production and international arms trade
* The privatisation of military security
* Standardisation and interoperability: Does NATO membership increase Swiss military efficiency
* Written exam

Lecture notes
As this course has been completely redesigned and is being offered for the first time in the fall semester of 2013, a script is not yet
available. However, the lecturer will distribute all necessary course material in time and directly to the students, either in the classroom or
by uploading files to a public server.

Literature
The Lecturer will distribute all necessary literature directly to the students by disseminating pdf files or citing links to online references.

Prerequisites / notice
Exam “Military Business Administration I” passed successfully or profound basic knowledge of business administration and economics. The
course is open to external participants.

Additional Elective Courses

These Electives may be chosen from the start of the Bachelor Study Programme.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1033-00L</td>
<td>History of Sports</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>M. Gisler</td>
</tr>
</tbody>
</table>

Abstract
Comprehension for development and changes of sports from the ancient world to the present. Description of sports in services of national
idea, from education and health promotion from the middle of the 18th century till this day.

Objective
Understanding for the development and adaptation of sports from the ancient world to present times.

Content
Kurzüberblick über Antike bis frühe Neuzeit. Darstellung des Sports im Dienst nationaler Ideen, von Bildung und Erziehung, der
Gesundheitsförderung von der Mitte des 18. Jahrhunderts bis heute.überblick über die Geschichte der Olympischen Spiele in der Antike
und Gegenwart.

Lecture notes
Ein Skript für die aktuelle Veranstaltung wird abgegeben.

Literature
Literaturangaben für eine Vertiefung der Inhalte werden im Skript gemacht. Die Anschaffung von Spezialliteratur ist allerdings nicht
notwendig.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-1107-00L</td>
<td>Sport Pedagogy</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>D. Seiler Hubler</td>
</tr>
</tbody>
</table>

Abstract
Central aspects of Sport related pedagogy will be handled in these lectures. These aspects cover, amongst others, the subject and tasks of
Sport related pedagogy. Furthermore, the general and sports relevant foundations of Sport related pedagogy will be covered.

Objective
To gain basic knowledge of sports pedagogy and to recognize starting points for applied sports pedagogical intervention in schools.

Content
Inhalliche Schwerpunkte der Vorlesung sind:
- Einführung in die Sportpädagogik
- Bedeutung des Sports im Kindes- und Jugendalter
- Leistungssport im Kindes- und Jugendalter
- Pädagogische Perspektiven des Sportunterrichts in der Schule
- Ein zeitgemäßer Schulsport
- Bewegungskulturelle Bildung: Bewegungserziehung, Spielerziehung

Lecture notes
Unterrichtsmaterialien zu den einzelnen Veranstaltungen werden den Studierenden zur Verfügung gestellt.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>376-1117-00L</td>
<td>Sport Psychology</td>
<td>W</td>
<td>2 credits</td>
<td>2V</td>
<td>H. Gubelmann</td>
</tr>
</tbody>
</table>

Abstract
This lecture is intended as an introduction to sport psychology and imparts knowledge on selected areas of the subject.
Students are given insight into different work areas of sport psychology. In order to understand what «sport psychology» is, it is necessary to explain the essence and tasks of sport psychology and what it relates to, and to work out an underlying basis for key topics, such as cognition and emotions. Students’ expertise is furthered by presenting and providing more in-depth treatment of additional topics of sport psychology. Selected intervention forms are intended to provide insight into applied sport psychology and ensure that mental processes and their impact in sport can be recognised. Case studies and practical exercises (e.g. objective training) are intended to prompt students to reflect to a greater extent on the forms in which sport psychology can be applied in their practice of sports and to integrate these in their teaching.

Main Topics
- Introduction to sport psychology
- Cognitions in sports: mental rehearsal and mental training
- Emotions and stress
- Motivation: goal-setting in sports
- Career and career transition in elite sport
- Coach-Athlete-Interaction
- Psychological aspects of sport-injury rehabilitation
- Group dynamics in sport

Technical change plays a crucial role in efforts to create a more sustainable future. In this context, policy decision makers must design rules that minimize its risks and maximize its benefits for society at large. The course discusses this challenge from an interdisciplinary perspective taking into account legal, economic, historical, development and environmental aspects.

- to recognize the challenges and opportunities of technological change in terms of sustainable development
- to become familiar with policy instruments to promote innovation
- to improve understanding of political decision-making processes in the regulation of science & technology
- improved understanding of the role of science and technology in the context of human and societal development
The objectives of this course are to (1) gain an overview of relevant questions in the area of Science, Technology and Innovation. State interventions are either designed to regulate (e.g. environmental regulations, anti-trust law) or facilitate (e.g. intellectual property rights protection, public investment in R&D and technical education, technology transfer) technological change. This will be illustrated by looking at different industries and different national systems of innovation. Subsequently the positive and negative consequences for society and the natural environment will be discussed from a short-term and a long-term perspective.

**Prerequisites / notice**

The 2-hour course (5-7 p.m.) will be held as a series of lectures. The course materials will be available in form of an electronic Reader at the beginning of the semester. The class will be taught in English. Students will be asked to give a (a) presentation (15 Minutes) or write a review paper based on a article selected from the electronic script, and (b) they will have to pass a written test at the end of the course in order to obtain 3 credit points in the ECTS System. In the final mark (a) will have a weight of 40% and (b) 60%.

**Content**

Science and Technology Policy is normally associated with the improvement of national competitiveness; yet, it is also an integral part of effective environmental and development policies. The course will discuss the challenges and opportunities of technological change in terms of sustainable development and show how public policy on the national and the international level is responding to this change.

In this context, students are to become familiar with the basic principles of political economy and New Growth Theory and how such theories help explain political decisions as well as political outcomes in the area of Science, Technology and Innovation. State interventions are either designed to regulate (e.g. environmental regulations, anti-trust law) or facilitate (e.g. intellectual property rights protection, public investment in R&D and technical education, technology transfer) technological change. This will be illustrated by looking at different industries and different national systems of innovation. Subsequently the positive and negative consequences for society and the natural environment will be discussed from a short-term and a long-term perspective.

**Literature**


The 2-hour course (5-7 p.m.) will be held as a series of lectures. The course materials will be available in form of an electronic Reader at the beginning of the semester. The class will be taught in English. Students will be asked to give a (a) presentation (15 Minutes) or write a review paper based on a article selected from the electronic script, and (b) they will have to pass a written test at the end of the course in order to obtain 3 credit points in the ECTS System. In the final mark (a) will have a weight of 40% and (b) 60%.

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**Content**

This course focuses on the conditions under which cooperation in international environmental politics emerges and the conditions under which such cooperation and the respective public policies are effective and/or efficient.

The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a social sciences viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems.

**Objective**

This course deals with how and why international cooperation in environmental politics emerges, and under what circumstances such cooperation and the respective public policies are effective and/or efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental politics are discussed: the management of international water resources, the problem of unsafe nuclear power plants in eastern Europe, political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

The course is open to all ETH students. Participation does not require previous coursework in the social sciences.

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 4 ECTS credit points. The workload is around 120 hours (meetings, reading assignments, preparation of test).

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory (http://www.rektorat.ethz.ch/students/admission/auditors/specialstudents_uzh/index_EN; see menu on left side of that webpage for students from other universities).

**Lecture notes**

Slides and reading material will be made available at www.ib.ethz.ch (teaching, materials, then menu on the left side of the screen). They are password protected. Use your Nethz username and password to access the material.

**Literature**

See www.ib.ethz.ch (teaching, materials)
Students from ETH will receive 4 ECTS credit points if they attend classes regularly and obtain a grade of 4.0 or higher for the written exam in the final week of the semester. Students who obtain a grade of less than 4.0 for the end-of-semester test will have a second chance in the first week of the following semester. The rules of the game are defined in detail on the course syllabus. Students who do not participate in the end of semester test will not have access to the repeat exam unless they submit compelling and documented reasons for why they were unable to participate in the first test. Except for language dictionaries, no additional materials and no laptops and mobile phones are allowed during the exam.

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory (http://www.rektorat.ethz.ch/students/admission/auditors/specialstudents_uzh/index_EN; see menu on left side of that webpage for students from other universities).

The workload for this course is approx. 120 hours (all inclusive).

<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
<th>701-0763-00L</th>
<th>Basic Concepts of Management</th>
<th>W</th>
<th>2 credits</th>
<th>2V</th>
<th>R. Schwarzenbach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>This course deals with fundamental and proven management concepts. The lecturers emphasize the practical applicability of concepts. The course was designed in close cooperation with practitioners; e.g. will Mr. S. Baldenweg, mechanical engineer ETH, MBA Insead, share his experience in several guest lectures.</td>
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<tr>
<td>Objective</td>
<td>Students: will be familiar with basic general management concepts. Learn about the fundamental concepts of strategy development with practical examples. will get to know the basic organisational issues and the essential types of organisations. get a rough overview on the concepts of financial management. will learn about the strategic positioning of small departments within larger organisations. will learn about the fundamental mechanisms for handling change, and will be able to recognise these situations. will learn the basic principles of project management and of successful self-management. will reflect on customer oriented information representation.</td>
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<tr>
<td>Lecture notes</td>
<td>Skripten werden elektronisch zur Verfügung gestellt.</td>
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<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
<th>363-0341-00L</th>
<th>Introduction to Management</th>
<th>W</th>
<th>3 credits</th>
<th>2G</th>
<th>S. Brusoni, P. Baschera, N. Rosenkrantz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>This course is an introduction to the critical management skills involved in planning, structuring, controlling and leading an organization. We develop a ‘systemic’ view of organizations. We look at organizations as part of an industry context, which is affected by different elements like strategy, structure, culture, tasks, people and outputs. We consider how managerial decisions are made in any one of these domains affect decisions in each of the others.</td>
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<tr>
<td>Objective</td>
<td>Further information is available on the Tim Group Chair's website: <a href="http://www.timgroup.ethz.ch/en/courses">http://www.timgroup.ethz.ch/en/courses</a> and on the Moodle of the course: <a href="https://moodle-app2.let.ethz.ch/course/view.php?id=1287">https://moodle-app2.let.ethz.ch/course/view.php?id=1287</a></td>
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<tr>
<td>Content</td>
<td>Selected readings from the book and additional learning materials will be available on the course Moodle: <a href="https://moodle-app2.let.ethz.ch/course/view.php?id=1287">https://moodle-app2.let.ethz.ch/course/view.php?id=1287</a></td>
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<table>
<thead>
<tr>
<th>Prerequisites / notice</th>
<th>851-0735-10L</th>
<th>Business Law</th>
<th>W</th>
<th>2 credits</th>
<th>2V</th>
<th>P. Peyrot</th>
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</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>Particularly suitable for students of D-ITET</td>
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<tr>
<td>Objective</td>
<td>The students shall obtain a basic knowledge about business law. They shall be able to recognize and evaluate issues in the area of business law and suggest possible solutions. The students shall obtain the following competence: - They shall obtain a working knowledge on the legal aspects involved in setting up and managing an enterprise. - They shall be acquainted with corporate functions as contracting, negotiation, claims management and dispute resolution - They shall be familiar with the issues of corporate compliance, i.e. the system to ascertain that all legal and ethical rules are observed. - They shall be able to contribute to the legal management of the company and to discuss legal issues. - They shall have an understanding of the law as a part of the corporate strategy and as a valuable resource of the company.</td>
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<tr>
<td>Lecture notes</td>
<td>A comprehensive script will be made available online on the moodle platform.</td>
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<thead>
<tr>
<th>Prerequisites / notice</th>
<th>101-0515-00L</th>
<th>Project Management</th>
<th>W</th>
<th>2 credits</th>
<th>2G</th>
<th>M. Kersting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>General introduction to the development, the life cycle and the characteristics of projects. Introduction to, and experience with, the methods and tools to help with the preparation, evaluation, organisation, planning, controlling and completion of projects.</td>
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<tr>
<td>Objective</td>
<td>To introduce the methods and tools of project management. To impart knowledge in the areas of project organisation and structure, project planning, resource management, project controlling and on team leadership and team work.</td>
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</tbody>
</table>
Content
- From strategic planning to implementation (Project phases, goals, constraints, and feasibility)
- Project leadership (Leadership, Teams)
- Project organization (Structure)
- Project planning (Schedule, cost and resource planning)
- Project controlling
- Risk and Quality Management
- Project completion

Lecture notes
Yes
The transparencies will be available for download from the website at least one week before each class. Copies of all necessary documents will be distributed at appropriate times.

851-0585-15L Complexity and Global Systems Science W 3 credits 2V D. Helbing, L. Sanders
Prerequisites: solid mathematical skills. Particularly suitable for students of D-ITET

Abstract
This course discusses complex techno-socio-economic systems, their counter-intuitive behaviors, and how their theoretical understanding empowers us to solve some long-standing problems that are currently bothering the world.

Objective
Participants should learn to get an overview of the state of the art in the field, to present it in a well understandable way to an interdisciplinary scientific audience, to develop models for open problems, to analyze them, and to defend their results in response to critical questions. In essence, participants should improve their scientific skills and learn to think scientifically about complex dynamical systems.

Content
This course starts with a discussion of the typical and often counter-intuitive features of complex dynamical systems such as self-organization, emergence, (sudden) phase transitions at “tipping points”, multi-stability, systemic instability, deterministic chaos, and turbulence. It then discusses phenomena in networked systems such as feedback, side and cascade effects, and the problem of radical uncertainty. The course progresses by demonstrating the relevance of these properties for understanding societal and, at times, global-scale problems such as traffic jams, crowd disasters, breakdowns of cooperation, crime, conflict, social unrests, political revolutions, bubbles and crashes in financial markets, epidemic spreading, and/or “tragedies of the commons” such as environmental exploitation, overfishing, or climate change. Based on this understanding, the course points to possible ways of mitigating techno-socio-economic-environmental problems, and what data science may contribute to their solution.

Prerequisites / notice
Mathematical skills can be helpful

363-0622-00L Basic Management Skills W 3 credits 8G R. Specht
Limited number of participants.
Mandatory registration by 3.8.2015 via the administration office of Prof. P. Baschera. E-Mail: bms@ethz.ch

Abstract
With the aim of preparing the students to take on managerial responsibility, this 2x5 days-seminar teaches basic and practical management skills.

Objective
To convey management behaviour based on practical examples, own experiences and team discussions complemented by short theory sessions (subsidized from the donation for promotion and training in enterprise sciences at the ETHZ).

Content
1 Fundamentals of Communication Psychology
2 Communication in Business-Life
3 Fundamentals of Leadership
4 Self-Management and Life Balance
5 Leadership Tools
6 Problem Solving and Decision Making Techniques
7 Performance Coaching
8 Conflict Management
9 Personality
10 Summary-Day, Domino-Examination

Lecture notes
Will be provided as electronic version at www.entrepreneurship.ethz.ch at least one week before the seminar starts

Prerequisites / notice
Special permission from lecturers required
10 days in two weeks, 09:00-17:00

The number of participants is limited. Please send an email to bms@ethz.ch by 03.08.15 for your registration

Week I: 17.08.15 to 21.08.15
Week II: 07.09.15 to 11.09.15

853-8000-00L History of Switzerland in the Late Middle Ages 1415-1515 (University of Zurich) W 3 credits 2V University lecturers
No enrollment to this course at ETH Zurich. Book the corresponding module directly at UZH.
UZH module code 600334.

Abstract
Currently the Late Middle Ages takes center stage in debates on national commemorative culture and identity, not least in connection with the centenary celebrations of the Aargau conquest (1415) and the battle of Marignano (1515). The lecture departs from the ongoing political use of history and confronts it with scholarly perspectives on the period.

751-1551-00L Ressourcen- und Umweltökonomie W 3 credits 2V L. Bretschger, A. Müller
Relationship between economy and environment, market failure, external effects and public goods, contingent valuation, internalisation of externalities; economics of non-renewable resources, economics of renewable resources, cost-benefit analysis, sustainability, and international aspects of resource and environmental economics.
Objective

Understanding of the basic issues and methods in resource and environmental economics; ability to solve typical problems in the field using the appropriate tools, which are concise verbal explanations, diagrams or mathematical expressions.

Topics are:
- Introduction to resource and environmental economics
- Importance of resource and environmental economics
- Main issues of resource and environmental economics
- Normative basis
  - Utilitarianism
  - Fairness according to Rawls
- Economic growth and environment
- Externalities in the environmental sphere
- Governmental internalisation of externalities
- Private internalisation of externalities: the Coase theorem
- Free rider problem and public goods
- Types of public policy
- Efficient level of pollution
- Tax vs. permits
- Command and Control Instruments
- Empirical data on non-renewable natural resources
- Optimal price development: the Hotelling-rule
- Effects of exploration and Backstop-technology
- Effects of different types of markets.
- Biological growth function
- Optimal depletion of renewable resources
- Social inefficiency as result of over-use of open-access resources
- Cost-benefit analysis and the environment
- Measuring environmental benefit
- Measuring costs
- Concept of sustainability
- Technological feasibility
- Conflicts sustainability / optimality
- Indicators of sustainability
- Problem of climate change
- Cost and benefit of climate change
- Climate change as international ecological externality
- International climate policy: Kyoto protocol
- Implementation of the Kyoto protocol in Switzerland
- Economy and natural environment, welfare concepts and market failure, external effects and public goods, measuring externalities and contingent valuation, internalising external effects and environmental policy, economics of non-renewable resources, renewable resources, cost-benefit-analysis, sustainability issues, international aspects of resource and environmental problems, selected examples and case studies.

Content

Economy and natural environment, welfare concepts and market failure, external effects and public goods, measuring externalities and contingent valuation, internalising external effects and environmental policy, economics of non-renewable resources, renewable resources, cost-benefit-analysis, sustainability issues, international aspects of resource and environmental problems, selected examples and case studies.

Abstract

The combining of training and coaching as in the example of sport analysis, which has an effect on youth training and athlete development

To develop basics for a differentiate analyses of sports (model)

- To develop a profile of requirements for specific sports
- To develop competencies of training with youth and talents
- To develop the basics of talent training in theory and practice
- To observe athletes in case studies, make judgments and conclusion

Literature

Für die Kreditvergabe sind die vorgeschriebenen Semesterarbeiten und die Präsenz zwingend. Die Benotung erfolgt durch eine schriftliche Arbeit.

Planung
Die Planungsunterlagen werden zu Semesterbeginn abgegebenen, sind provisorisch und können vom Dozenten geändert werden. Die Praxislektionen werden jeweils am Mittwoch von 13.00 - 15.00 abgehalten. Die Termine werden in Absprache festgelegt.

Die Semesterarbeit ist 4 Wochen nach Semesterende abzugeben.


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**Public Policy Bachelor - Key for Type**

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

**Key for Hours**

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
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</tr>
</tbody>
</table>

**ECTS**

European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Core Courses

In each subject area, the core courses offered are normally mathematical as well as application-oriented in content. For each subject area, only one of these is recognised for the Master degree.

Regression

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0649-00L</td>
<td>Applied Statistical Regression</td>
<td>W</td>
<td>5 credits</td>
<td>2V+1U</td>
<td>M. Dettling</td>
</tr>
</tbody>
</table>

Abstract
This course offers a practically oriented introduction into regression modeling methods. The basic concepts and some mathematical background are included, with the emphasis lying in learning “good practice” that can be applied in every student's own projects and daily work life.

Objective
The students acquire advanced practical skills in linear regression analysis and are also familiar with its extensions to generalized linear modeling.

Content
The course starts with the basics of linear regression modeling, and then proceeds to parameter estimation, tests and confidence intervals, residual analysis, model choice, and prediction. More rarely touched but practically relevant topics that will be covered include variable transformations, categorical input variables, shrinkage and general modeling strategies.

The last third of the course is dedicated to an introduction into generalized linear regression models: this includes logistic regression for binary response variables, Poisson regression for count data, cumulative logit models for ordered, and multinomial regression for categorical response variables.

Analysis of Variance and Design of Experiments

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0625-01L</td>
<td>Applied Analysis of Variance and Experimental Design</td>
<td>W</td>
<td>5 credits</td>
<td>2V+1U</td>
<td>L. Meier</td>
</tr>
</tbody>
</table>

Abstract
Key concepts of experimental design. Planning and analysis of single factor experiments, block designs, full factorial and fractional designs, split-plot and strip-plot designs. Random effects and mixed effects models.

Objective
Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R.

Content

Time Series and Stochastic Processes

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-4623-00L</td>
<td>Time Series Analysis</td>
<td>W</td>
<td>6 credits</td>
<td>3G</td>
<td>not available</td>
</tr>
</tbody>
</table>

Abstract
Statistical analysis and modeling of observations in temporal order, which exhibit dependence. Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. Implementations in the software R.

Objective
Understanding of the basic models and techniques used in time series analysis and their implementation in the statistical software R.

Content
This course deals with modeling and analysis of variables which change randomly in time. Their essential feature is the dependence between successive observations. Applications occur in geophysics, engineering, economics and finance. Topics covered: Stationarity, trend estimation, seasonal decomposition, autocorrelations, spectral and wavelet analysis, ARIMA-, GARCH- and state space models. The models and techniques are illustrated using the statistical software R.
401-3621-00L  Fundamentals of Mathematical Statistics  
W  10 credits  4V+1U  S. van de Geer  
Abstract  The course covers the basics of inferential statistics.

401-8623-00L  Likelihood Inference (University of Zurich)  
W  5 credits  3G  University lecturers  
Abstract  No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH. UZH Module Code: STA402  
Mind the enrolment deadlines at UZH: http://www.uzh.ch/studies/application/mobiletae_en.html  
Overview over the basics of likelihood inference.

Specialization Areas and Electives

Statistical and Mathematical Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3601-00L</td>
<td>Probability Theory</td>
<td>W</td>
<td>10 credits</td>
<td>4V+1U</td>
<td>A.S. Sznitman</td>
</tr>
<tr>
<td>401-3627-00L</td>
<td>High-Dimensional Statistics</td>
<td>W</td>
<td>4 credits</td>
<td>2V</td>
<td>P. L. Bühlmann</td>
</tr>
<tr>
<td>401-3611-00L</td>
<td>Advanced Topics in Computational Statistics</td>
<td>W</td>
<td>4 credits</td>
<td>2V</td>
<td>M. H. Maathuis, M. Mächler</td>
</tr>
<tr>
<td>401-4633-00L</td>
<td>Data Analytics in Organisations and Business</td>
<td>W</td>
<td>5 credits</td>
<td>2V+1U</td>
<td>I. Flückiger</td>
</tr>
<tr>
<td>401-6217-00L</td>
<td>Using R for Data Analysis and Graphics (Part II)</td>
<td>W</td>
<td>1 credit</td>
<td>1G</td>
<td>A. J. Papritz, C. B. Schwierz</td>
</tr>
</tbody>
</table>

Prerequisites / notice

- Advanced Topics in Computational Statistics: Knowledge of basic concepts in probability theory, and intermediate knowledge of statistics (e.g. a course in linear models or computational statistics).
- Data Analytics in Organisations and Business: Familiarity with the "business language", current problems and thinking in organisations and business and tools used.
- Using R for Data Analysis and Graphics (Part II): The students will be able to use the software R efficiently for data analysis.

Course Schedule

- 401-3601-00L: December 2, 2019 - February 17, 2020  
- 401-3627-00L: December 2, 2019 - February 17, 2020  
- 401-3611-00L: December 2, 2019 - February 17, 2020  
- 401-4633-00L: December 2, 2019 - February 17, 2020  
- 401-6217-00L: December 2, 2019 - February 17, 2020

Lecture Notes

- Probability Theory: Lecture notes will be available, will be sold in the course.
- High-Dimensional Statistics: Lecture notes will be available, will be sold in the course.
- Advanced Topics in Computational Statistics: Lecture notes will be available, will be sold in the course.
- Data Analytics in Organisations and Business: Lecture notes will be available, will be sold in the course.
- Using R for Data Analysis and Graphics (Part II): Lecture notes will be available, will be sold in the course.

Literature

- H. Bauer, Probability Theory, de Gruyter 1996
- J. Jacod and P. Protter, Probability essentials, Springer 2004
- D. Williams, Probability with martingales, Cambridge University Press 1991
- Ionescu Tulcea, Markov chains.
### Content

The course provides the second part of an introduction to the statistical software R for scientists. R is free software that contains a huge collection of functions with focus on statistics and graphics. If one wants to use R one has to learn the programming language R - on very rudimentary level. The course aims to facilitate this by providing a basic introduction to R.

Part II of the course builds on part I and covers the following additional topics:
- Elements of the R language: control structures (if, else, loops), lists, overview of R objects, attributes of R objects;
- More on R functions;
- Applying functions to elements of vectors, matrices and lists;
- Object oriented programming with R: classes and methods;
- Tayloring R: options;
- Extending basic R: packages

### Lecture notes


Basic knowledge of R equivalent to "Using R ... (part 1)" ( = 401-6215-00L ) is a prerequisite for this course.

### Prerequisites

Rough Outline:
- Parametric estimation methods: selection of important results
  - Maximum likelihood
  - Least squares: regression & diagnostics
- Nonparametric curve estimation
  - Density estimation, Kernel regression, Local polynomials, Bandwidth selection
  - Selection of special topics (as time permits, we will cover as many topics as possible) such as change points, modes & monotonicity, robustness, partial linear models, roughness penalty, local likelihoods, etc.
- Applications: potential areas of applications will be discussed such as, change assessment, trend and surface estimation, probability and quantile curve estimation, and others.

Brief summaries or outlines of some of the lecture material will be posted at http://www.wsl.ch/info/mitarbeitende/ghosh/index_EN (click on "ETH Course" in the left panel).

**Note:** The posted notes will tend to be just sketches whereas only the in-class lessons will contain complete information.

**Log in:** In order to have access to the posted notes, you will need the course user id & the password. These will be given out on the first day of the lectures.

### Literature

- Statistical Inference, by S.D. Silvey, Chapman & Hall.
- Density Estimation, by B.W. Silverman, Chapman and Hall.
- Kernel Smoothing, by M.P. Wand and M.C. Jones, Chapman and Hall.
- Nonparametric Simple Regression, by J. Fox, Sage Publications.

Additional references will be given out in the lectures.

Prerequisites: A background in Linear Algebra, Calculus, Probability & Statistical Inference including Estimation and Testing.
This course focusses on nonparametric estimation of probability densities and regression functions. These recent methods allow modelling
Many scientific and commercial applications require insights from massive, high-dimensional data sets. This course introduces principled,

Data Mining: Learning from Large Data Sets
Nonparametric Regression

After an introductory discussion of the types of problems and the kind of data that arise in environmental research, an introduction into
In many research fields, spatially referenced data are collected. When analysing such data the focus is either on exploring their structure
The course will provide an overview of the basic concepts and stochastic models that are commonly used to model spatial data. In addition, the participants will learn a number of geostatistical techniques and acquire some familiarity with software that is useful for analysing spatial data.

Prerequisites / notice
Special Students "University of Zurich (UZH)" in the Master Program in Biostatistics at UZH cannot register for this course unit electronically. Forward the lecturer's written permission to attend to the Registrar's Office. Alternatively, the lecturer may also send an email directly to kanzlei@rektorat.ethz.ch. The Registrar's Office will then register you for the course.

Prerequisites:
- Solid basic knowledge in statistics, algorithms and programming. Background in machine learning is helpful but not required.

Objective
Knowledge on estimation of probability densities and regression functions via various statistical methods.

Objective
Understanding of the choice of weight function and of the smoothing parameter, also done automatically.
Practical application on data sets at the computer.

Abstract
This course focusses on nonparametric estimation of probability densities and regression functions. These recent methods allow modelling without restrictive assumptions such as 'linear function'. These smoothing methods require a weight function and a smoothing parameter. Focus is on one dimension, higher dimensions and samples of curves are treated briefly. Exercises at the computer.

Objective
Knowledge on estimation of probability densities and regression functions via various statistical methods.

Objective
Understanding of the choice of weight function and of the smoothing parameter, also done automatically.
Practical application on data sets at the computer.

Abstract
In many research fields, spatially referenced data are collected. When analysing such data the focus is either on exploring their structure (dependence on explanatory variables, autocorrelation) and/or on spatial prediction. The course provides an introduction to geostatistical methods that are useful for such purposes.

Objective
The course will provide an overview of the basic concepts and stochastic models that are commonly used to model spatial data. In addition, the participants will learn a number of geostatistical techniques and acquire some familiarity with software that is useful for analysing spatial data.

Content
After an introductory discussion of the types of problems and the kind of data that arise in environmental research, an introduction into linear geostatistics (models: stationary and intrinsic random processes, modelling large-scale spatial patterns by regression, modelling autocorrelation by variogram; kriging; mean-square prediction of spatial data) will be taught. The lectures will be complemented by data analyses that the participants have to do themselves.

Lecture notes
Slides, descriptions of the problems for the data analyses and worked-out solutions to them will be provided.

Literature
Part 1, Classification, recalls logistic regression and linear / quadratic discriminant analysis (LDA/QDA) and extends these (in the framework of "Bayes classifier") to (generalized) additive (GAM) and tree models (CART), and further mentions other flexible ("nonparametric") methods.

Part 2, Flexible Prediction (of continuous or "class" response/target) contains additive models, MARS, Y-Transformation models (ACE, AVAS); Projection Pursuit Regression (PPR), neural nets.

The block course is based on (German language) lecture notes.

The exercises are done exclusively with the (free, open source) software "R" (http://www.r-project.org). A final exam will also happen at the computers, using R (and your brains!).

Knowledge of the Elements and the process of a sample survey. Understanding of the paradigm of random samples. Knowledge of simple random sampling and stratified random sampling with their estimation procedures and the use of auxiliary information including the Horvitz-Thompson estimator are introduced. Data preparation, non-response and its treatment, variance estimation and analysis of survey data is discussed.

Knowledge of the Elements and the process of a sample survey. Understanding of the paradigm of random samples. Knowledge of simple random sampling and stratified random sampling and capability to apply the corresponding methods. Knowledge of further methods of sampling and estimation as well as data preparation and analysis.

Bayes statistics is attractive, because it allows to make decisions under uncertainty where a classical frequentist statistical approach fails. The course provides an introduction into bayesian methods. It is moderately mathematically technical, but demands a flexibility of mind, which should not be underestimated.

The course gives a first introduction to the main modelling ideas and mathematical tools from mathematical finance. It aims at a double audience: mathematicians who want to learn the modelling ideas and concepts for finance, and non-mathematicians who need an introduction to the main tools from stochastic used in mathematical finance. The main emphasis will be on ideas, but important results will be given with (sometimes partial) proofs.

The exercises are done exclusively with the (free, open source) software "R" (http://www.r-project.org). A final exam will also happen at the computers, using R (and your brains!).

The course provides an introduction into bayesian methods. It is moderately mathematically technical, but demands a flexibility of mind, which should not be underestimated.

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Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistical methods in clinical research.

**Objective**

- Understand the fundamental "scientific process" in the field of statistical Bioinformatics
- Be equipped with the skills/tools to preprocess genomic data (Unix, Bioconductor, mapping, etc.) and ensure reproducible research (Sweave)
- Have a general knowledge of the types of data and biological applications encountered with microarray and sequencing data
- Have the general knowledge of the range of statistical methods that get used with microarray and sequencing data
- Gain the ability to apply statistical methods/knowledge/software to a collaborative biological project
- Gain the ability to critically assess the statistical bioinformatics literature
- Write a coherent summary of a bioinformatics problem and its solution in statistical terms

**Content**

Lectures will include: microarray preprocessing; normalization; exploratory data analysis techniques such as clustering, PCA and multidimensional scaling; Controlling error rates of statistical tests (FRR versus FDR versus FWER); limma (linear models for microarray analysis); mapping algorithms (for R/ChIP-seq); RNA-seq quantification; statistical analyses for differential count data; isoform switching; epigenomics data including DNA methylation; gene set analyses; classification

**Lecture notes**

Lecture notes, published manuscripts

**Prerequisites / notice**

Prerequisites: Basic knowledge of the programming language R, sufficient knowledge in statistics

**Former course title:** Statistical Methods for the Analysis of Microarray and Short-Read Sequencing Data

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**401-8625-00L Statistical Methods in Clinical Research (University of Zurich)**

**Abstract**

A range of topics will be covered, including basic molecular biology, genomics technologies and in particular, a wide range of statistical and computational methods that have been used in the analysis of DNA microarray and high throughput sequencing experiments.

**Objective**

- Discussion of the different statistical methods that are used in clinical research.

**Content**

Lectures will include: sample size calculation, randomization and blinding, analysis of clinical trials (parallel groups design, analysis of covariance, crossover design, equivalence studies), intention-to-treat analysis, multiple testing, group sequential methods, adaptive designs, diagnostic studies, and agreement studies.

**Literature**


**Prerequisites / notice**

Basic knowledge of the programming language R, sufficient knowledge in calculus, linear algebra, probability, statistics

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**252-0535-00L Machine Learning**

**Abstract**

Machine learning algorithms provide analytical methods to search data sets for characteristic patterns. Typical tasks include the classification of data, function fitting and clustering, with applications in image and speech analysis, bioinformatics and exploratory data analysis. This course is accompanied by practical machine learning projects.

**Objective**

Students will be familiarized with the most important concepts and algorithms for supervised and unsupervised learning; reinforce the statistics knowledge which is indispensible to solve modeling problems under uncertainty. Key concepts are the generalization ability of algorithms and systematic approaches to modeling and regularization. A machine learning project will provide an opportunity to test the machine learning algorithms on real world data.

**Content**

The theory of fundamental machine learning concepts is presented in the lecture, and illustrated with relevant applications. Students can deepen their understanding by solving both pen-and-paper and programming exercises, where they implement and apply famous algorithms to real-world data.

**Topics covered in the lecture include:**

- Bayesian theory of optimal decisions
- Maximum likelihood and Bayesian parameter inference
- Classification with discriminant functions: Perceptrons, Fisher's LDA and support vector machines (SVM)
- Ensemble methods: Bagging and Boosting
- Regression: least squares, ridge and LASSO penalization, non-linear regression and the bias-variance trade-off
- Non parametric density estimation: Parzen windows, nearest neighbour
- Dimension reduction: principal component analysis (PCA) and beyond

**Lecture notes**

No lecture notes, but slides will be made available on the course webpage.

**Literature**

Computational Biology

**Title**: The course provides the first part of an introduction to the statistical software R for scientists. Topics covered are data generation and selection, graphical and basic statistical functions, creating simple functions, basic types of objects.

**Objective**: The students will be able to use the software R for simple data analysis.

**Content**: The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www.rstudio.org

**Prerequisites**: An Introduction to R. http://stat.ethz.ch/CRAN/doc/contrib/Lam-IntroductionToR_LHL.pdf

**Lecture notes**: The course resources will be provided via the Moodle web learning platform

**Notice**: Please login (with your ETH (or other University) username+password) at https://moodle-app2.let.ethz.ch/enrol/users.php?id=1145

Choose the course "Using R for Data Analysis and Graphics" and follow the instructions for registration.

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**Statistical and Mathematical Courses: not eligible for credits**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>401-6215-00L</td>
<td>Using R for Data Analysis and Graphics (Part I)</td>
<td>E-</td>
<td>1</td>
<td>1G</td>
<td>A. J. Papritz, C. B. Schwierz</td>
</tr>
<tr>
<td></td>
<td>The course provides the first part an introduction to the statistical software R for scientists. Topics covered are data generation and selection, graphical and basic statistical functions, creating simple functions, basic types of objects.</td>
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<td>Note: Part I of UsingR is complemented and extended by Part II, which is offered during the second part of the semester and which can be taken independently from Part I.</td>
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<td></td>
<td>Prerequisites / notice: An Introduction to R. <a href="http://stat.ethz.ch/CRAN/doc/contrib/Lam-IntroductionToR_LHL.pdf">http://stat.ethz.ch/CRAN/doc/contrib/Lam-IntroductionToR_LHL.pdf</a></td>
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<td>Please login (with your ETH (or other University) username+password) at <a href="https://moodle-app2.let.ethz.ch/enrol/users.php?id=1145">https://moodle-app2.let.ethz.ch/enrol/users.php?id=1145</a></td>
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<tr>
<td></td>
<td>Choose the course &quot;Using R for Data Analysis and Graphics&quot; and follow the instructions for registration.</td>
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</tbody>
</table>

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**Application Areas**

Students select one area of application and look for suitable courses in which quantitative methods and modeling play a role. They need the consent by the Advisor (http://stat.ethz.ch/~kalisch/) that the chosen courses are eligible in the category "Application Areas".

For the category assignment of eligible courses keep the choice "no category" and take contact with the Study Administration Office (www.math.ethz.ch/studiensekretariat/staff/ekuenti) after having received the credits. The Study Administration Office needs the Advisor's consent.

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**Seminar or Semester Paper**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-3630-06L</td>
<td>Semester Paper ■</td>
<td>W</td>
<td>6</td>
<td>9A</td>
<td>Professors</td>
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<td></td>
<td>No direct enrolment to this course unit in myStudies.</td>
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<td>Please fill in the online application form.</td>
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<td>Requirements and application form under <a href="http://www.math.ethz.ch/intranet/students/study-administration/theses.html">www.math.ethz.ch/intranet/students/study-administration/theses.html</a></td>
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<td>(Afterswards the enrolment will be done by the Study Administration.)</td>
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<tr>
<td></td>
<td>Abstract: Semester papers serve to delve into a problem in statistics and to study it with the appropriate methods or to compile and clearly exhibit a case study of a statistical evaluation.</td>
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<th>Type</th>
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<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>401-3630-04L</td>
<td>Semester Paper ■</td>
<td>W</td>
<td>4</td>
<td>6A</td>
<td>Professors</td>
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<td></td>
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</tbody>
</table>

| 252-5051-00L| Advanced Topics in Machine Learning ■                   | W    | 2    | 2S    | J. M. Buhmann, T. Hofmann, A. Krause |
|             | In this seminar, recent papers of the pattern recognition and machine learning literature are presented and discussed. Possible topics cover statistical models in computer vision, graphical models and machine learning. |
Objective

The seminar "Advanced Topics in Machine Learning" familiarizes students with recent developments in pattern recognition and machine learning. Original articles have to be presented and critically reviewed. The students will learn how to structure a scientific presentation in English which covers the key ideas of a scientific paper. An important goal of the seminar presentation is to summarize the essential ideas of the paper in sufficient depth while omitting details which are not essential for the understanding of the work. The presentation style will play an important role and should reach the level of professional scientific presentations.

Content

The seminar will cover a number of recent papers which have emerged as important contributions to the pattern recognition and machine learning literature. The topics will vary from year to year but they are centered on methodological issues in machine learning like new learning algorithms, ensemble methods or new statistical models for machine learning applications. Frequently, papers are selected from computer vision or bioinformatics - two fields, which relies more and more on machine learning methodology and statistical models.

Literature

The papers will be presented in the first session of the seminar.

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-MATH.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Master Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-2000-00L</td>
<td>Scientific Works in Mathematics</td>
<td>O</td>
<td>0</td>
<td></td>
<td>E. Kowalski</td>
</tr>
<tr>
<td></td>
<td>Target audience:</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Third year Bachelor students;</td>
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<td></td>
<td>Master students who cannot document to have</td>
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<td></td>
<td>received an adequate training in working</td>
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<td></td>
<td>scientifically.</td>
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<td></td>
<td>Mandatory for all Bachelor and Master students</td>
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<td></td>
<td>with matriculation in the autumn semester 2014</td>
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<td>or later.</td>
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<td></td>
<td>Optional for Bachelor and Master students</td>
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<td>with matriculation until or before the spring</td>
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<td>semester 2014.</td>
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<td>Example: You matriculated in the autumn</td>
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<td>semester 2013 into the first semester of the</td>
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<td>Bachelor programme, are</td>
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<td>now in the third year and plan to</td>
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<td>matriculate in the autumn</td>
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<td>semester 2016 into the first semester of the</td>
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<tr>
<td></td>
<td>Master programme. In this case, you don't</td>
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<tr>
<td></td>
<td>need &quot;Scientific Works in Mathematics&quot; in</td>
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<td></td>
<td>order to complete the Bachelor degree, but</td>
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<td>for the Master degree you will need it.</td>
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<td>In this case, we recommend that you register</td>
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<td></td>
<td>for &quot;Scientific Works in Mathematics&quot; in</td>
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<td></td>
<td>the autumn semester 2015 or spring</td>
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<tr>
<td></td>
<td>semester 2016.</td>
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</tr>
</tbody>
</table>

Directive


Abstract

Introduction to scientific writing for students with focus on publication standards and ethical issues, especially in the case of citations (references to works of others.)

Objective

Learn the basic standards of scientific works in mathematics.

Content

- Types of mathematical works
- Publication standards in pure and applied mathematics
- Data handling
- Ethical issues
- Citation guidelines

Lecture notes

Moodle of the Mathematics Library: https://moodle-app2.let.ethz.ch/course/view.php?id=519

Prerequisites / notice

This course is completed by the optional course "Recherchieren in der Mathematik" (held in German) by the Mathematics Library. For more details see: http://www.math.ethz.ch/library/services/schulungen

401-4990-02L

Master's Thesis

Only students who fulfil the following criteria are allowed to begin with their master's thesis:

a. successful completion of the bachelor programme;

b. fulfilling of any additional requirements necessary to gain admission to the master programme;

c. They have acquired at least 16 credits in the category Core Courses.

No direct enrolment to this course unit in myStudies. Please fill in the online application form.

Requirements and application form under www.math.ethz.ch/intranet/students/study-administration/theses.html

(Afterwards the enrolment will be done by the Study Administration.)

Abstract

The master's thesis concludes the study programme. Thesis work should prove the students' ability to independent, structured and scientific working.

Objective

Thesis work should prove the students' ability to independent, structured and scientific working.

Content

Five-month project to solve a research question. The content can be more theoretical (e.g. proving a new result) or applied (developing new methods or making a very sophisticated application and adapting existing methods).

Prerequisites / notice

Supervisors are chosen on a first-come-first-served basis. Collaborations with industry are possible.
### Statistics Master - Key for Type

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
<tr>
<td>O</td>
<td>Compulsory</td>
</tr>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
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</table>

### Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>V</td>
<td>lecture</td>
</tr>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
</tr>
<tr>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
</tr>
</tbody>
</table>

ECTS European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Environmental Engineering Bachelor

1. Semester

First Year Examinations (1. Sem.)

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0241-00L</td>
<td>Analysis I</td>
<td>O</td>
<td>7 credits</td>
<td>5V+2U</td>
<td>M. Akveld</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td>Mathematical tools for the engineer</td>
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<tr>
<td></td>
<td>Objective</td>
<td>Mathematics as a tool to solve engineering problems. Basic mathematical knowledge for engineers. Mathematical formulation of technical and scientific problems.</td>
<td></td>
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<tr>
<td></td>
<td>Content</td>
<td>Complex numbers. Calculus for functions of one variable with applications. Simple Mathematical models in engineering.</td>
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<tr>
<td></td>
<td>Lecture notes</td>
<td>Die Vorlesung folgt weitgehend</td>
<td></td>
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</tr>
<tr>
<td>401-0141-00L</td>
<td>Linear Algebra and Numerical Analysis</td>
<td>O</td>
<td>5 credits</td>
<td>3V+1U</td>
<td>P. Grohs</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td>Introduction to Linear Algebra and Numerical Analysis with emphasis on both abstract concepts and algorithms.</td>
<td></td>
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<tr>
<td></td>
<td>Objective</td>
<td>To acquire basic knowledge of Linear Algebra and Numerical Methods. Enhanced capability for abstract and algorithmic thinking based on mathematical concepts and models. Ability to select appropriate numerical linear algebra methods, to apply them properly and to implement them efficiently in MATLAB.</td>
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<tr>
<td></td>
<td>Content</td>
<td>1. Linear systems of equations</td>
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<td></td>
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<td>2. Vector and matrix calculus</td>
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<td>3. Subspaces and bases</td>
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<td>4. The Euclidean space Rn</td>
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<td>5. Numerical linear algebra with MATLAB</td>
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<td>6. Linear mappings [optional]</td>
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<td>7. Diagonalization (eigenproblems)</td>
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<tr>
<td></td>
<td>Literature</td>
<td>K. Nipp, D. Stoffer, Lineare Algebra, VdF Hochschulverlag ETH</td>
<td></td>
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<tr>
<td></td>
<td>Lecture notes</td>
<td>Lecture Slides will be provided for Download.</td>
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</tr>
<tr>
<td>252-0845-00L</td>
<td>Computer Science I</td>
<td>O</td>
<td>5 credits</td>
<td>2V+2U</td>
<td>M. Hirt</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td>The course covers the basic concepts of computer programming.</td>
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<td></td>
<td>Objective</td>
<td>Basic understanding of programming concepts. Students will be able to write and read simple programs and to modify existing programs.</td>
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<tr>
<td></td>
<td>Content</td>
<td>Variablen, Typen, Kontrollanweisungen, Prozeduren und Funktionen, Scoping, Rekursion, dynamische Programmierung, vektorisierte Programmierung, Effizienz. Als Lernsprachen werden Pascal und Matlab verwendet.</td>
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<tr>
<td>101-0031-01L</td>
<td>Systems Engineering</td>
<td>O</td>
<td>4 credits</td>
<td>3G</td>
<td>B. T. Adey, C. Richmond</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td>An introduction to system development, analysis and optimization, and decision making, with focus on linear programming, networks, formal decision methods and economic analysis.</td>
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<td></td>
<td>Objective</td>
<td>- to gain competency in methods used to plan and analyse systems</td>
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<td></td>
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<td>- to gain the ability to formulate, analyse and solve complex problems</td>
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<td>- to gain competency in the methods used for the evaluation of multiple solutions</td>
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<tr>
<td></td>
<td>Content</td>
<td>- Introduction</td>
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<td></td>
<td></td>
<td>- System development</td>
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<td></td>
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<td>- System analysis</td>
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<td>- Networks</td>
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<td>- Decision theory</td>
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<td>- Economic analysis</td>
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<td></td>
<td></td>
<td>- Cost-benefit analysis</td>
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<tr>
<td></td>
<td>Literature</td>
<td>Script and transparencies as well as additional material via Moodle. The transparencies will be provided via Moodle two days before the respective class.</td>
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<tr>
<td>651-0032-00L</td>
<td>Geology and Petrography</td>
<td>O</td>
<td>4 credits</td>
<td>2V+1U</td>
<td>C. A. Heinrich, S. Löw, K. Rauchenstein</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td>This course gives an overview of the basic concepts of geology and petrography and shows some links to the application of these concepts. The course consists of lectures and exercises in groups. The lectures cover all aspects of the dynamic earth, from the history of the earth, to the formation of rocks, mountains, and oceans, and the degradation processes shaping the uppermost earth's crust.</td>
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<tr>
<td></td>
<td>Objective</td>
<td>This course gives an overview of the basic concepts of geology and petrography and shows some links to the application of these concepts.</td>
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<tr>
<td></td>
<td>Literature</td>
<td>Übungen zum Gesteinsbestimmen und Lesen von geologischen, tektonischen und geotechnischen Karten, einfache Konstruktionen.</td>
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<tr>
<td></td>
<td>Lecture notes</td>
<td>The course is based on the book Dynamic Earth from Press &amp; Siever</td>
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<tr>
<td></td>
<td></td>
<td>Press, F.; Siever, R.: Allgemeine Geologie, Spektrum Akademischer Verlag, Heidelberg</td>
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<tr>
<td>529-2001-02L</td>
<td>Chemistry I</td>
<td>O</td>
<td>4 credits</td>
<td>2V+2U</td>
<td>W. Uhlig, J. E. E. Buschmann, S. Canonica, P. Funck, E. C. Meister, R. Verel</td>
</tr>
</tbody>
</table>

Data: 06.02.2019 13:00   Autumn Semester 2015   Page 1296 of 1434
Abstract
General Chemistry I: Chemical bond and molecular structure, chemical thermodynamics, chemical equilibrium.

Objective
Introduction to general and inorganic chemistry. Basics of the composition and the change of the material world. Introduction to the thermodynamically controlled physico-chemical processes. Macroscopic phenomena and their explanation through atomic and molecular properties. Using the theories to solve qualitatively and quantitatively chemical and ecologically relevant problems.

Content
1. Stoichiometry
2. Atoms and Elements (Quantenmechanical Model of the Atom)
3. Chemical Bonding
4. Thermodynamics
5. Chemical Kinetics
6. Chemical Equilibrium (Acids and Bases, Solubility Equilibria)

Lecture notes
ca. 360 Seiten mit vielen Figuren und durchgerechneten Beispielen.

Literature

Weiterführende Literatur:
Brown, LeMay, Bursten CHEMIE (deutsch)
Housecroft and Constable, CHEMISTRY (englisch)
Oxtoby, Gillis, Nachtrieb, MODERN CHEMISTRY (englisch)

3. Semester

Compulsory Courses 3. Semester

Block 1

<table>
<thead>
<tr>
<th>Number</th>
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<tr>
<td>402-0023-01L</td>
<td>Physics</td>
<td>O</td>
<td>7 credits</td>
<td>5V+2U</td>
<td>L. Degiorgi</td>
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<tr>
<td>101-0203-01L</td>
<td>Hydraulics I</td>
<td>O</td>
<td>5 credits</td>
<td>3V+1U</td>
<td>R. Stocker</td>
</tr>
<tr>
<td>103-0233-01L</td>
<td>GIS I</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>A. Donaubauer</td>
</tr>
<tr>
<td>102-0293-00L</td>
<td>Hydrology</td>
<td>O</td>
<td>3 credits</td>
<td>2G</td>
<td>P. Burlando</td>
</tr>
</tbody>
</table>

Abstract
This course will cover the basic topics in Physics and will show/display/explain with a variety of experiments the most important physical effects. The course will address classical as well as modern physics, and the interplay between basic research and applications.

Objective

Content

Abstract
The course teaches the basics of hydromechanics, relevant for civil and environmental engineers.

Objective
Familiarization with the basics of hydromechanics of steady state flows

Content
Properties of water, hydrostatics, continuity, Euler equation of motion, Navier Stokes equation, similarity, Bernoulli principle, momentum equation for finite volumes, potential flows, ideal fluids-real fluids, boundary layer, pipe flow, open channel flow, flow in porous media, flow measurements, demonstration experiments in the lecture hall and in the laboratory.

Literature
Bollrich, Technische Hydromechanik 1, Verlag Bauwesen, Berlin

Abstract
Fundamentals of geoinformation technologies: spatial data modeling, metrics & topology, vector and raster data, thematic data, spatial queries and analysis, spatial databases; labs with GIS software

Objective
Knowing the fundamentals of geoinformation technologies for the realization, application and operation of geographic information systems in engineering projects.

Content
Einführung GIS & GIScience
Konzeptionelles Modell & Datenschema
Vektorgeometrie & Topologie
Rastergeometrie und -algebra
Thematische Daten
Räumliche Abfragen & Analysen
Geodatenbanken

Literature

Abstract
The course introduces the students to engineering hydrology. It covers first physical hydrology, that is the description and the measurement of hydrological processes (precipitation, interception, evapotranspiration, runoff, erosion, snow), and it introduces then the basic mathematical models of the single processes and of the rainfall-runoff transformation, thereby including flood analysis.

Objective
Know the main features of engineering hydrology. Apply methods to estimate hydrological variables for dimensioning hydraulic structures and managing water resources.
The objective of this lecture is to teach basic ecological concepts and the different levels of complexity in ecological research: the individual, the population, the community and the ecosystem level.

Intervention: Messung und Schätzungen.

Evapotranspiration: Messung, Prozesse, Messung und Schätzungen, potentielle und effektive Evapotranspiration.

Energiebilanzmethode, empirische Methoden.

Infiltration: Messung, Horton-Equations, empirische und konzeptionelle Methoden, F-index und Prozenteuale Methode, SCS-CN Methode.

Einzugsgebietsscharakteristik: Morphologie des Einzugsgebietes, topografische und unterirdische Wasserscheide, hypsometrische Kurve, Gefälle, Dichte des Entwässerungssystems.


Schnee und Eis: Schneeeigenschaften und -messungen Schätzung des Schneeschmelzprozesses durch die Energiebilanzmethode, Abfluss aus Schneeablauffläche, Temperatur-Index- und Grad-Tag-Verfahren.


Lecture notes
Ein internes Skript ist zur Verfügung (kostenpflichtig, nur Herstellungskosten)

Prerequisites / notice
Die Kopie der Folien zur Vorlesung können auf den Websites der Professoren für Hydrologie und Wasserwirtschaft herunterladen werden


Evaporation und Evapotranspiration: Messung, Potentialsatzung, potentielle und effektive Evapotranspiration.


Biology III: Essentials of Ecology

This lecture presents an introduction to ecology. It includes basic ecological concepts and the most important levels of complexity in ecological research. Ecological concepts are exemplified by using aquatic and terrestrial systems; corresponding methodological approaches are demonstrated. In a more applied part of the lecture the threat to biodiversity and the appropriate management are discussed.

A further aim of the lecture is that students achieve an understanding of biodiversity, why it is threatened and how it can be managed.

Teaching of basic knowledge in microbiology with main focus on Microbial Cell Structure and Function, Molecular Genetics, Microbial Growth, Metabolic Diversity, Phylogeny and Taxonomy, Prokaryotic Diversity, Human-Microbe Interactions, Biotechnology.

Teaching of basic knowledge in microbiology.

Lecture notes

Wird von den jeweiligen Dozenten ausgegeben.

Literature

Die Behandlung der Themen erfolgt auf der Basis des Lehrbuchs Brock, Biology of Microorganisms

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
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<th>Lecturers</th>
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<tr>
<td>701-0255-00L</td>
<td>Biochemistry</td>
<td>O</td>
<td>2</td>
<td>2V</td>
<td>H.P. Kohler</td>
</tr>
<tr>
<td>Abstract</td>
<td>Building on the biology courses in the 1st and 2nd semesters, this course covers basic biochemical knowledge in the areas of enzymology and metabolism. Those completing the course are able to describe and understand fundamental cellular metabolic processes.</td>
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<tr>
<td>Objective</td>
<td>Students are able to understand - the structure and function of biological macromolecules - the kinetic bases of enzyme reactions - thermodynamic and mechanistic basics of relevant metabolic processes Students are able to describe the relevant metabolic reactions in detail</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content</td>
<td>Program: Introduction, basics, composition of cells, biochemical units, repetition of relevant organic chemistry Structure and function of proteins Carbohydrates Lipids and biological membranes Enzymes and enzyme kinetics Catalytic strategies Metabolism: Basic concepts and design. Repetition of basic thermodynamics Glycolysis, fermentation The citric acid cycle Oxidative phosphorylation Fatty acid metabolism</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lecture notes</td>
<td>Horton et al. (Pearson) serves as lecture notes.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Basic knowledge in biology and chemistry is a precondition.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### 5. Semester

##### Compulsory Courses 5. Semester

##### Examination Block 3

As of examination session winter 2015, examination block 3 will be implemented in its new structure (i.e. new, Earth Observation will be examined within examination block 3 instead of within examination block 4). The new structure is valid for those students NOT having taken exams of examination block 3 nor of examination block 4 for the first time. All other students take the exams of examination block 3 as well as of examination block 4 in the present structure, including repetition where applicable.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>102-0215-00L</td>
<td>Urban Water Management II</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>M. Maurer, P. Staufer</td>
</tr>
<tr>
<td>Objective</td>
<td>Consolidation of the basic procedures for design and operation of technical networks in water engineering.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lecture notes</td>
<td>Written material and copies of the overheads will be available.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prerequisites / notice</td>
<td>Prerequisite: Introduction to Urban Water Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| 102-0455-01L | Groundwater I | O    | 3    | 2G    | M. Willmann |
| Abstract     | The course provides an introduction into quantitative analysis of groundwater flow and transport. It is focussed on formulating flow and transport problems in groundwater, which are to be solved analytically or numerically. |
| Objective    | a) Students understand the basic concepts of flow and contaminant transport processes and boundary conditions in groundwater. b) Students are able to formulate simple practical flow and transport problems. c) Students are able to understand and apply simple analytical solutions to simple flow and transport problems. d) Students are able to use simple numerical codes to adequately solve simple flow (and transport) problems. |
Introdiction, aquifers, groundwater use, sustainability, porosity.

Properties of porous media.
Exercises: Groundwater use, porosity, grain size analysis.

Flow properties, Darcy’s law, filter.

Flow equations, stream function.
Exercises: Darcy’s law.

Analytical solutions, confined aquifers, steady-state flow.
Exercises: Head isolines.

Use of superposition principles, transient flow, free surface flow.
Exercises: Analytical solutions to flow problems.

Finite difference solutions to flow problems I.
Exercises: Analytical solutions to flow problems.

Finite difference solutions to flow problems II.
Exercises: Finite difference formulations to flow problems.

Transport processes.
Exercises: Computer workshop using PMWIN.

Analytical solutions to transport problems I.
Exercises: Computer workshop using PMWIN.

Analytical solutions to transport problems II.
Exercises: Analytical solutions to transport problems.

Path lines, groundwater protection.
Exercises: Analytical solutions to transport problems.

Groundwater remediation, groundwater management.
Exercises: Groundwater remediation.

Lecture notes
Folien auf Internet unter www.ihw.ethz.ch/GWH/education/index
Altes Skript auf Internet www.ihw.ethz.ch/GWH/education/index
Weitere Texte auf Internet www.ihw.ethz.ch/GWH/education/index

Didaktische Software auf Internet unter www.ihw.ethz.ch/GWH/education/index

W. Kinzelbach, R. Rausch, Grundwassermodellierung, Gebrüder Bornträger, Stuttgart, 1995
Krusemann, de Ridder, Untersuchung und Anwendung von Pumpversuchen, Verl. R. Müller, Köln, 1970
G. de Marsily, Quantitative Hydrogeology, Academic Press, 1986

102-0635-01L Air Pollution Control O 6 credits 4G B. Buchmann, P. Hofer

Abstract
The lecture provides in the first part an introduction to the formation of air pollutants by technical processes, the emission of these chemicals into the atmosphere and their impact on air quality. The second part covers different strategies and techniques for emission reduction. The basic knowledge is deepened by the discussion of specific air pollution problems of today's society.

Objective
The students gain general knowledge of the factors resulting in air pollution and the techniques used for air pollution control. The students can identify major air pollution sources and understand the methods for measurement, data collection and analysis. The students can evaluate possible control methods and equipment, design a control system and estimate the efficiency and cost. The students know the different techniques of air pollution control and their scientific bases. They are able to incorporate goals concerning the air quality into their engineering work.

Content
Part 1 Emission, Immission, Transmission
Fluxes of pollutants and their environmental impact
- physical and chemical processes leading to emission of pollutants
- mass and energy of processes
- Emission measurement techniques and concepts
- quantification of emissions from individual and aggregated sources
- extent and development of the emissions (Switzerland and global)
- propagation and transport of pollutants (transmission)
- meteorological parameters influencing air pollution dispersion
- deterministic and stochastic models, describing the air pollution dispersion
- dispersion models (Gaussian model, box model, receptor model)
- measurement concepts for ambient air (immission level)
- extent and development of ambient air mixing ratios
- goal and instrument of air pollution control

Part 2 Air Pollution Control Technologies
- The reduction of the formation of pollutants is done by modifying the processes (process-integrated measures) and by different engineering operations for the cleaning of waste gas (downstream pollution control). It will be demonstrated, that the variety of these procedures can be traced back on the application of a few basic principles of physical chemistry.
- Procedures for the removal of particles (inertial separator, filtration, electrostatic pre-cipitators, scrubbers) with their different mechanisms (field forces, impaction and diffusion processes) and the modeling of these mechanisms.
- Procedures for the removal of gaseous pollutants and the description of the driving forces involved, as well as the equilibrium and the kinetics of the relevant processes (absorption, adsorption as well as thermal, catalytic and biological conversions).
- Discussion of the technical possibilities to solve the actual air pollution problems.

Autumn Semester 2015
The aim of the course is to provide the fundamental knowledge about earth observation sensors, techniques and methods for bio/geophysical environmental parameter estimation.

Objective

The aim of the course is to provide the fundamental knowledge about earth observation sensors, techniques and methods for bio/geophysical environmental parameter estimation. Students should know at the end of the course:

1. Basics of measurement principle
2. Fundamentals of image acquisition
3. Basics of the sensor-specific geometries
4. Sensor-specific determination of environmental parameters

Content

Die Lehrveranstaltung gibt einen Einblick in die heutige Erdbeobachtung mit dem folgenden skizzierten Inhalt:

1. Einführung in die Fernerkundung von Luft- und Weltraum gestützen Systemen
2. Einführung in das Elektromagnetische Spektrum
3. Einführung in optische Systeme (optisch und hyperspektral)
4. Einführung in Mikrowellen-Technik (aktiv und passiv)
5. Einführung in atmosphärische Systeme (meteo und chemisch)
6. Einführung in die Techniken und Methoden zur Bestimmung von Umweltparametern
7. Einführung in die Anwendungen zur Bestimmung von Umweltparametern in der Hydrologie, Glaziologie, Forst und Landwirtschaft, Geologie und Topographie

Lecture notes

Folien zu jeden Vorlesungsblock werden zur Verfügung gestellt.

Literature

Ausgewählte Literatur wird am Anfang der Vorlesung vorgestellt.
The aim of the course is to provide the fundamental knowledge about earth observation sensors, techniques and methods for bio/geophysical environmental parameter estimation.

### Content

1. Basics of measurement principle
2. Fundamentals of image acquisition
3. Basics of the sensor-specific geometries
4. Sensor-specific determination of environmental parameters

### Literature

- Boillod, J.-P.: Manuel de droit, éd Slatkine, Genève
- Nef, Urs Ch.: Le droit des obligations à l’usage des ingénieurs et des architectes, trad. Bovay, J., éd. Payot, Lausanne

### Examination

- Examen au 1er propédeutique; convient pour travail de semestre.
- Les examens peuvent se faire en français ou en italien.
- Remarques: 
  - Boillod, J.-P.: Manuel de droit, éd Slatkine, Genève

### Prerequisites

- le Code civil et le Code des obligations;
- Nef, Urs Ch.: Le droit des obligations à l’usage des ingénieurs et des architectes, trad. Bovay, J., éd. Payot, Lausanne
- Boillod, J.-P.: Manuel de droit, éd Slatkine, Genève

### Additional Compulsory Courses

- From strategic planning to implementation (Project phases, goals, constraints, and feasibility)
- Project leadership (Leadership, Teams)
- Project organization (Structure)
- Project planning (Schedule, cost and resource planning)
- Project controlling
- Risk and Quality Management
- Project completion

### Notice

- The transparencies will be available for download from the website at least one week before each class.
- Copies of all necessary documents will be distributed at appropriate times.
### Elective Blocks

#### Elective Block: Environmental Planning

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>102-0535-00L</td>
<td>Noise Abatement</td>
<td>W</td>
<td>5</td>
<td>4G</td>
<td>K. Eggenswiler, J. M. Wunderli</td>
</tr>
</tbody>
</table>

**Abstract**  

**Objective**  
The students will understand the basics of noise abatement: acoustics, impact of noise, meas-urement techniques and legislation. The students will be able to analyze different noise prob-lems and they will be able to solve simple problems of noise abatement.

**Content**  

**Lecture notes**  
Skript "Lärmbekämpfung" erhältlich zu Beginn der Vorlesung.

**Prerequisites / notice**  

#### Elective Block: Soil Protection

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0501-00L</td>
<td>Pedosphere</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>R. Kretzschmar</td>
</tr>
</tbody>
</table>

**Abstract**  
Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

**Objective**  
Definition of the pedosphere, soil functions, rocks as parent materials, minerals and weathering, soil organisms, soil organic matter, physical soil properties and functions, chemical soil properties and functions, soil formation, principles of soil classification, global soil regions, soil fertility, land use and soil degradation.

**Content**  
Lecture notes  
Literature  

**Prerequisites / notice**  
Prerequisites: Basic knowledge in chemistry, biology and geology.

#### Elective Block: Civil Engineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0339-00L</td>
<td>Environmental Geotechnics</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>L. M. Plötze</td>
</tr>
</tbody>
</table>

**Abstract**  
Introduction of basic knowledge about problems with contaminated sites, investigation of this sites, risk management, remediation and reclamation techniques as well as monitoring systems.

**Objective**  
Introduction of basic knowledge about problems with contaminated sites, investigation of this sites, risk management, remediation and reclamation techniques as well as monitoring systems.

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Data: 06.02.2019 13:00  
Autumn Semester 2015  
Page 1303 of 1434
The understanding and the computation of the essential hydraulic processes in wastewater hydraulics are presented. On the one hand, free-surface hydraulics is reviewed with particular reference to problems in wastewater hydraulics, whereas various special hydraulic structures such as manholes, separation structures and collector channels are analyzed with a hydraulic approach on the other hand. Particularities of wastewater schemes including depositions and the choking of a sewer as the abrupt transition from free-surface to pressurized high-speed flow are highlighted.

### Elective Block: Energy

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>529-0193-00L</td>
<td>Renewable Energy Technologies I</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>A. Wokaun, A. Steinfeld</td>
</tr>
</tbody>
</table>

### Course Catalogue of ETH Zurich

#### Electives

The entire course programs of ETH Zurich and the University of Zurich are open to the students to individual selection.

#### Electives ETH Zurich

<table>
<thead>
<tr>
<th>Recommended GESS compulsory elective courses (Type B) for D-BAUG.</th>
</tr>
</thead>
<tbody>
<tr>
<td>see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability</td>
</tr>
</tbody>
</table>
## Bachelor Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>102-0006-00L</td>
<td>Bachelor's Thesis</td>
<td>O</td>
<td>10 credits</td>
<td>20D</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

**Abstract**
The Bachelor Programme concludes with the Bachelor Thesis. This project is supervised by a professor. Writing up the Bachelor Thesis encourages students to show independence and to produce structured work.

**Objective**
Encourages students to show independence, to produce scientifically structured work and to apply engineering working methods.

**Content**
The contents base upon the fundamentals of the Bachelor Programme. Students can choose from different subjects and tasks. The thesis consists of both a written report and an oral presentation.

### Environmental Engineering Bachelor - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

### Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
<th>P</th>
<th>practical/laboratory course</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
<td>A</td>
<td>independent project</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
<td>R</td>
<td>revision course / private study</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
<td></td>
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</tr>
</tbody>
</table>

**ECTS**
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
Environmental Engineering Master

1. Semester

Compulsory Specialized Computer Laboratory for Env. Engin.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

Abstract
Technical systems are investigated in projects with measurement campaigns and numerical modeling. The students learn how to answer given questions with target oriented methodologies.

Objective
Technical systems are investigated in projects with measurement campaigns and numerical modeling. The students learn how to answer given questions with target oriented methodologies.

Content
The following projects are conducted
- Construction, operation and characterization of a mini wastewater treatment plant
- Characterization of aquifers with pumping experiments
- Measuring of hydrological systems
- Measuring of nanoparticles at workplaces
- Measuring and modeling of sediment transport in rivers
- Investigations of polluted terrain

Lecture notes
Written material will be available.

Major Courses

Major in Water Resources Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>102-0237-00L</td>
<td>Hydrology II</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>P. Burlando, S. Fatichi</td>
</tr>
</tbody>
</table>

Abstract
The course presents advanced hydrological analyses of rainfall-runoff processes. The course is given in English.

Objective
Tools for hydrological modelling are discussed at the event and continuous scale. The focus is on the description of physical processes and their modeling with practical examples.

Content

Lecture notes
Parts of the script for "Hydrology II" are used. Also available are the overhead transparencies used in the lectures. The semester project consists of a two part instruction manual.

Literature
Additional literature is presented during the course.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>101-0267-01L</td>
<td>Numerical Hydraulics</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>M. Holzer</td>
</tr>
</tbody>
</table>

Abstract
In the course Numerical Hydraulics the basics of numerical modelling of flows are presented.

Objective
The goal of the course is to develop the understanding of the students for numerical simulation of flows to an extent that they can later use commercial software in a responsible and critical way.

Content
The basic equations are derived from first principles. Possible simplifications relevant for practical problems are shown and their applicability is discussed. Using the example of non-steady state pipe flow numerical methods such as the method of characteristics and finite difference methods are introduced. The finite volume method as well as the method of characteristics are used for the solution of the shallow water equations. Special aspects such as wave propagation and turbulence modelling are also treated.

All methods discussed are applied practically in exercises. This is done using programs in MATLAB which partially are programmed by the students themselves. Further, some generally available softwares such as Hydraulic Systems and HEC RAS for non-steady flows are used.

Lecture notes
Lecture notes, powerpoints shown in the lecture and programs used can be downloaded. They are also available in German.

Literature
Given in lecture

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>102-0287-00L</td>
<td>Fluvial Systems</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>P. Molnar</td>
</tr>
</tbody>
</table>

Abstract
The course presents an integrated view of the river basin and fluvial system. The fluvial system is viewed in terms of the dynamics in the transfer of water and sediment, the resulting geomorphology of the river network and streams, and finally the basin and river management options for conservation and restoration.

Objective
The goal of the course is to develop process-understanding of fluvial systems and to introduce the students to appropriate analysis tools.

Content
In the first section the estimation of basin sediment supply from upland sheet, rill and gully erosion, and basin sediment yield are discussed. The second section focuses on sediment transport in rivers in general, e.g. basic mechanics of sediment laden flows, bedforms, flow resistance, sediment type and load measurement and estimation, the morphology of rivers. It is illustrated how the river network can be analyzed in terms of its connectivity and topological characteristics. Channel stability and channel erosion modelling are discussed. The third section looks at fluvial system management in terms of engineering and nonstructural sediment (e.g. upland and channel erosion protection) and water (e.g. the importance of the natural streamflow regime on riverine ecosystem integrity, river rehabilitation) resource management.

Lecture notes
There is no script.

Literature
Study materials (lecture handouts and selected papers) are distributed in class and available on the web.

Prerequisites / notice
Prerequisites: Hydrology 1 and Hydrology 2 (or contact instructor).

Major in Urban Water Management

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>102-0217-00L</td>
<td>Process Engineering I (Biological Processes)</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>E. Morgenroth</td>
</tr>
</tbody>
</table>

Abstract
Introduction of kinetic models for activated sludge systems and biological nutrient removal as a basis for design and dynamic simulation: Nitrification, denitrification, biological phosphorus removal (ASM1 to ASM3). Kinetics of biofilms, application to full scale reactors. Anaerobic treatment schemes, industrial waste, biogas production, sludge handling. Aerobic thermophilic processes.
Objective: The goal of this unit is to provide the background for understanding, design and simulation of today's biological wastewater treatment and sludge stabilization processes. The students shall be capable of applying and recognizing the limits of the kinetic models which have been developed to simulate these systems.

Content:
- Microbial transformation processes
- Introduction to the activated sludge process
- Modeling activated sludge systems
- Nitrification / denitrification / biological P elimination
- Enrichment, selectors, filamentous growth
- Biofilm kinetics and application to full scale plants
- Anaerobic processes, industrial applications, sludge stabilization
- Aerobic thermophilic processes

Lecture notes: Copies of overheads will be made available.

Literature: There will be a required textbook that students need to purchase (see http://www.ifu.ethz.ch/SWW/education/lectures/Proc_Eng_I for further information).

Prerequisites / notice: This course will be offered together with the course Systems Analysis and Mathematical Modeling. It is advantageous to follow both courses simultaneously. For detailed information on prerequisites and information needed from Systems Analysis and Mathematical Modeling the student should consult the lecture program and important information (syllabus) of the course Process Engineering I that can be downloaded at http://www.ifu.ethz.ch/SWW/education/lectures/Proc_Eng_I.

102-0227-00L Systems Analysis and Mathematical Modeling in Urban Water Management

This course supports the course in Biological Wastewater Treatment (102-0217-00L). It is therefore advantageous to follow both courses simultaneously.


Objective: The goal of this course is to provide the students with an understanding and the tools to develop their own mathematical models, to plan experiments, to evaluate error propagation and to test simple process control strategies in the field of process engineering in urban water management.

Content: The course will provide a broad introduction into the fundamentals of modeling water treatment systems. The topics are:
- Introduction into modeling and simulation
- The material balance equations, transport processes, transformation processes (kinetics, stoichiometry, conservation)
- Ideal reactors
- Hydraulic residence time distribution and modeling of real reactors
- Dynamic behavior of reactor systems
- Systems analytical tools: Sensitivity, parameter identification, error propagation, Monte Carlo simulation
- Introduction to process control (PID controller, fuzzy control)

Lecture notes: Copies of overheads will be made available.

Literature: There will be a required textbook that students need to purchase:

Prerequisites / notice: This course will be offered together with the course Process Engineering I. It is advantageous to follow both courses simultaneously.


In the Major in "Ecolog. Systems Design, Air Quality Contr. and Waste Manag.," one out of three possible combinations of modules must be taken:

1st combination: ESD & Air Quality Control;
2nd combination: Air quality control & Waste management;
3rd combination: Waste management & ESD.

Students that choose either combination 2 or 3 and have Urban Water Management as a second Major need to take course "102-0337-00L Landfilling, Contaminated Sites and Radioactive Waste Repositories" (offered in spring semester) instead of "102-0217-00L Process Engineering I (Biological Processes)."

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>102-0217-00L</td>
<td>Process Engineering I (Biological Processes)</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>E. Morgenroth</td>
</tr>
</tbody>
</table>


Objective: The goal of this unit is to provide the background for understanding, design and simulation of today's biological wastewater treatment and sludge stabilization processes. The students shall be capable to apply and recognize the limits of the kinetic models which have been developed to simulate these systems.

Content: Microbial transformation processes
- Introduction to the activated sludge process
- Modeling activated sludge systems
- Nitrification / denitrification / biological P elimination
- Enrichment, selectors, filamentous growth
- Biofilm kinetics and application to full scale plants
- Anaerobic processes, industrial applications, sludge stabilization
- Aerobic thermophilic processes

Lecture notes: Copies of overheads will be made available.

Literature: There will be a required textbook that students need to purchase (see http://www.ifu.ethz.ch/SWW/education/lectures/Proc_Eng_I for further information).

Prerequisites / notice: This course will be offered together with the course Systems Analysis and Mathematical Modeling. It is advantageous to follow both courses simultaneously. For detailed information on prerequisites and information needed from Systems Analysis and Mathematical Modeling the student should consult the lecture program and important information (syllabus) of the course Process Engineering I that can be downloaded at http://www.ifu.ethz.ch/SWW/education/lectures/Proc_Eng_I.
This course deepens students' knowledge of environmental, economic, and social assessment methodologies and their various applications.

In particular, students completing the course should have the
- ability to judge the scientific quality and reliability of environmental assessment studies, the appropriateness of inventory data and modelling, and the adequacy of life cycle impact assessment models and factors.
- knowledge about the current state of the scientific discussion and new research developments
- ability to properly plan, conduct and interpret environmental assessment studies

In the course element "Implementation of...", students will learn to
- describe key sustainability problems of the current economic system and measuring units;
- describe the management system of an organisation and illustrate how to improve its sustainability management (especially planning and controlling), based on current ISO management standards and additional frameworks.
- discuss approaches to measure environmental performance measurement of an organisation, including 'organisational LCA' (Ecobalance)
- single score env. assessment methods
- demonstrate life cycle costing from a sustainability viewpoint
- interpret stakeholder relations of an organisation
- (if time allows) describe sustainable supply chain management

Part I (Advanced Environmental Assessments):
- Inventory database developments, transparency, data quality, data completeness, and data exchange formats, uncertainties
- Software tools (MFA, LCA)
- Allocation (multioutput processes and recycling)
- Hybrid LCA methods.
- Consequential and marginal analysis
- Impact assessment of waterborne chemical emissions, sum parameters, mixture toxicity
- Spatial differentiation in Life Cycle Assessment
- Workplace and indoor exposure in Risk and Life Cycle Assessment
- Subjectivity in environmental assessments
- Case Studies

Part II (Implementation of Environmental and other Sustainability Goals):
- Sustainability problems of the current economic system and its measuring units;
- The structure of a management system, and elements to integrate environmental management (ISO 14001) and social management (SA8000 as well as ISO 26000), especially into strategy development, planning, controlling and communication;
- Sustainability Opportunities and Innovation
- The concept of 'Continuous Improvement'
- Life Cycle Costing, Life Cycle Management
- environmental performance measurement of an organisation, including 'organisational LCA' (Ecobalance), based on practical examples of companies and new concepts
- single score env. assessment methods (Swiss ecopoints)
- stakeholder management and sustainability oriented communication
- an intro into sustainability issues of supply chain management

Students will get small exircises related to course issues.

Part III (Computer Lab): this is an exercise and software lab to apply the methods from Part I and II of this lecture.

Introduction
Waste Recycling; Scope and objectives
Waste recycling technologies in Switzerland
Fundamentals
Properties of particles: Liberation conditions, Particle size and shape, Porosity of bulk materials
Fluid dynamics of particles: Stationary particle beds, Fluidized beds, Free settling particles
Flow sheet basics: Balancing mass flows
Standard processes: batch vs. continuous
Assessment of separation success: Separation function; grade vs. recovery

Separation Process
Separation according to size and shape (Classification): Screening, Flow separation
Separation according to material properties (Concentration): Magnetic sorting, Gravity concentration; Magnetic separation, Eddy current separation, Electrostatic separation, Sensor technology, Froth flotation

Lecture notes
The script consists of the transparencies shown during the lectures. Background material will be provided on the script-server.

Literature
A list of recommended books will be provided.

Prerequisites / notice
We will approach this topic from the perspective not of theory, but of practical application. However, solid fundamentals in physics (in particular in mechanics) are strongly recommended.
Hydraulic structures and their function within a hydraulic scheme are explained. The basic concepts of their layout and design with regard to ECTS Type

**W. Hummel**

Short script plus copies of overheads

Air pollutants cause negative effects on humans, wildlife and buildings. To control and reduce the impact of air pollutants, their transfer to economy and safety are provided.

**I. Hajnsek**

Lists of suitable books and papers will be provided in the lecture.

This lecture course comprises of lectures with exercises and guided case studies. Literature will be made available.

The course should provide an understanding of SAR techniques and the use of the imaging tools for bio/geophysical parameter estimation.

**L. M. Plötze**

This lecture course comprises of lectures with exercises and guided case studies. Literature will be made available.

The students understand the fundamental principles of atmospheric transport, dispersion and chemistry of pollutants on the local to regional scale and their transfer between air and condensed phases (aerosols, water, solids). This includes the knowledge of important atmospheric reactions, sources and sinks. The obtained understanding enables the students to apply computational tools to predict the transport and transformation of chemicals at the local to regional scale.

**Objective**

- Structure of the Atmosphere
- Thermodynamics of the atmosphere
- Atmospheric stability
- Atmospheric boundary layer and turbulence
- Dispersion in the atmospheric boundary layer
- Numerical models of atmospheric dispersion
- Gas phase reaction kinetics
- Tropospheric chemistry and ozone formation
- Chemistry box models
- Volatile organic pollutants (VOCs) and semi-volatile organic pollutants (SVOCs)
- Distribution of chemicals between different phases
- Kinetics of phase transfer processes
- Computational tools to estimate volatility, distribution and phase transfer rates of organic chemicals

**Content**

**Lecture notes**

Hand-outs of lecture material with extended comments will be made available along with the lecture.

**Literature**

Lists of suitable books and papers will be provided in the lecture.

**Prerequisites / notice**

- Structure of the Atmosphere
- Thermodynamics of the atmosphere
- Atmospheric stability
- Atmospheric boundary layer and turbulence
- Dispersion in the atmospheric boundary layer
- Numerical models of atmospheric dispersion
- Gas phase reaction kinetics
- Tropospheric chemistry and ozone formation
- Chemistry box models
- Volatile organic pollutants (VOCs) and semi-volatile organic pollutants (SVOCs)
- Distribution of chemicals between different phases
- Kinetics of phase transfer processes
- Computational tools to estimate volatility, distribution and phase transfer rates of organic chemicals

**102-0337-00L Landfilling, Contaminated Sites and Radioactive Waste Repositories**

- Structure of the Atmosphere
- Thermodynamics of the atmosphere
- Atmospheric stability
- Atmospheric boundary layer and turbulence
- Dispersion in the atmospheric boundary layer
- Numerical models of atmospheric dispersion
- Gas phase reaction kinetics
- Tropospheric chemistry and ozone formation
- Chemistry box models
- Volatile organic pollutants (VOCs) and semi-volatile organic pollutants (SVOCs)
- Distribution of chemicals between different phases
- Kinetics of phase transfer processes
- Computational tools to estimate volatility, distribution and phase transfer rates of organic chemicals

**Objective**

Upon successful completion of this course students are able to:
- assess the risk posed to the environment of landfills, contaminated sites and radioactive waste repositories in terms of fate and transport of contaminants
- describe technologies available to minimize environmental contamination
- describe the principles in handling of contaminated sites and to propose and evaluate suitable remediation techniques
- explain the concepts that underlie radioactive waste disposal practices

**Content**

This lecture course comprises of lectures with exercises and guided case studies.

- A short overview of the principles of environmental protection in waste management and how this is applied in legislation.
- A overview of the chemistry underlying the release and transport of contaminants from the landfilled/contaminated material/radioactive waste repository focusing on processes that control redox state and pH buffer capacity; mobility of heavy metals and organic compounds
- Technical barrier design and function. Clay as a barrier.
- Contaminated site remediation: Site evaluation, remediation technologies
- Concepts and safety in radioactive waste management
- Role of the geological and engineered barriers and radionuclide transport in geological media.

**Lecture notes**

Short script plus copies of overheads

**Literature**

Lists of suitable books and papers will be provided in the lecture.

**Prerequisites / notice**

This is an interdisciplinary course aimed at environmental scientists and environmental engineers.

### Major in Hydraulic Engineering

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>101-0247-01L</td>
<td>Hydraulic Engineering II</td>
<td>O</td>
<td>6 credits</td>
<td>4G</td>
<td>R. Boes</td>
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</tbody>
</table>

**Abstract**

Hydraulic structures and their function within a hydraulic scheme are explained. The basic concepts of their layout and design with regard to economy and safety are provided.

**Objective**

Knowledge of hydraulic structures and their function within a hydraulic scheme. Skills for the layout and design of hydraulic structures with regard to economy and safety.

**Content**

- Weirs: Weir stability, gates, inflatable dams, appurtenant structures.
- Conduits: Design of headraces, pressure shafts, and penstocks, constructive details and construction.
- Power plants: Power house and turbine types, design, structure, construction.
- Dams: Dam types, appurtenant structures (diversion, spillways, bottom outlet), dam type selection criteria, layout and design of gravity dams, buttress dams, arch dams, rockfill dams with central core or concrete face, measures in the foundation, mass concrete, RCC dams, reservoir siltation and sediment management, dam surveillance.
- Artificial reservoirs: Purpose, layout, sealing, appurtenant structures, environmental aspects.

**Lecture notes**

Manuscript and further documentation

**Literature**

Is specified in the lecture and in the manuscript

**Prerequisites / notice**

Information: Enrolment of Hydraulic Engineering II is not recommended without having attended Hydraulic Engineering (101-0206-00L) previously since Hydraulic Engineering II is strongly based on Hydraulic Engineering (101-0206-00L).

**102-0617-00L Basics and Principles of Radar Remote Sensing for Environmental Applications**

- Structure of the Atmosphere
- Thermodynamics of the atmosphere
- Atmospheric stability
- Atmospheric boundary layer and turbulence
- Dispersion in the atmospheric boundary layer
- Numerical models of atmospheric dispersion
- Gas phase reaction kinetics
- Tropospheric chemistry and ozone formation
- Chemistry box models
- Volatile organic pollutants (VOCs) and semi-volatile organic pollutants (SVOCs)
- Distribution of chemicals between different phases
- Kinetics of phase transfer processes
- Computational tools to estimate volatility, distribution and phase transfer rates of organic chemicals

**Objective**

The course will provide the basics and principles of Radar Remote Sensing (specifically Synthetic Aperture Radar (SAR)) and its imaging techniques for the use of environmental parameter estimation.

At the end of the course the student has the understanding of:
1. SAR basics and principles,
2. SAR polarimetry,
3. SAR interferometry and
4. environmental parameter estimation from multi-parametric SAR data

**Abstract**

The course should provide an understanding of SAR techniques and the use of the imaging tools for bio/geophysical parameter estimation.
Content

The course is giving an introduction into SAR techniques, the interpretation of SAR imaging responses and the use of SAR for different environmental applications. The outline of the course is the following:
1. Introduction into SAR basics and principles
2. Introduction into electromagnetic wave theory
3. Introduction into scattering theory and decomposition techniques
4. Introduction into SAR interferometry
5. Introduction into polarimetric SAR interferometry
6. Introduction into bio/geophysical parameter estimation (classification/segmentation, soil moisture estimation, earth quake and volcano monitoring, forest height inversion, wood biomass estimation etc.)

Lecture notes

Handouts for each topic will be provided

Literature

First readings for the course:

Prerequisites / notice

This course in combination with 102-0627-00-G: Applied Radar Remote Sensing for Environmental Parameter Estimation is providing a profound basis for independent data analysis. It is recommended to take both courses together.

101-0258-00L River Engineering

Main subjects treated:
Fundamentals (e.g. sediment sampling methods), alluvial channel hydraulics, incipient motion, bed forms, bed load and suspended load, sediment budget and morphological changes, river morphology, scour, river management concepts and selected measures (e.g. bank and bed protection works).
A practical exercise (voluntary, unmarked) is offered to deepen the learned subjects.

Objective

The students shall
- be able to describe quantitatively the interrelation between discharge, sediment transport and channel evolution
- know the fundamentals and be able to apply the approaches and methods to treat river engineering problems associated with flood protection and river restoration

Content

The first part of the lecture treats the fundamentals required to deal with river engineering problems. Sampling methods for the river bed material and methods to calculate the discharge in alluvial rivers are presented. The process of river bed armoring and the principles of incipient motion, of bed load and suspended load transport are treated. In the second part of the lecture the procedures to quantify the sediment budget and the morphological changes (erosion, aggradation) in river systems are explained. Furthermore, the process of natural channel formative, and the different plan forms of rivers (straight, meandering, braided) are discussed. Own chapters are dedicated to the topics of bed forms, river morphology and scour.

The last part of the lecture concentrates on the design and dimensioning of river engineering works. The topics treated are the stabilization of banks and of the longitudinal profile of rivers.

Lecture notes

Autography River Engineering (in German)

Autography contains a comprehensive list of references to relevant literature.

Literature

The voluntary and unmarked exercise bases on field data, which are collected by the students on a river in nature. Besides the collection of fundamentals and field data, the exercise comprehends the calculation of the stage-discharge relationship, of the critical discharges at the onset of bed load transport and bed erosion and of the annual sediment load in a given river reach.

101-0269-00L Numerical Modelling in Fluvial Hydraulics and River Engineering

The basics of numerical modelling of fluvial hydraulics and river engineering problems are presented. The governing equations for flow and sediment transport in open channels and corresponding numerical solution strategies are introduced. The theoretical parts are discussed by examples.

Objective

Get to know possibilities and limitations of numerical modelling in fluvial hydraulics and river engineering.

Content

- Governing equations and modelling approaches
- Initial and boundary conditions
- Simulation process and grid generation
- Numerical methods: basics, accuracy and stability
- Examples of numerical schemes, 1D and 2D models

Lecture notes

Slides of lecture are available for download as PDF. Supplementary material will be provided during lecture.

Literature

Relevant books and citations will be mentioned.

Prerequisites / notice

Exercises are based on the simulation software BASEMENT (www.basement.ethz.ch), the open-source GIS Qgis (www.qgis.org) and code examples written in MATLAB. The applications comprise one- and two-dimensional approaches for the modelling of flow and sediment transport.


Major in Soil Protection

As replacement of 101-0314-99 Soil Mechanics, one of following three courses is compulsory for students of major Soil Protection:
1. 651-4033-00 Soil Mechanics and Foundation (HS), or
2. 751-3404-00L Nutrient Fluxes in Soil-Plant Systems (FS), or
3. 701-1802-00L Ökologie von Waldböden (FS),

Number Title Type ECTS Hours Lecturers

701-0535-00L Environmental Soil Physics/Vadose Zone Hydrology O 3 credits 2G+2U D. Or

Abstract

The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/ near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.

Objective

Students are able to
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media,
- quantify driving forces and resulting fluxes of water, solute, and heat in soils,
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 1310 of 1434
Content

Weeks 1 to 3: Physical Properties of Soils and Other Porous Media Units and dimensions, definitions and basic mass-volume relationships between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay behavior

Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity

Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing

Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:
Part 1 - Laminar flow in tubes (Poiseuille's Law); Darcy's Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement.

Lab #1: Measurement of saturated hydraulic conductivity in uniform and layered soil columns using the constant head method.

Part 2 - Unsataturated steady state flow: unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.

Midterm exam

Lab #2: Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip's approximations; infiltration rates and wetting front propagation.

Part 3 - Use of Hydrus model for simulation of unsaturated flow

Week 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface evaporation.

Week 12 to 13: Solute Transport in Soils Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion eq.; solutions for pulse and step solute application; parameter estimation; salt balance.

Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

Additional topics:
Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.

Biological Processes in the Vadose Zone An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology

Lecture notes
Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller
(available at the beginning of the semester)

Literature
Supplemental textbook (not mandatory) - Environmental Soil Physics, by: D. Hillel

701-1315-00L Biogeochemistry of Trace Elements O 3 credits 2G A. Voegelin, J. G. Wiederhold, L. Winkel
Abstract
The course addresses major biogeochemical processes that drive the cycling of different groups of trace elements (heavy metals, redox-sensitive trace elements, chalcophile elements) in the environment, and the chemical methods that are used to study the behavior of these elements in the geosphere.

Objective
The students gain a detailed understanding of the sources and the cycling of trace elements in the terrestrial and aquatic environment. The interaction of environmentally important trace elements with abiotic and biotic geosphere components as well as their abiotically and biotically driven transformations will be discussed. Relevant methods/techniques to study these processes will be presented.

Content
The course deals in-depth with the major biogeochemical processes controlling the cycling of different groups of trace elements (heavy metals, redox-sensitive and chalcophile elements) in the environment. Sources and cycling of trace elements as related to interactions with abiotic and biotic geosphere components, and abiotically and biotically driven transformations will be discussed. The techniques most commonly used to study these processes will be presented as well.

Lecture notes
Selected handouts (lecture notes, literature, exercises) will be distributed during the course.

Prerequisites / notice
Students are expected to be familiar with the concepts of aquatic or soil chemistry covered in the respective classes at the bachelor level.

This lecture is a prerequisite for attending the laboratory course “Trace elements laboratory”.

701-1681-00L Element Balancing and Soil Functions in Managed Ecosystems O 3 credits 2G A. Keller
Abstract
Applying element balances of agricultural soils and the assessment of soil functions for real applications in computer exercises to design preventive strategies against soil pollution and to support sustainable management of regional agroecosystems also in the context of spatial planning procedures.

Objective
The students learn to critically assess changes in land use management on element cycles in agro-ecosystems and to assess soil services (soil functions). You design solutions for chemical problems in soil protection at the regional scale and learn to assess soil functions using different methods.

Content
The students apply a regional balance model for Swiss regions in computer exercises and assess major soil functions of agricultural soils. You assess the sustainability of current land use and analyse management options improving nutrient and metal cycling in agro-ecosystems. The students will have the opportunity to calculate specific scenarios regarding land use management and environmental changes. Special focus we be paid on the soil services such as regulation-, production function and soil as habitat, and the assessment of these functions based on soil mapping data.

Lecture notes
Literature and Exercises for a case study

Literature
Literature will be provided.
The course consists of lectures and computer exercises. The course take place every 2 weeks à 4 hours. recommended prerequisites for attending this course:
- Bodenschutz und Landnutzung
- Biochemistry of Trace Elements
- Angewandte Bodenökologie

**651-4033-00L**

**Soil Mechanics and Foundation Engineering**

| W  | 4 credits | 3V+2U | M. Perras, A. Wolter, M. Stolz |

**Abstract**
The course presents the principles of soil mechanics and soil behaviour characteristics and its applications in geotechnical structures and systems. It is based on more descriptive courses on Engineering Geology within the BSc Geol. Program and is a compulsory prerequisite for other courses within the MSc Eng. Geol. program.

**Objective**
Understanding the principles of soil behaviour and the fundamentals of geotechnical practices in soils.

**Content**
- Soil Mechanics: Fundamental concepts of strength and deformation of different soils. Introduction to geotechnical calculations
- Significance of (ground)water
- Geotechnical Engineering in Soils: Evaluation of geotechnical scenarios, handling of forecast uncertainties, relation of soil properties and soil composition, interactions between soil and building,
- standard construction methods in soils (foundations, slopes, dams and levees), requirements for the geotechnical prognosis

**Lecture notes**
This lecture is supported by the textbook: “Geotechnical Engineering” by Donald P. Coduto, 2nd edition, 2011; ISBN-13: 978-0-13-135425-8

**Prerequisites / notice**
Courses must be completed:
- Introduction to Engineering Geology (BSc level)
- Introduction to Groundwater
- Sedimentology and Quaternary deposits
- Principles of Physics

Courses recommended:
- Eng Geol Site Investigations
- Eng Geol Field Course I (soils)
- Clay Mineralogy

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### Minors

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<th>Number</th>
<th>Title</th>
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<th>Hours</th>
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<tr>
<td>102-0227-00L</td>
<td>Systems Analysis and Mathematical Modeling in Urban Water Management</td>
<td>W</td>
<td>6</td>
<td>4G</td>
<td>E. Morgenroth, M. Maurer</td>
</tr>
</tbody>
</table>

**Abstract**

**Objective**
The goal of this course is to provide the students with an understanding and the tools to develop their own mathematical models, to plan experiments, to evaluate error propagation and to test simple process control strategies in the field of process engineering in urban water management.

**Content**
The course will provide a broad introduction into the fundamentals of modeling water treatment systems. The topics are:
- Introduction into modeling and simulation
- The material balance equations, transport processes, transformation processes (kinetics, stoichiometry, conservation)
- Ideal reactors
- Hydraulic residence time distribution and modeling of real reactors
- Dynamic behavior of reactor systems
- Systems analytical tools: Sensitivity, parameter identification, error propagation, Monte Carlo simulation
- Introduction to process control (PID controller, fuzzy control)

**Lecture notes**
Copies of overheads will be made available.

**Literature**
There will be a required textbook that students need to purchase:

**Prerequisites / notice**
This course will be offered together with the course Process Engineering I. It is advantageous to follow both courses simultaneously.

<table>
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<tr>
<th>Number</th>
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<td>102-0217-00L</td>
<td>Process Engineering I (Biological Processes)</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>E. Morgenroth</td>
</tr>
</tbody>
</table>

**Abstract**
This course will be combined with Systems Analysis and Mathematical Modeling (102-0227-00L). It is therefore advantageous to follow both courses simultaneously.

**Objective**
The goal of this unit is to provide the background for the understanding, design and simulation of todays biological wastewater treatment and sludge stabilization processes. The students shall be capable to apply and recognize the limits of the kinetic models which have been developed to simulate these systems.

**Content**
- Microbial transformation processes
- Introduction to the activated sludge process
- Modeling activated sludge systems
- Nitrification / denitrification / biological P elimination
- Enrichment, selectors, filamentous growth
- Biofilm kinetics and application to full scale plants
- Anaerobic processes, industrial applications, sludge stabilization
- Aerobic thermophilic processes

**Lecture notes**
Copies of overheads will be made available.

**Literature**
There will be a required textbook that students need to purchase (see http://www.ifu.ethz.ch/SWW/education/lectures/Proc_Eng_I for further information).
### Prerequisites / notice
This course will be offered together with the course Systems Analysis and Mathematical Modeling. It is advantageous to follow both courses simultaneously. For detailed information on prerequisites and information needed from Systems Analysis and Mathematical Modeling the student should consult the lecture program and important information (syllabus) of Process Engineering I that can be downloaded at http://www.ifu.ethz.ch/SWW/education/lectures/Proc_Eng_I.

<table>
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<th>Course Code</th>
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<tr>
<td>101-0247-01L</td>
<td>Hydraulic Engineering II</td>
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<tr>
<td>101-0269-00L</td>
<td>Numerical Modelling in Fluvial Hydraulics and River Engineering</td>
</tr>
<tr>
<td>101-0249-00L</td>
<td>Selected Topics on Hydraulic Engineering</td>
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<tr>
<td>101-0289-00L</td>
<td>Applied Glaciology</td>
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<tr>
<td>102-0287-00L</td>
<td>Fluvial Systems</td>
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</table>

**Abstract**
- Hydraulic structures and their function within a hydraulic scheme are explained. The basic concepts of their layout and design with regard to economy and safety are provided.
- The basics of numerical modelling of fluvial hydraulics and river engineering problems are presented. The governing equations for flow and sediment transport in open channels and corresponding numerical solution strategies are introduced. The theoretical parts are discussed by examples.
- The lecture focuses on selected topics in hydraulic engineering, water management and aquatic ecology relating to hydropower and flood protection projects.
- We will explain the fundamentals of physics of glaciers which are necessary for treating applied problems. We will go into climate-glacier interactions, flow of glaciers, lake ice and hydrology of glaciers.

**Objective**
- Knowledge of hydraulic structures and their function within a hydraulic scheme. Skills for the layout and design of hydraulic structures with regard to economy and safety.
- To get to know possibilities and limitations of numerical modelling in fluvial hydraulics and river engineering.
- To identify glaciological hazards and to learn some assessment and mitigation possibilities.
- To understand the fundamental physical processes in glaciology, To learn some basic numerical modelling techniques for glacier flow.

**Content**
- Weirs: Weir stability, gates, inflatable dams, appurtenant structures.
- Conduits: Design of headraces, pressure shafts, and penstocks, constructive details and construction.
- Power plants: Power house and turbine types, design, structure, construction.
- Dams: Dam types, appurtenant structures (diversion, spillways, bottom outlet), dam type selection criteria, layout and design of gravity dams, buttress dams, arch dams, rockfill dams with central core or concrete face, measures in the foundation, mass concrete, RCC dams, reservoir siltation and sediment management, dam surveillance.
- Artificial reservoirs: Purpose, layout, sealing, appurtenant structures, environmental aspects.
- The basics of numerical modelling of fluvial hydraulics and river engineering problems are presented. The governing equations for flow and sediment transport in open channels and corresponding numerical solution strategies are introduced. The theoretical parts are discussed by examples.
- The lecture focuses on selected topics in hydraulic engineering, water management and aquatic ecology relating to hydropower and flood protection projects.
- We will explain the fundamentals of physics of glaciers which are necessary for treating applied problems. We will go into climate-glacier interactions, flow of glaciers, lake ice and hydrology of glaciers.

**Lecture notes / Literature**
- Slides of lecture are available for download as PDF. Supplementary material will be provided during lecture.
- Relevant books and citations will be mentioned.
- Lecture notes/handouts will be available online.
- External speakers will present current topics and projects in Switzerland and abroad.

**Prerequisites / notice**
- Information: Enrolment of Hydraulic Engineering II is not recommended without having attended Hydraulic Engineering (101-0206-00L) previously since Hydraulic Engineering II is strongly based on Hydraulic Engineering (101-0206-00L).
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- Enrolment of Hydraulic Engineering II is not recommended without having attended Hydraulic Engineering (101-0206-00L) previously since Hydraulic Engineering II is strongly based on Hydraulic Engineering (101-0206-00L).
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The goal of the course is to develop process-understanding of fluvial systems and to introduce the students to appropriate analysis tools. In the first section the estimation of basin sediment supply from upland sheet, rill and gully erosion, and basin sediment yield are discussed. The second section focuses on sediment transport in rivers in general, e.g. basic mechanics of sediment laden flows, bedforms, flow resistance, sediment type and load measurement and estimation, the morphology of rivers. It is illustrated how the river network can be analysed in terms of its connectivity and topological characteristics. Channel stability and channel erosion modelling are discussed. The third section looks at fluvial system management in terms of engineering and nonstructural sediment (e.g. upland and channel erosion protection) and water (e.g. the importance of the natural streamflow regime on riverine ecosystem integrity, river rehabilitation) resource management.

All methods discussed are applied practically in exercises. This is done using programs in MATLAB which partially are programmed by the students themselves. Further, some generally available softwares such as Hydraulic Systems and HEC RAS for non-steady flows are used.

Lecture notes: Lecture notes, powerpoints shown in the lecture and programs used can be downloaded. They are also available in German.

Content
- Monitoring of hydrological systems (point and space monitoring, remote sensing). The use of GIS in hydrology (practical applications).

Objective
- Tools for hydrological modelling are discussed at the event and continuous scale. The focus is on the description of physical processes and their modelisation with practical examples.
- Monitoring of hydrological systems (point and space monitoring, remote sensing). The use of GIS in hydrology (practical applications).

Prerequisites / notice
- Basic knowledge of environmental assessment tools is a prerequisite for this class. Students that have not done classwork in this topic before are required to read an appropriate textbook before or at the beginning of this course (e.g. Baumann&Tillman, The Hitch Hiker's Guide to LCA: An Orientation in Life Cycle Assessment Methodology and Applications, Studentlitteratur, Lund, 2004).

Literature
- Additional literature is presented during the course.
- Sustainability Goals
- Inventory developments, transparency, data quality, data completeness, and data exchange formats
- Allocation (multioutput processes and recycling)
- Hybrid LCA methods.
- Consequential and marginal analysis
- Recent development in impact assessment
- Spatial differentiation in Life Cycle Assessment
- Workplace and indoor exposure in Risk and Life Cycle Assessment
- Uncertainty analysis
- Subjectivity in environmental assessments
- Multicriteria analysis
- Case Studies

Prerequisites / notice
- Basic knowledge of environmental assessment tools is a prerequisite for this class. Students that have not done classwork in this topic before are required to read an appropriate textbook before or at the beginning of this course (e.g. Baumann&Tillman, The Hitch Hiker's Guide to LCA: An Orientation in Life Cycle Assessment Methodology and Applications, Studentlitteratur, Lund, 2004).

Literature
- Given in lecture
The course should provide an understanding of SAR techniques and the use of the imaging tools for bio/geophysical parameter estimation.

**Objective**
To provide understanding of how sustainability can be made operational in an organisation. To do so, students will understand how to integrate sustainability thinking into the typical current organisational environment and processes, such as planning, implementing and controlling.

**Content**
We meet for five 3-hour-lectures, with discussions and case studies during course time. Additionally, small case studies in-between courses will be given at most course days. Course topics are:

- Sustainable Development and its meaning for Management
- Management Standards for Sustainability (ISO and others)
- Sustainability Opportunities and Innovation
- Organisation and Implementation
- The concept of 'Continuous Improvement'
- Environmental Performance Measurement (Concepts, Standards, Methods)
- Life Cycle Costing, Life Cycle Management
- (Sustainable) Supply Chain Management
- Communication of Sustainability Issues

**Literature**
Course documentation as well as case study descriptions will be provided during the course via the "Ilias" repository.

**Prerequisites / notice**
If you have specific interests or questions, let me know at arthurb@ethz.ch. Maybe I can include your issues - or I can't :-)

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### 102-0357-00L Waste Recycling Technologies

**Abstract**
Waste Recycling Technology (WRT) is sub-discipline of Mechanical Process Engineering. WRT is employed in production plants processing contaminated soil, construction wastes, scrap metal, recovered paper and the like. While WRT is well established in Central Europe, it is only just now catching on in emerging markets as well.

**Objective**
At the core of this course is the separation of mixtures of solid bulk materials according to physical properties such as color, electrical conductivity, magnetism and so forth. After having taken this course, the students should have concept not only of the unit operations employed in WRT but also of how these unit operations are integrated into the flow sheets of production plants.

**Content**
Introduction
Waste Recycling; Scope and objectives
Waste recycling technologies in Switzerland
Fundamentals
- Properties of particles: Liberation conditions, Particle size and shape, Porosity of bulk materials
- Fluid dynamics of particles: Stationary particle beds, Fluidized beds, Free settling particles
- Flow sheet basics: Balancing mass flows
- Standard processes: batch vs. continuous
- Assessment of separation success: Separation function; grade vs. recovery

Separation Process
- Separation according to size and shape (Classification): Screening, Flow separation
- Separation according to material properties (Concentration): Manual Sorting, Gravity concentration, Magnetic separation, Eddy current separators, Electrostatic separation, Sensor technology, Froth flotation

**Lecture notes**
The script consists of the transparencies shown during the lectures. Background material will be provided on the script-server.

**Literature**
A list of recommended books will be provided.

**Prerequisites / notice**
We will approach this topic from the perspective not of theory, but of practical application. However, solid fundamentals in physics (in particular in mechanics) are strongly recommended.

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### 102-0617-00L Basics and Principles of Radar Remote Sensing for Environmental Applications

**Abstract**
The course will provide the basics and principles of Radar Remote Sensing (specifically Synthetic Aperture Radar (SAR)) and its imaging techniques for the use of environmental parameter estimation.

**Objective**
At the end of the course the student has the understanding of:
1. SAR basics and principles,
2. SAR polarimetry,
3. SAR interferometry and
4. environmental parameter estimation from multi-parametric SAR data

**Content**
The course is giving an introduction into SAR techniques, the interpretation of SAR imaging responses and the use of SAR for different environmental applications. The outline of the course is the following:
1. Introduction into SAR basics and principles
2. Introduction into electromagnetic wave theory
3. Introduction into scattering theory and decomposition techniques
4. Introduction into SAR interferometry
5. Introduction into polarimetric SAR interferometry
6. Introduction into bio/geophysical parameter estimation (classification/segmentation, soil moisture estimation, earth quake and volcano monitoring, forest height inversion, wood biomass estimation etc.)

**Lecture notes**
Handouts for each topic will be provided.
Structural reliability aims at quantifying the probability of failure of systems due to uncertainties in their design, manufacturing and environmental parameters. The goal of this course is to provide the students with a thorough understanding of the key concepts behind structural reliability and risk analysis and modelling of technical processes; characterisation of environmental and health risks. Risk analysis on the basis of quality assurance and protection goals. Estimation of model and parameter uncertainty. Precaution and safety measures.

Content

The main focus of the course is the handling of multi-parameter SAR data for environmental parameter estimation with the following content:

1. Read and display multi-parametric SAR data
2. Application of different speckle filtering techniques
3. Derivation of the coherency and covariance matrix
4. Application of polarimetric correlation functions
5. Application of different decomposition techniques
6. Generation of a polarimetric SAR interferometry data set from a simulated forest
7. Processing of the polarimetric SAR interferometry data set
8. Estimation of environmental parameters (segmentation, soil moisture estimation, forest height estimation, etc.)

Lecture notes

Handouts for each topic will be provided.

Literature

First readings for the course:

Prerequisites / notice

This course in combination with 102-0617-G: Basics and Principles of Radar Remote Sensing provides the basis for an independent handling of multi-parametric SAR data. The content of this course is offering to apply the theory to practical exercises using the free software PolSARPro.

Abstract

The course presents the underlying probabilistic modelling and computational methods for reliability and risk assessment. The course aims at quantifying the probability of failure of systems due to uncertainties in their design, manufacturing and environmental conditions. Risk analysis combines this information with the consequences of failure in view of optimal decision making. The second part is related to structural reliability analysis, i.e. methods that allow one to compute probabilities of failure of a given system with respect to prescribed criteria. The framework of reliability analysis is first set up. Reliability indices are introduced together with the first order-second moment method (FOSM) and the first order reliability method (FORM). Methods based on Monte Carlo simulation are then reviewed and illustrated through various examples. By-products of reliability analysis such as sensitivity measures and partial safety coefficients are derived and their links to structural design codes is shown. The reliability of structural systems is also introduced as well as the methods used to reassess existing structures based on new information.

Content

The first part of the course is a reminder on probability theory that is used as a main tool for reliability and risk analysis. Classical concepts such as random variables and vectors, dependence and correlation are recalled. Basic statistical inference methods used for building a probabilistic model from the available data, e.g. the maximum likelihood method, are presented.

Objective

The second part is related to structural reliability analysis, i.e. methods that allow one to compute probabilities of failure of a given system with respect to prescribed criteria. The framework of reliability analysis is first set up. Reliability indices are introduced together with the first order-second moment method (FOSM) and the first order reliability method (FORM). Methods based on Monte Carlo simulation are then reviewed and illustrated through various examples. By-products of reliability analysis such as sensitivity measures and partial safety coefficients are derived and their links to structural design codes is shown. The reliability of structural systems is also introduced as well as the methods used to reassess existing structures based on new information.

The third part of the course addresses risk assessment methods. Techniques for the identification of hazard scenarios and their representation by fault trees and event trees are described. Risk is defined with respect to the concept of expected utility in the framework of decision making. Elements of Bayesian decision making, i.e. pre-, post and pre-post risk assessment methods are presented. Bayesian networks are introduced as a generic numerical tool for solving such problems. The course also includes a tutorial using a software dedicated to real world structural reliability analysis.

Literature


Prerequisites / notice

Basic course on probability theory and statistics
Projects on chemical assessment with the focus on the following aspects:

- Analysis and assessment of basic substance data for selected chemical classes: physical chemical properties, environmental behaviour (distribution, persistence), human and eco-toxicity (biochemical metabolism, effect mechanisms), safety.
- Analysis and modelling of technical processes determining chemical release into the environment, e.g., chemicals applications.
- Characterisation of environmental and health risks on the basis of exposure and effect models, QSARs from environmental chemistry, toxicology and methods of risk analysis.
- Risk assessment on the basis of quality and safety goals. Estimation of the model and data uncertainty.
- Demonstration of possibilities and limits of precaution and safety measures (technical, organisational, concerning personnel) including effectiveness and efficiency.

**Lecture notes**
Project teaching; time frame totals ca. 80 hours.

**Literature**

**Prerequisites / notice**
Co-operation with chemical companies.

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### 701-0423-00L Chemistry of Aquatic Systems

**Abstract**
This course gives an introduction to chemical processes in aquatic systems and shows applications to various systems. The following topics are treated: acid-base reactions and carbonate system, solubility of solids and weathering, redox reactions, complexation of metals, reactions at the solid/water interface, applications to lakes, rivers and groundwater.

**Objective**
Understanding of chemical processes in aquatic systems. Quantitative application of chemical equilibria to processes in natural waters.

**Content**
Evaluation of analytical data from aquatic systems.

**Lecture notes**
Script is distributed.

**Literature**

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### 529-0193-00L Renewable Energy Technologies I

**Abstract**
Scenarios for world energy demand and CO2 emissions, implications for climate. Methods for the assessment of energy chains. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaic electricity, solar chemistry). Wind and ocean energy, heat pumps, geothermal energy, energy from waste. CO2 sequestration.

**Objective**
Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals.

**Content**

**Lecture notes**
Lecture notes will be distributed during the course.

**Literature**
- Heinloth, K.; Die Energiefrage (Vieweg, 2003)
- Henkel, K.; Die Energiefrage (Vieweg, 2003)

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### 363-0387-00L Corporate Sustainability

**Abstract**
We introduce the concept of corporate sustainability; discuss its implications focusing on strategy, technology, and financial markets; and offer e-modules to train relevant critical thinking skills. With this input, students explore the practical challenges of corporate sustainability in a group project, focusing on one of the four sustainability challenges of water, energy, mobility, and food.

**Objective**
Understand the limits and the potential of corporate sustainability for sustainable development

**Content**
Develop critical thinking skills that are useful for corporate sustainability (argumentation, communication, evaluative judgment)

**Prerequisites / notice**
Fundamentals of chemistry and physics are a prerequisite for this course.

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### 701-1543-00L Transdisciplinary Methods and Applications

**Abstract**
Evaluation of analytical data from aquatic systems.

**Objective**
Transdisciplinary Methods and Applications

**Content**
Co-operation with chemical companies.

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**Lecture notes**
Presentation slides will be distributed prior to lectures.

**Literature**
Literature recommendations will be distributed during the lecture.

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**Data:** 06.02.2019 13:00  
**Autumn Semester 2015**  
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The course deals with transdisciplinary (td) methods, concepts and their applications in the context of case studies and other problem oriented research projects. Td methods are used in research at the science-society interface and when collaborating across scientific disciplines. Students learn to apply methods within a functional framework. The format of the course is seminar-like, interactive.

### Objective
At the end of the course students should:

#### Know:
- Function, purpose and algorithm of a selected number of transdisciplinary methods

#### Understand:
- Functional application in case studies and other problem oriented projects

#### Be able to reflect on:
- Potential, limits, and necessity of transdisciplinary methods

#### Be prepared for:
- Transdisciplinary Case Study 2016

### Content
The lecture is structured as follows:

- Overview of concepts and methods of inter-/transdisciplinary integration of knowledge, values and interests (approx. 20%)
- Analysis of a selected number of transdisciplinary methods focusing problem framing, problem analysis, and impact (approx. 50%)
- Practical application of the methods in a broader project setting (approx. 30%)

**Lecture notes**  
Handouts are provided by the lecturers

**Literature**  
Selected scientific articles and book-chapters

**Prerequisites / notice**  
This course is recommended for students participating in the Transdisciplinary Case Study 2016.

**701-1541-00L Multivariate Methods**  
3 credits  
2V+1U  
R. Hansmann

*One of the lectures 701-1541-00 (autumn semester) OR 752-2110-00 (spring semester) are highly recommended for students in Environmental Sciences with the Major Environmental systems and Policy.*

**Abstract**  
The course teaches multivariate statistical methods such as linear regression, analysis of variance, cluster analysis, factor analysis and logistic regression.

**Objective**  
Upon completion of this course, the student should have acquired:

1. Knowledge on the foundations of several methods of multivariate data analysis, along with the conditions under which their use is appropriate
2. Skill in the estimation, specification and diagnostics of the various models
3. Hands-on experience with those methods through the use of appropriate software and actual data sets in the PC lab

**Content**  
The course will begin with an introduction to multivariate statistical methods such as analysis of variance and multiple linear regression, where a metric dependent variable is "explained" by two or more independent variables. Then two methods for structuring complex data, cluster analysis and factor analysis will be covered. In the last part, procedures for the analysis of relationships involving dichotomous or polytomous dependent variables (e.g., the choice of a mode of transportation) will be discussed.

**Literature**  
Will be announced at the beginning of the course.

**701-1551-00L Sustainability Assessment**  
3 credits  
2G  
P. Krütli, C. E. Pohl

**Abstract**  
The course deals with the concepts and methodologies for the analysis and assessment of sustainable development. A special focus is given to the social dimension and to social justice as a guiding principle of sustainability as well as to trade-offs between the three dimensions of sustainability.

The course is seminar-like, interactive.

**Objective**  
At the end of the course students should

#### Know:
- core concepts of sustainable development, and;
- the concept of social justice - normatively and empirically - as a core element of social sustainability;
- important empirical methods for the analysis and assessment of local / regional sustainability issues.

#### Understand and reflect on:
- the challenges of trade-offs between the different goals of sustainable development;
- and the respective impacts on individual and societal decision-making.

**Content**  
The course is structured as follows:

- Overview of rationale, objectives, concepts and origins of sustainable development;
- Importance and application of sustainability in science, politics, society, and economy;
- Sustainable (local / regional) development in different national / international contexts;
- Analysis and evaluation methods of sustainable development with a focus on social justice;
- Tradeoffs in selected examples.

**Literature**  
Selected scientific articles & book-chapters

**851-0589-00L Technology and Innovation for Development**  
3 credits  
2V  
P. Aerni

**Abstract**  
Technological change plays a crucial role in efforts to create a more sustainable future. In this context, policy decision makers must design rules that minimize its risks and maximize its benefits for society at large. The course discusses this challenge from an interdisciplinary perspective taking into account legal, economic, historical, development and environmental aspects.

**Objective**  
- to recognize the challenges and opportunities of technological change in terms of sustainable development
- to become familiar with policy instruments to promote innovation
- to improve understanding of political decision-making processes in the regulation of science & technology
- improved understanding of the role of science and technology in the context of human and societal development
In this context, students are to become familiar with the basic principles of political economy and New Growth Theory and how such theories help explain political decisions as well as political outcomes in the area of Science, Technology and Innovation. State interventions are either designed to regulate (e.g. environmental regulations, anti-trust law) or facilitate (e.g. intellectual property rights protection, public investment in R&D and technical education, technology transfer) technological change. This will be illustrated by looking at different industries and different national systems of innovation. Subsequently the positive and negative consequences for society and the natural environment will be discussed from a short-term and a long-term perspective.

Prerequisites / notice


Prerequisites / notice

The 2-hour course (5-7 p.m.) will be held as a series of lectures. The course materials will be available in form of an electronic Reader at the beginning of the semester. The class will be taught in English. Students will be asked to give a (a) presentation (15 Minutes) or write a review paper based on a article selected from the electronic script, and (b) they will have to pass a written test at the end of the course in order to obtain 3 credit points in the ECTS System. In the final mark (a) will have a weight of 40% and (b) 60%.

701-0015-00L Seminar on Transdisciplinary Research for Sustainable Development

Abstract

The seminar is designed for students and researchers (MA, PhD, PostDoc) who use inter- and transdisciplinary elements in their projects. It addresses the challenges of this research: How to integrate disciplines? How (and in which order) to include societal actors? How to bring results to fruition? We discuss these questions based on case studies and theories and on the participant's projects.

Objective

The participants understand the specific challenges of inter- and transdisciplinary research in general and in the context of sustainable development in particular. They know methods and concepts to address these challenges and apply them to their research projects.

Content

The seminar covers the following topics:

1. Theories and concepts of inter- and transdisciplinary research
2. The specific challenges of inter- and transdisciplinary research
3. Involving stakeholders
4. Collaborating disciplines
5. Exploration of tools and methods
6. Analysing participants' projects to improve inter- and transdisciplinary elements

Literature

Literature will be made available to the participants

Prerequisites / notice

The seminar is specifically suitable for PhD or PostDoc researchers. It is open to master students (minor "global change and sustainability") and further interested people, who preferably are preparing, or working on, a project/thesis.

701-0473-00L Weather Systems

Abstract

This lecture introduces the theoretical principles and the observational and analytical methods of atmospheric dynamics. Based on these principles, the following aspects are discussed: the energetics of the global circulation, the basic synoptic- and meso-scale flow phenomena, in particular the dynamics of extratropical cyclones, and the influence of mountains on the atmospheric flow.

Objective

The students are able to:
- explain up-to-date meteorological observation techniques and the basic methods of theoretical atmospheric dynamics
- to discuss the mathematical basis of atmospheric dynamics, based on selected atmospheric flow phenomena
- to explain the basic dynamics of the global circulation and of synoptic- and meso-scale flow features
- to explain how mountains influence the atmospheric flow on different scales

Content

Satellite observations; analysis of vertical soundings; geostrophic and thermal wind; cyclones at mid-latitude; global circulation; north-atlantic oscillation; atmospheric blocking situations; Eulerian and Lagrangian perspective; potential vorticity; Alpine dynamics (storms, orographic wind); planetary boundary layer

Lecture notes

Lecture notes and slides
Environmental Fluid Dynamics

Abstract
This course covers the basic physical concepts and mathematical equations used to describe environmental fluid systems on the rotating Earth. Fundamental concepts (e.g. vorticity dynamics and waves) are formally introduced, applied quantitatively and illustrated using examples. Exercises help to deepen knowledge of the material.

Objective
Students are able
- to name the bases, concepts and methods of environmental fluid dynamics.
- to understand and discuss the components of the basic physical equations in fluid dynamics.
- to apply basic mathematical equations to simple problems of environmental fluid dynamics.

Content

- Basic physical terminology and mathematical laws:
  - Continuum hypothesis, forces, constitutive laws, state equations and basic principles of thermodynamics, kinematics, laws of mass and momentum on rotating earth.
  - Concepts and illustrative flow systems: vorticity dynamics, boundary layers, instability, turbulence - with respect to environmental fluid systems.
  - Scale analysis: dimensionless variables and dynamical similarity, simplification of the fluid system, e.g. shallow water assumption, geostrophic flow.
  - Waves in environmental fluid systems.

Lecture notes
In English language

Literature
Will be presented in class.
See also: web-site.

Biogeochemistry of Trace Elements

Abstract
The course addresses major biogeochemical processes that drive the cycling of different groups of trace elements (heavy metals, redox-sensitive trace elements, chalcophile elements) in the environment, and the chemical methods that are used to study the behavior of these elements in the geosphere.

Objective
The students gain a detailed understanding of the sources and the cycling of trace elements in the terrestrial and aquatic environment. The interaction of environmentally important trace elements with abiotic and biotic geosphere components as well as their abiotically and biotically driven transformations will be discussed. Relevant methods/techniques to study these processes will be presented.

Content
The course deals in-depth with the major biogeochemical processes controlling the cycling of different groups of trace elements (heavy metals, redox-sensitive and chalcophile elements) in the environment. Sources and cycling of trace elements as related to interactions with abiotic and biotic geosphere components, and abiotically and biotically driven transformations will be discussed. The techniques most commonly used to study these processes will be presented as well.

Lecture notes
Selected handouts (lecture notes, literature, exercises) will be distributed during the course.

Prerequisites / notice
Students are expected to be familiar with the concepts of aquatic or soil chemistry covered in the respective classes at the bachelor level.

Element Balancing and Soil Functions in Managed Ecosystems

Abstract
Applying element balances of agricultural soils and the assessment of soil functions for real applications in computer exercises to design preventive strategies against soil pollution and to support sustainable management of regional agroecosystems also in the context of spatial planning procedures.

Objective
The students learn to critical assess changes in land use management on element cycles in agro-ecosystems and to assess soil services (soil functions). You design solutions for chemical problems in soil protection at the regional scale and learn to assess soil functions using different methods.

Content
The students apply a regional balance model for Swiss regions in computer exercises and assess major soil functions of agricultural soils. You assess the sustainability of current land use and analyse management options improving nutrient and metal cycling in agro-ecosystems. The students will have the opportunity to calculate specific scenarios regarding land use management and environmental changes. Special focus will be paid on the soil services such as regulation-, production function and soil as habitat, and the assessment of these functions based on soil mapping data.

Lecture notes
Literature and Exercises for a case study

Prerequisites / notice
The course consists of lectures and computer exercises. The course take place every 2 weeks à 4 hours. Recommended prerequisites for attending this course:
- Bodenschutz und Landnutzung
- Biochemie of Trace Elements
- Angewandte Bodenkologie

River Engineering

Abstract
Main subjects treated:
- Fundamentals (e.g. sediment sampling methods), alluvial channel hydraulics, incipient motion, bed forms, bed load and suspended load, sediment budget and morphological changes, river morphology, scour, river management concepts and selected measures (e.g. bank and bed protection works).

A practical exercise (voluntary, unmarked) is offered to deepen the learned subjects.

Objective
The students shall
- be able to describe quantitatively the interrelation between discharge, sediment transport and channel evolution.
- know the fundamentals and be able to apply the approaches and methods to treat river engineering problems associated with flood protection and river restoration.

Content

- The first part of the lecture treats the fundamentals required to deal with river engineering problems. Sampling methods for the river bed material and methods to calculate the discharge in alluvial rivers are presented. The process of river bed armoring and the principles of incipient motion, of bed load and suspended load transport are treated.

- In the second part of the lecture the procedures to quantify the sediment budget and the morphological changes (erosion, aggradation) in river systems are explained. Furthermore, the process of natural channel formation and the different plan forms of rivers (straight, meandering, braided) are discussed. Own chapters are dedicated to the topics of bed forms, river morphology and scour.

- The last part of the lecture concentrates on the design and dimensioning of river engineering works. The topics treated are the stabilization of banks and of the longitudinal profile of rivers.

Lecture notes
Autography River Engineering (in German)

Literature
The autography contains a comprehensive list of references to relevant literature.
The voluntary and unmarked exercise bases on field data, which are collected by the students on a river in nature. Besides the collection of fundamentals and field data, the exercise comprehends the calculation of the stage-discharge relationship, of the critical discharges at the onset of bed load transport and bed erosion and of the annual sediment load in a given river reach.

102-0337-00L Landfilling, Contaminated Sites and Radioactive Waste Repositories

Abstract
Practices of landfilling and remediation of contaminated sites and disposal of radioactive waste are based on the same concepts that aim to protect the environment. The assessment of contaminants that may leach into the environment as a function of time and how to reduce the rate of their release is key to the design of chemical, technical and geological barriers.

Objective
Upon successful completion of this course students are able to:
- assess the risk posed to the environment of landfills, contaminated sites and radioactive waste repositories in terms of fate and transport of contaminants.
- describe technologies available to minimize environmental contamination.
- describe the principles in handling of contaminated sites and to propose and evaluate suitable remediation techniques.
- explain the concepts that underlie radioactive waste disposal practices.

Content
This lecture course comprises of lectures with exercises and guided case studies.
- A short overview of the principles of environmental protection in waste management and how this is applied in legislation.
- A survey of the chemistry underlying the release and transport of contaminants from the landfilled/contaminated material/radioactive waste repository focusing on processes that control redox state and pH buffer capacity, mobility of heavy metals and organic compounds.
- Technical barrier design and function. Clay as a barrier.
- Contaminated site remediation: Site evaluation, remediation technologies.
- Concepts and safety in radioactive waste management.
- Role of the geological and engineered barriers and radionuclide transport in geological media.

Lecture notes
Short script plus copies of overheads.

Literature
Lecture notes will be made available.

Prerequisites / notice
This is an interdisciplinary course aimed at environmental scientists and environmental engineers.

151-0709-00L Stochastic Methods for Engineers and Natural Scientists

Abstract
The course provides an introduction into stochastic methods that are applicable for example for the description and modeling of turbulent and subsurface flows. Moreover, mathematical techniques are presented that are used to quantify uncertainty in various engineering applications.

Objective
By the end of the course you should be able to mathematically describe random quantities and their effect on physical systems. Moreover, you should be able to develop basic stochastic models of such systems.

Content
- Probability theory, single and multiple random variables, mappings of random variables.
- Stochastic differential equations, Ito calculus, PDF, evolution equations.
- Polynomial chaos and other expansion methods.
- All topics are illustrated with application examples from engineering.

Lecture notes
Detailed lecture notes will be provided.

Literature
Some textbooks related to the material covered in the course:

102-0377-00L Air Pollution Modeling and Chemistry

Abstract
Air pollutants cause negative effects on humans, wildlife and buildings. To control and reduce the impact of air pollutants, their transfer from sources to receptors needs to be known. This transfer includes transport within the atmospheric boundary layer, chemical transformation reactions and phase-transfer processes from air to liquid and solid materials (aerosols, water).

Objective
The students understand the fundamental principles of atmospheric transport, dispersion and chemistry of pollutants on the local to regional scale and their transfer between air and condensed phases (aerosols, water, solids). This includes the knowledge of important atmospheric reactions, sources and sinks. The obtained understanding enables the students to apply computational tools to predict the transport and transformation of chemicals at the local to regional scale.

Content
- Structure of the Atmosphere.
- Thermodynamics of the atmosphere.
- Atmospheric stability.
- Atmospheric boundary layer and turbulence.
- Dispersion in the atmospheric boundary layer.
- Numerical models of atmospheric dispersion.
- Gas phase reaction kinetics.
- Tropospheric chemistry and ozone formation.
- Chemistry box models.
- Volatile organic pollutants (VOCs) and semi-volatile organic pollutants (SVOCs).
- Distribution of chemicals between different phases.
- Kinetics of phase transfer processes.
- Computational tools to estimate volatility, distribution and phase transfer rates of organic chemicals.

Lecture notes
Hand-outs of lecture material with extended comments will be made available along with the lecture.

Literature
Lists of suitable books and papers will be provided in the lecture.

Prerequisites / notice
strongly recommended: 102-0635-01L Luftreinhaltung (Air Pollution Control) or similar.

701-0535-00L Environmental Soil Physics/Vadose Zone Hydrology

Abstract
The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.

Objective
Students are able to:
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media.
- quantify driving forces and resulting fluxes of water, solute, and heat in soils.
- apply modern measurement methods and analytical tools for hydrological data collection.
- conduct and interpret a limited number of experimental studies.
- explain links between physical processes in the vadose-zone and major societal and environmental challenges.

Autumn Semester 2015
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Weeks 1 to 3: Physical Properties of Soils and Other Porous Media. Units and dimensions, definitions and basic mass-volume relationships between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay behavior.

Weeks 4 to 5: Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.

Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:
- Part 1: Laminar flow in tubes (Poiseuille's Law); Darcy's Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement.
- Part 2: Unsaturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.

Midterm exam

Weeks 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration models and estimation; transpiration, plant development and transpiration coefficients. Small and large scale influences on hydrological cycle; surface evaporation.

Weeks 12 to 13: Solute Transport in Soils - Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion equation; solutions for pulse and step solute application; parameter estimation; salinity balance.

Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

Additional topics:
- Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.
- Biological Processes in the Vadose Zone - An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

Lecture notes
Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller (available at the beginning of the semester)
http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology

Literature
Supplemental textbook (not mandatory) - Environmental Soil Physics, by: D. Hillel

Advanced Environmental Assessment (Computer Lab and Exercises) 102-0317-01 Advanced Environmental Assessments (Exercises) (2KP) and 102-0317-02 Advanced Environmental Assessment (Lab) (2KP) cannot be chosen if 102-0307-00 Advanced Environmental, Social and Economic Assessments (6KP) is selected. 102-0317-01 and 102-0317-02 are already included in 102-0307-00.

Abstract
Technical systems are investigated in projects with numerical modeling. The students learn how to answer given questions with target oriented methodologies using various software programs for environmental assessment.

Objective
Become acquainted with various software programs for environmental assessment including Life Cycle Assessment, Environmental Risk Assessment, Probabilistic Modelling, Material Flow Analysis.

Minors Limited to 6 KP Total

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<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>102-0535-00L</td>
<td>Noise Abatement</td>
<td>W</td>
<td>5</td>
<td>4G</td>
<td>K. Egghenschwiler, J. M. Wunderli</td>
</tr>
<tr>
<td></td>
<td>The students will understand the basics of noise abatement: acoustics, impact of noise, measure-ment techniques and legislation. The students will be able to analyze different noise prob-lems and they will be able to solve simple problems of noise abatement.</td>
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<td></td>
<td>Skript &quot;Lärmbekämpfung&quot; erhältlich zu Beginn der Vorlesung.</td>
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</tbody>
</table>

Introduction of basic knowledge about problems with contaminated sites, investigation of this sites, risk assessment, remediation and operation of regional drainage systems.

Objective
Consolidation of the basic procedures for design and operation of technical networks in water engineering.

Content
Demand Side Management versus Supply Side Management
Optimization of wastewater systems
Corrosion and hygiene
Drainage systems
Stability
Research projects and results
Wastewater transport, remediation, clean-up and retaining techniques (e.g. bioremediation, incineration, retaining walls, pump-and-treat, permeable reactive barriers), monitoring, research projects and results

Prerequisites / notice
Prerequisite: Introduction to Urban Water Management

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101-0339-00L
Environmental Geotechnics

Abstract
Introduction of basic knowledge about problems with contaminated sites, investigation of this sites, risk management, remediation and reclamation techniques as well as monitoring systems. Introduction in landfill design and engineering with focus on barrier- and drainage systems and lining materials, evaluation of geotechnical problems, e.g. stability

Objective
Introduction of basic knowledge about problems with contaminated sites, investigation of this sites, risk management, remediation and reclamation techniques as well as monitoring systems. Introduction in landfill design and engineering with focus on barrier- and drainage systems and lining materials, evaluation of geotechnical problems, e.g. stability

Content
Definition of contaminated sites, site investigation methods, historical research and technical investigation, risk assessment, contamination transport, remediation, clean-up and retaining techniques (e.g. bioremediation, incineration, retaining walls, pump-and-treat, permeable reactive barriers), monitoring, research projects and results

Lecture notes
Visit of VAW hydraulic laboratories to add to applied resources. Description of a number of selected, at the time available hydraulic models.

Prerequisites / notice
Dr. R. Hermanns Stengele, Dr. M. Plötze: Environmental Geotechnics (german) digital excursion

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101-0501-00L
Pedosphere

Abstract
Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

Objective
Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

Content
Definition of the pedosphere, soil functions, rocks as parent materials, minerals and weathering, soil organisms, soil organic matter, physical soil properties and functions, chemical soil properties and functions, soil formation, principles of soil classification, global soil regions, soil fertility, land use and soil degradation.
Lecturers Working on a concrete task in Hydraulic Engineering

The project work is supervised by a professor. Students can choose from different subjects and tasks.

Lecture notes Can be purchased during the first lecture (15.- SFr)


Prerequisites / notice

701-0533-00L Soil Chemistry W 3 credits 2G R. Kretzschmar, D. I. Christl

Abstract This course discusses chemical and biogeochemical processes in soils and their influence on the behavior and cycling of nutrients and pollutants in terrestrial systems. Approaches for quantitative modeling of the processes are introduced.

Objective Understanding of important chemical soil properties and processes and their influence on the behavior (e.g., speciation, bioavailability, mobility) of nutrients and pollutants.

Content Important topics include the structure and properties of clays and oxides, the chemistry of the soil solution, gas equilibria, dissolution and precipitation of mineral phases, cation exchange, surface complexation, chemistry of soil organic matter, redox reactions in flooded soils, soil acidification and soil salinization.

Lecture notes Handouts in lectures.


3. Semester

Project Work

<table>
<thead>
<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>102-0199-01L Project on Water Resources Management</td>
<td>W</td>
<td>12 credits</td>
<td>24A</td>
<td>Lecturers</td>
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</tbody>
</table>

Abstract Working during one semester on a task on Water Resources Management

Objective Promote independent, structured and scientific work; learn to apply engineering methods; deepen the knowledge in the field of the treated task.

Content The project work is supervised by a professor. Students can choose from different subjects and tasks.

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</thead>
<tbody>
<tr>
<td>102-0299-01L Project on Urban Water Management</td>
<td>W</td>
<td>12 credits</td>
<td>24A</td>
<td>Lecturers</td>
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</tbody>
</table>

Abstract Working during one semester on a task on Urban Water Management

Objective Promote independent, structured and scientific work; learn to apply engineering methods; deepen the knowledge in the field of the treated task.

Content The project work is supervised by a professor. Students can choose from different subjects and tasks.

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</thead>
<tbody>
<tr>
<td>102-0399-01L Project on Ecological Systems Design, Air Quality Control and Waste Management</td>
<td>W</td>
<td>12 credits</td>
<td>24A</td>
<td>Lecturers</td>
<td></td>
</tr>
</tbody>
</table>

Abstract Working during one semester on a task on Material Flow and Waste Management

Objective Promote independent, structured and scientific work; learn to apply engineering methods; deepen the knowledge in the field of the treated task.

Content The project work is supervised by a professor. Students can choose from different subjects and tasks.

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>102-0499-01L Project on Soil Protection</td>
<td>W</td>
<td>12 credits</td>
<td>24A</td>
<td>Lecturers</td>
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</tbody>
</table>

Abstract Working during one semester on a task on Soil Protection

Objective Promote independent, structured and scientific work; learn to apply engineering methods; deepen the knowledge in the field of the treated task.

Content The project work is supervised by a professor. Students can choose from different subjects and tasks.

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<thead>
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</thead>
<tbody>
<tr>
<td>102-0599-01L Project on Hydraulic Engineering</td>
<td>W</td>
<td>12 credits</td>
<td>24A</td>
<td>Lecturers</td>
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</tr>
</tbody>
</table>

Abstract Working on a concrete task in Hydraulic Engineering

Objective Promote independent, structured and scientific work; learn to apply engineering methods; deepen the knowledge in the field of the treated task.

Content The project work is supervised by a professor. Students can choose from different subjects and tasks.

Practical Work Experience

<table>
<thead>
<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>102-0003-00L External Professional Training</td>
<td>O</td>
<td>16 credits</td>
<td></td>
<td>Lecturers</td>
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</tbody>
</table>

Abstract External professional training according to a special regulation. The compulsory professional training lasts for at least 12 weeks and is a precondition to be allowed to write up the Master thesis, and to acquire the Master degree.

Objective Experience how environmentally friendly solutions are reached in praxis.

Prerequisites / notice Das Reglement für das obligatorische Berufspraktikum im Masterstudiengang Umwelt ingenieurwissenschaften kann heruntergeladen werden unter: http://www.umwelting.ethz.ch/download/Praktregl_MSc_Umwelting.pdf

Electives

The entire course programs of ETH Zurich and the University of Zurich are open to the students to individual selection.

Electives ETH Zürich

Course Catalogue of ETH Zurich

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-BAUG.

see GESS Compulsory Electives: Language Courses ETH/ UZH

Master Thesis

<table>
<thead>
<tr>
<th>Number</th>
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<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>102-0010-00L Master’s Thesis in Water Resources Management</td>
<td>W</td>
<td>24 credits</td>
<td>47D</td>
<td>Supervisors</td>
<td></td>
</tr>
</tbody>
</table>
The Master Programme concludes with the Master Thesis, which has to be done in one of the chosen Majors and has to be completed within 16 weeks. The Master Thesis is supervised by a professor and shall attest the students ability to work independently and to produce scientifically structured work.

**Objective**

To work independently and to produce a scientifically structured work.

**Content**

The topics of the Master Thesis are published by the professors. The Topic can be set also in consultation between the student and the professor.

### Course Units for Additional Admission Requirements

The courses below are only available for MSc students with additional admission requirements.

<table>
<thead>
<tr>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>101-0203-AAL</td>
<td><strong>Hydraulics I</strong></td>
<td>E-</td>
<td>5 credits</td>
<td>11R</td>
<td>M. Holzer</td>
</tr>
<tr>
<td><strong>Abstract</strong></td>
<td>The course teaches the basics of hydromechanics, relevant for civil and environmental engineers.</td>
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<td></td>
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<tr>
<td><strong>Objective</strong></td>
<td>Familiarization with the basics of hydromechanics of steady state flows</td>
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</tr>
<tr>
<td><strong>Content</strong></td>
<td>Properties of water, hydrostatics, continuity, Euler equation of motion, Navier Stokes equation, similarity, Bernoulli principle, momentum equation for finite volumes, potential flows, ideal fluids-real fluids, boundary layer, pipe flow, open channel flow, flow in porous media, flow measurements, demonstration experiments in the lecture hall and in the laboratory</td>
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<tr>
<td><strong>Lecture notes</strong></td>
<td>Script and collection of problems available</td>
<td></td>
<td></td>
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<tr>
<td><strong>Literature</strong></td>
<td>Bolirich, Technische Hydromechanik 1, Verlag Bauwesen, Berlin</td>
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</tbody>
</table>

| 102-0214-AAL | **Introduction to Urban Water Management** | E-   | 6 credits | 4R    | E. Morgenroth, M. Maurer |
| **Abstract** | Introduction to urban water management (water supply, urban drainage, wastewater treatment, sewage sludge treatment). Introduction to Urban Water Management is a self-study course. |
In this self-study course the students must work through and understand selected sections from the following book:

Groundwater I

This course provides an introduction and an overview over the topics of urban water management (water supply, urban drainage, planning of urban water infrastructure).

Lecture notes

Water Supply and Pollution Control. 8th edition (2009).

By: Warren Viessman, Jr., Mark J. Hammer, Elizabeth M. Perez and Paul A. Chadik.

Pearson Prentice Hall, Upper Saddle River, NJ.

Students must understand and be able to discuss the required reading in a 30 min oral exam. The required reading is explained in detail on the website of the professors of urban water management. Additional information can be asked during the office hours of the professors' assistants.

Prerequisites

Some students joining the MSc program in Environmental Engineering at ETH Zürich have to take additional courses from our BSc program. The decision of what courses to take is done at the time of admission at ETH.

The course program. The decision of what courses to take is done at the time of admission at ETH.

Literature

Students who can speak and understand German must take the course (Siedlungswasserwirtschaft GZ) and get a passing grade. For students that do not have sufficient German language skills there is a self-study course and they have to take an oral exam.

This course is required for further in depth courses in urban water management.

Prerequisite: Hydraulics I and Hydrology

102-0324-AAL
Ecological Systems Analysis

Enrolment only for MSc students who need this course as additional admission requirement.

Objective

Methodological basics and application of various environmental assessment tools.

Corequisites

Students learn about environmental assessment tools, such as material flow analysis, risk assessment, and life cycle assessment. They can identify and apply the appropriate tool in a given situation. Also, they are able to critically assess existing studies.

Lecture notes

No script, but literature available on homepage.

Literature


102-0325-AAL
Waste Management

Enrolment only for MSc students who need this course as additional admission requirement.

Objective

Introduction into the problems of waste handling with the goal to get the ability of seeing and improving the influence of commodities and products with there packaging to the environment - as they are becoming waste. Knowing the different mechanical and chemical processes, which are applicable in the field of waste management.

Content

- To know the different mechanical and chemical processes, which are applicable in the field of waste management (C6)
- To know the historical development of the waste problems (C2)
- To see and to improve the influence of commodities and products to the environment (C5)
- To identify and apply the appropriate tool in a given situation (C4)
- To recognize waste and its components as raw material and resources and to get the know how for a correct handling (C6)
- To know the different mechanical and chemical processes, which are applicable in the field of waste management (C6)
- Waste composition as a mirror of the human evolution
- Waste definition (formation, amount, energy content, waste composition)
- Several recycling possibilities and processes
- Thermal waste treatment (electricity/district heat as products), including off-gas cleaning and incineration residue handling with regards to the final residue storage in a landfill and the problems which have to be solved there
- Special fields like biological waste handling (composting, fermentation), handling of special wastes and municipal sewage sludge treatment
- Economical aspects

Lecture notes

Siehe englische Ausgabe

Literature

see bibliographie in the script

102-0455-AAL
Groundwater I

Enrolment only for MSc students who need this course as additional admission requirement.

Abstract

The course provides an introduction into quantitative analysis of groundwater flow and transport. It is focussed on formulating flow and transport problems in groundwater, which are to be solved analytically or numerically.
**Objective**

a) Students understand the basic concepts of flow and contaminant transport processes and boundary conditions in groundwater.

b) Students are able to formulate simple practical flow and transport problems.

c) Students are able to understand and apply simple analytical solutions to simple flow and transport problems.

d) Students are able to use simple numerical codes to adequately solve simple flow (and transport) problems.

**Content**

Introduction, aquifers, groundwater use, sustainability, porosity.

Properties of porous media.

Exercises: Groundwater use, porosity, grain size analysis.

Flow properties, Darcy's law, filter.

Flow equations, stream function.

Exercises: Darcy's law.

Analytical solutions, confined aquifers, steady-state flow.

Exercises: Head isolines.

Use of superposition principles, transient flow, free surface flow.

Exercises: Analytical solutions to flow problems.

Finite difference solutions to flow problems I.

Exercises: Analytical solutions to flow problems.

Finite difference solutions to flow problems II.

Exercises: Finite difference formulations to flow problems.

Transport processes.

Exercises: Computer workshop using PMWIN.

Analytical solutions to transport problems I.

Exercises: Computer workshop using PMWIN.

Analytical solutions to transport problems II.

Exercises: Analytical solutions to transport problems.

Path lines, groundwater protection.

Exercises: Analytical solutions to transport problems.

Groundwater remediation, groundwater management.

Exercises: Groundwater remediation.

Lecture notes

Folien auf Internet unter www.ihw.ethz.ch/GWH/education/index

Altes Skript auf Internet www.ihw.ethz.ch/GWH/education/index

Weitere Texte auf Internet www.ihw.ethz.ch/GWH/education/index

Didaktische Software auf Internet unter www.ihw.ethz.ch/GWH/education/index

Literature


W. Kinzelbach, R. Rausch, Grundwassermodellierung, Gebrüder Bornträger, Stuttgart, 1995

Krusemann, de Ridder, Untersuchung und Anwendung von Pumpversuchen, Verl. R. Müller, Köln, 1970

G. de Marsily, Quantitative Hydrogeology, Academic Press, 1986

**Abstract**

The lecture provides an introduction to the formation of air pollutants by technical processes, the emission of these chemicals into the atmosphere and the impact on air quality. Theoretical description and modeling of these processes, air quality measurement techniques and pollution control techniques are covered.

**Objective**

The students gain general knowledge of the factors resulting in air pollution and the techniques used for air pollution control. The students can identify major air pollution sources and understand the methods for measurement, data collection and analysis. The students can evaluate possible control methods and equipment, design a control system and estimate the efficiency and cost.

**Content**

- the physical and chemical processes leading to emission of pollutants
- air quality analysis
- the meteorological parameters influencing air pollution dispersion
- deterministic and stochastic models, describing the air pollution dispersion
- measurement concepts to observe ambient air pollution
- removal of gaseous pollutants by absorption and adsorption
- control of NOx and SOx
- fundamentals of particulate control
- design and application of wet scrubbers

**Literature**

Text book


**Prerequisites / notice**

College lectures on basic physics, chemistry and mathematics.
The course offers an introduction to the basics of water resources analysis and management covering the topics of water demand vs availability, water exploitation and reservoir design, aquatic physics, water quality and pollution, water conservation and remediation in rivers, lakes and aquifers, sustainable water use.

### Objective

Introduction to the basics of water resources management based on physical and chemical processes; principle of sustainability

### Content


Wassergüte: Anforderungen, Schadstoffausbreitung, Selbstreinigung, Thermische Belastung, relevante Schadstoffe und Quellen, Stossbelastungen, Zeitkonstanten und Grössenordnungen.

Wasserwirtschaft: Struktur von Dargebot und Nachfrage.

Optionen zur Schliessung der Disparität: Reservoire, Grundwasserspeicher, Überleitungen, Wasserwirtschaftliche Rahmenplanung (Masterplan) , Gewässerschutz, Sanierung und Renaturierung (Oberflächengewässer und Grundwasser), Variabilität, Stochastik und Risiko.

Nachhaltigkeit: Definitionen, Beispiele für nicht-nachhaltiges Wirtschaften, Wasserprobleme der Entwicklungsländer, Wasser und Landwirtschaft, Projektbewertung und Umweltverträglichkeitsprüfung. Ökonomische und Soziologische Bezüge.

Alle Aspekte sollen mit Fallbeispielen illustriert werden.


### Lecture notes

Script in wöchentlichen Folgen.

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### 252-0846-AAL Computer Science II

Enrolment only for MSc students who need this course as additional admission requirement.

**Abstract**

Introduction to programming in Java. Procedural foundations of programming and outlook to object oriented programming. Variables, types, assignments, control structures (branch, loop), data structures, algorithms, line graphics, graphical user interface. Writing small programs.

**Objective**

The students will be able to write simple programs and to modify existing programs.

**Content**

This course offers an introduction to variables, control structures (branch, loop), algorithms and data structures, as well as an outlook to modularisation and object oriented techniques.

In the exercises students train programming skills (in the programming language JAVA). Students can solve the exercises on their own laptop or in the computer labs at ETH. The software used in this course runs on MS Windows, MacOS X and Linux.

**Prerequisites / notice**

Enrolment only for MSc students who need this course as additional admission requirement.

**Lecture notes**

Nivaldo J. Tro
Chemistry - A molecular Approach (Pearson), Chapter 1-18

**Literature**

Housecroft and Constable, CHEMISTRY

Oxtoby, Gillis, Nachtrieb, MODERN CHEMISTRY

### 529-2001-AAL Chemistry I and II

Enrolment only for MSc students who need this course as additional admission requirement.

**Abstract**

General Chemistry I and II: Chemical bond and molecular structure, chemical thermodynamics, chemical equilibrium, kinetics, acids and bases, electrochemistry

**Objective**

Introduction to general and inorganic chemistry. Basics of the composition and the change of the material world. Introduction to the thermodynamically controlled physico-chemical processes. Macroscopic phenomena and their explanation through atomic and molecular properties. Using the theories to solve qualitatively and quantitatively chemical and ecologically relevant problems.

**Content**

1. Stoichiometry

2. Atoms and Elements (Quantenmechanical Model of the Atom)

3. Chemical Bonding

4. Thermodynamics

5. Chemical Kinetics

6. Chemical Equilibrium (Acids and Bases, Solubility Equilibria)

7. Electrochemistry

**Lecture notes**

Nivaldo J. Tro
Chemistry - A molecular Approach (Pearson), Chapter 1-18

**Literature**

Housecroft and Constable, CHEMISTRY

Oxtoby, Gillis, Nachtrieb, MODERN CHEMISTRY

### 529-2002-AAL Chemistry II

Enrolment only for MSc students who need this course as additional admission requirement.

**Abstract**

Chemistry II: Redox reactions, chemistry of the elements, introduction to organic chemistry

**Objective**

Erarbeiten der Grundlagen von anorganischer und organischer Stoffchemie

1. Redoxreactions

2. Inorganic Chemistry

Rules for nomenclature of inorganic compounds. Systematic description of the groups of elements in the periodical system and the most important compounds of these elements. Formation of compounds as a consequence of the electronic structure of the elements.

3. Introduction to organic chemistry

Description of the most important classes of compounds and of the functional groups. Principal reactivity of these functional groups. Stereochemistry.

Reaction mechanisms: SN1- and SN2-reactions, electrophilic aromatic substitutions, eliminations (E1 and E2), addition reactions (C=C and C=O double bonds). Chemistry of carbony and carboxyl groups.

Rules for nomenclature of inorganic compounds. Systematic description of the groups of elements in the periodical system and the most important compounds of these elements. Formation of compounds as a consequence of the electronic structure of the elements.

3. Introduction to organic chemistry

Description of the most important classes of compounds and of the functional groups. Principal reactivity of these functional groups. Stereochemistry.

Reaction mechanisms: SN1- and SN2-reactions, electrophilic aromatic substitutions, eliminations (E1 and E2), addition reactions (C=C and C=O double bonds). Chemistry of carbony and carboxyl groups.

Lecture notes

Biochemistry

**Enrolment only for MSc students who need this course as additional admission requirement.**

**Abstract**
Introduction to basic biochemistry and the most important metabolic reactions.

**Objective**
Based on the biology and chemistry courses in the 1. and 2. semester more detailed biochemical knowledge about enzymology, membrane biochemistry, and central metabolism will be presented

**Content**
Introduction, basics, composition of cells, biochemical units, repetition of relevant organic chemistry
Structure and function of proteins
Carbohydrates, structure of DNA
Lipids and biological membranes
Enzymes and enzyme kinetics
Catalytic strategies
Metabolism: Basic concepts and design. Repetition of basic thermodynamics
Glycolysis
The citric acid cycle
Oxidative phosphorylation
Fatty acid metabolism

**Lecture notes**
by Laurence A. Moran (Author), Robert A Horton (Author), Gray Scrimgeour (Author), Marc Perry (Author)

**Literature**
by Laurence A. Moran (Author), Robert A Horton (Author), Gray Scrimgeour (Author), Marc Perry (Author)

**Prerequisites / notice**
Basic knowledge in biology and chemistry is a precondition.
Literature

Prerequisites / notice
Vorbereitend zu Hydrologie I sind die Vorlesungen in Statistik. Der Inhalt, der um ein Teil der Übungen zu behandeln und um ein Teil der Vorlesungen zu verstehen notwendig ist, kann zusammengefasst werden, wie hintereinander es beschrieben wird:
Elementare Datenverarbeitung: Hydrologische Messungen und Daten, Datenreduzierung (grafische Darstellungen und numerische Kenngrößen).

Environmental Engineering Master - Key for Type

| O   | Compulsory          | E- | Recommended, not eligible for credits |
| W+  | Eligible for credits and recommended | Z  | Courses outside the curriculum        |
| W   | Eligible for credits                  | Dr | Suitable for doctorate                |

Key for Hours

| V   | lecture                      | P  | practical/laboratory course        |
| G   | lecture with exercise        | A  | independent project                |
| U   | exercise                     | D  | diploma thesis                     |
| S   | seminar                     | R  | revision course / private study    |
| K   | colloquium                   |    |                                    |

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Educational Science

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>851-0240-00L</td>
<td><strong>Human Learning (EW1)</strong>&lt;br&gt;This lecture is only apt for students who intend to enrol in the programs &quot;Teaching Diploma&quot; or &quot;Teaching Certificate&quot;. It is about learning in childhood and adolescence.</td>
<td>O</td>
<td>2 credits</td>
<td>2G</td>
<td>E. Stern</td>
</tr>
<tr>
<td>851-0242-05L</td>
<td><strong>Cognitively Activating Instructions in MINT Subjects</strong>&lt;br&gt;Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
<td>W</td>
<td>2 credits</td>
<td>2S</td>
<td>R. Schumacher</td>
</tr>
<tr>
<td>851-0242-07L</td>
<td><strong>Human Intelligence</strong>&lt;br&gt;Enrolment only possible with matriculation in Teaching Diploma or Teaching Certificate (excluding Teaching Diploma Sport).</td>
<td>W</td>
<td>1 credit</td>
<td>1S</td>
<td>E. Stern, P. Edelsbrunner, B. Rütsche</td>
</tr>
<tr>
<td>851-0242-08L</td>
<td><strong>Research Methods in Educational Science</strong>&lt;br&gt;Number of participants limited to 30.</td>
<td>W</td>
<td>1 credit</td>
<td>1S</td>
<td>P. Edelsbrunner, B. Rütsche, E. Stern, E. Ziegler</td>
</tr>
<tr>
<td>851-0240-22L</td>
<td><strong>Coping with Psychosocial Demands of Teaching (EW4 W DZ)</strong>&lt;br&gt;Number of participants limited to 20.</td>
<td>W</td>
<td>2 credits</td>
<td>3S</td>
<td>A. Deiglmayr, P. Greutmann, S. Hofer</td>
</tr>
</tbody>
</table>

#### Abstract
- **Human Learning (EW1)**: This course looks into scientific theories and also empirical studies on human learning and relates them to the school.
- **Cognitively Activating Instructions in MINT Subjects**: This seminar focuses on teaching units in chemistry, physics and mathematics that have been developed at the MINT Learning Center of 3S.
- **Human Intelligence**: Anyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.
- **Coping with Psychosocial Demands of Teaching (EW4 W DZ)**: Anyone wishing to be a successful teacher must first of all understand the learning process. Against this background, theories and findings on the way humans process information and on human behaviour are prepared in such a manner that they can be used for planning and conducting lessons. Students additionally gain an understanding of what is going on in learning and behavioural research so that teachers are put in a position where they can further educate themselves in the field of research into teaching and learning.

#### Prerequisites / notice
- **Human Learning (EW1)**: Participation in, or during enrollment in the course "Human Learning (EW 1)".
- **Cognitively Activating Instructions in MINT Subjects**: Participation in, or during enrollment in the course "Human Learning (EW 1)".
- **Human Intelligence**: Participation in, or during enrollment in the course "Human Learning (EW 1)".
- **Research Methods in Educational Science**: Participation in, or during enrollment in the course "Human Learning (EW 1)".
- **Coping with Psychosocial Demands of Teaching (EW4 W DZ)**: Participation in, or during enrollment in the course "Human Learning (EW 1)".

#### Literature

#### Number of participants
- Limited to 20.
- Limited to 30.
- Limited to 20.
- Limited to 30.
- Limited to 30.
- Limited to 30.
The successful participation in EW1 ("Human Learning") and EW2 ("Designing Learning Environments for School") is recommended, but not a mandatory prerequisite.

Abstract
In this class, students will learn concepts and skills for coping with psychosocial demands of teaching.

Objective
Students possess theoretical knowledge and practical competences to be able to cope with the psychosocial demands of teaching.

1. They know the basic rules of negotiation and conflict management (e.g., mediation) and can apply them in the school context (e.g., in conversations with parents).
2. They can apply diverse techniques of classroom management (e.g., prevention of disciplinary problems in the classroom) and know relevant authorities for further information (e.g., legal conditions).

Subject Didactics and Professional Training

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0823-00L</td>
<td>Environmental Education Didactics I</td>
<td>O</td>
<td>4</td>
<td>3G</td>
<td>C. Colberg, F. Keller</td>
</tr>
</tbody>
</table>

Abstract
Environmental Education Didactics supplies the basic concepts for the application of the contents of the lecture Human Learning (EW 1) in educational environment.

Objective
On the basis of selected environmental topics didactical theories are used practice-oriented, whereas the appliance of different teaching methods is pointed out. In addition a didactical topic is exercised exemplary in an assignment.

Content
Berufsfelder, Denkansätze, unsere Orientierung, Möglichkeiten der Umweltlehre, Umsatzerze des Stoffes, Wirkungen auf Zuhörer/innen, Konfliktmanagement; Anwendungen allg. Didaktik z. B. in den Bereichen: Globale Umweltzusammenhänge, Klima, Kreisläufe, Boden als Lebensgrundlage, Abfallwirtschaft, Ökobilanzierung als Beurteilungsgrundlage, Schadstoffe in der Umwelt, Quellenarbeit, Umwelt und Wirtschaft, Medien und Umfeld, Zukunftsperspektiven

Lecture notes
Die Unterlagen zu den behandelten Themen werden über den BSCW-Server abgegeben (Anmeldung obligatorisch).

Literature
Gemäss Literaturliste auf dem BSCW-Server.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-0827-00L</td>
<td>Teaching Internship Including Examination Lessons Environmental Studies</td>
<td>O</td>
<td>6</td>
<td>13P</td>
<td>C. Colberg, F. Keller</td>
</tr>
</tbody>
</table>

Abstract
Students apply the insights, abilities and skills they have acquired within the context of an educational institution. They observe 10 lessons and teach 20 lessons independently. Two of them are as assessed as Examination Lessons.

Objective
- Students use their specialist-subject, educational-science and subject-didactics training to draw up concepts for teaching.
- They are able to assess the significance of tuition topics for their subject from different angles (including interdisciplinary angles) and impart these to their pupils.
- They learn the skills of the teaching trade.
- They practise finding the balance between instruction and openness so that pupils can and, indeed, must make their own cognitive contribution.
- They learn to assess pupils' work.
- Together with the teacher in charge of their teacher training, the students constantly evaluate their own performance.

Content
The students will be able to watch and evaluate the teaching of colleagues and experts. They get profit out of their teaching experiences not only when preparing but also when teaching. Doing so they will be supported by their mentors.

Lecture notes
Dokumente unter http://www.didaktische-ausbildung.ethz.ch/docs/uwis
- Raster zum Bericht über das Unterrichtspraktikum im DZ Umweltlehre an der ETH Zürich (PDF)
- Beurteilungsbericht Prüfungslektionen Umweltlehre

Literature
Wird von der Praktikumslehrperson bestimmt.

Environmental Studies TC - Key for Type

<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
</tr>
</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
</tr>
<tr>
<td>E-</td>
<td>Recommended, not eligible for credits</td>
</tr>
<tr>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>Dr</td>
<td>Suitable for doctorate</td>
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</tbody>
</table>

Key for Hours

<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
</tr>
<tr>
<td>U</td>
<td>exercise</td>
</tr>
<tr>
<td>S</td>
<td>seminar</td>
</tr>
<tr>
<td>K</td>
<td>colloquium</td>
</tr>
<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

ECTS  European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>529-2001-02L</td>
<td>Chemistry I</td>
<td>O</td>
<td>4</td>
<td>2V+2U</td>
<td>W. Uhlig, J. E. E. Buschmann, S. Canonica, P. Funck, E. C. Meister, R. Verel</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Introduction to general and inorganic chemistry. Basics of the composition and the change of the material world. Introduction to the thermodynamically controlled physico-chemical processes. Macroscopic phenomena and their explanation through atomic and molecular properties. Using the theories to solve qualitatively and quantitatively chemical and ecologically relevant problems.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>1. Stoichiometry</td>
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<td></td>
<td>2. Atoms and Elements (Quantenmechanical Model of the Atom)</td>
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<td>3. Chemical Bonding</td>
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<td>4. Thermodynamics</td>
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<td>5. Chemical Kinetics</td>
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<td>6. Chemical Equilibrium (Acids and Bases, Solubility Equilibria)</td>
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<tr>
<td></td>
<td>Lecture notes</td>
<td></td>
<td></td>
<td></td>
<td>ca. 360 Seiten mit vielen Figuren und durchgerechneten Beispielen.</td>
</tr>
<tr>
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<td>Weiterführende Literatur:</td>
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<td>Brown, LeMay, Bursten CHEMIE (deutsch)</td>
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<td>Hauscroft and Constable, CHEMISTRY (englisch)</td>
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<td>Oxtoby, Gillis, Nachtrieb, MODERN CHEMISTRY (englisch)</td>
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<tr>
<td>401-0251-00L</td>
<td>Mathematics I</td>
<td>O</td>
<td>6</td>
<td>4V+2U</td>
<td>A. Cannas da Silva</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>This course covers mathematical concepts and techniques necessary to model, solve and discuss scientific problems - notably through ordinary differential equations.</td>
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<tr>
<td></td>
<td>Objective</td>
<td></td>
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<td>Mathematics is of ever increasing importance to the Natural Sciences and Engineering. The key is the so-called mathematical modelling cycle, i.e. the translation of problems from outside of mathematics into mathematics, the study of the mathematical problems (often with the help of high level mathematical software packages) and the interpretation of the results in the original environment.</td>
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<td>The goal of Mathematics I and II is to provide the mathematical foundations relevant for this paradigm. Differential equations are by far the most important tool for modelling and are therefore a main focus of both of these courses.</td>
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<td>1. Single-Variable Calculus:</td>
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<td>review of differentiation, linearisation, Taylor polynomials, maxima and minima, antiderivative, fundamental theorem of calculus, integration methods, improper integrals.</td>
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<td>2. Linear Algebra and Complex Numbers:</td>
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<td></td>
<td>systems of linear equations, Gauss-Jordan elimination, matrices, determinants, eigenvalues and eigenvectors, cartesian and polar forms for complex numbers, complex powers, complex roots, fundamental theorem of algebra.</td>
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<td>3. Ordinary Differential Equations:</td>
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<td>separable ordinary differential equations (ODEs), integration by substitution, 1st and 2nd order linear ODEs, homogeneous systems of linear ODEs with constant coefficients, introduction to 2-dimensional dynamical systems.</td>
</tr>
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<td></td>
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<td>- Bretscher, O.: Linear Algebra with Applications (Pearson Prentice Hall).</td>
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<td>Prerequisites / notice</td>
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<td>Assistance:</td>
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<tr>
<td>701-0757-00L</td>
<td>Principles of Economics</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>R. Schubert</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
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<td>This course covers the bases for understanding micro- and macroeconomic issues and theories. Participants are given the tools to argue in economic and political terms and to evaluate the corresponding measures. Group and individual exercises deepen the knowledge gained.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>Students are able to</td>
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<td>- describe fundamental micro- and macroeconomic issues and theories.</td>
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<td>- apply suitable economic arguments to a given theme.</td>
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<td>- evaluate economic measures.</td>
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<td></td>
<td></td>
<td>Content</td>
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<td></td>
<td>Supply and demand behaviour of firm and households; market equilibrium and taxation; national income and indicators; inflation; unemployment; growth; macroeconomic policies</td>
</tr>
<tr>
<td></td>
<td>Lecture notes</td>
<td></td>
<td></td>
<td></td>
<td>available on electronic platform</td>
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<td></td>
<td>Prerequisites / notice</td>
</tr>
<tr>
<td>701-0005-00L</td>
<td>Introduction to the Handling of Environmental Systems</td>
<td>O</td>
<td>5</td>
<td>1G+4S</td>
<td>P. M. Frischknecht, H. R. Heinimann, B. T. Schmied, N. Dajcar, C. E. Pohl</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
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<td>Imparting basic understanding of systematical problem-solving and target-oriented process presentations. Introduction of methods for working out environmentally relevant problems. Practical application of theoretical knowledge on a case study on renewable energy. Practice of communication skills, especially of writing a scientific report.</td>
</tr>
</tbody>
</table>
Abgabe einer Fall bezogenen Literaturliste
Abgabe ausgewählter Literatur zum Fall
O. U. Sauer
General Biology I
S. Güsewell
The objective of this lecture is to teach basic ecological concepts and the different levels of complexity in ecological research: the
Biology III: Essentials of Ecology
This lecture presents an introduction to ecology. It includes basic ecological concepts and the most important levels of complexity in
The understanding of some basic principles of biology: the hierarchy of the structural levels of biological organisation, with particular
- Übersicht der aquatischen und terrestrischen Lebensräume mit ihren Bewohnern
3V
- Evolutionäre Ökologie: Methodik, Spezialisierung, Koevolution
- Aktuelle Naturschutzprobleme und -massnahmen
- Ökosysteme: Kompartimente, Stoff- und Energieflusse
- Lebensgemeinschaften: Struktur, Stabilität, Sukzession
- Interaktionen zwischen Arten (Konkurrenz, Koexistenz, Prädation, Parasitismus, Nahrungsnetze)
- Lebensgemeinschaften: Struktur, Stabilität, Sukzession
- Aktuelle Naturschutzprobleme und -massnahmen
- Evolutionäre Ökologie: Methodik, Spezialisierung, Koevolution
Abgabe eines Skripts
551-0001-00L General Biology I O 3 credits 3V U. Sauer, A. Widmer
Abstract
The understanding of some basic principles of biology: the hierarchy of the structural levels of biological organisation, with particular
Objective
The structure and function of biomacromolecules; basics of metabolism; cell biology; membrane structure and function; basic energetics of
Content
- Evolutionäre Ökologie: Methodik, Spezialisierung, Koevolution
- Aktuelle Naturschutzprobleme und -massnahmen
- Ökosysteme: Kompartimente, Stoff- und Energieflusse
- Lebensgemeinschaften: Struktur, Stabilität, Sukzession
- Interaktionen zwischen Arten (Konkurrenz, Koexistenz, Prädation, Parasitismus, Nahrungsnetze)
- Lebensgemeinschaften: Struktur, Stabilität, Sukzession
- Aktuelle Naturschutzprobleme und -massnahmen
- Evolutionäre Ökologie: Methodik, Spezialisierung, Koevolution
Abgabe einer Fall bezogenen Literaturliste
Die Lehrveranstaltung beinhaltet neben einer Exkursion auch verschiedene Gruppensitzungen sowie ein Blockseminar.
Lecture notes Abgabe ausgewählter Literatur zum Fall
Literature
Prerequisites / notice
The lecture notes are not available
The lecture is the first in a series of two lectures given over two semesters for students with biology as a basic subject.

Abstract
This lecture presents an introduction to ecology. It includes basic ecological concepts and the most important levels of complexity in
ecological research. Ecological concepts are exemplified by using aquatic and terrestrial systems; corresponding methodological
approaches are demonstrated. In a more applied part of the lecture threats to biodiversity and the appropriate management are discussed.
Objective
The objective of this lecture is to teach basic ecological concepts and the different levels of complexity in ecological research: the
individual, the population, the community and the ecosystem level.

Content
- Übersicht der aquatischen und terrestrischen Lebensräume mit ihren Bewohnern
- Einfluss von Umweltfaktoren (Temperatur, Strahlung, Wasser, Nährstoffe etc.) auf Organismen; Anpassung an bestimmte
Umweltbedingungen
- Populationsdynamik: Ursachen, Beschreibung, Vorhersage und Regulation
- Interaktionen zwischen Arten (Konkurrenz, Koexistenz, Prädation, Parasitismus, Nahrungsnetze)
- Lebensgemeinschaften: Struktur, Stabilität, Sukzession
- Ökosysteme: Kompartimente, Stoff- und Energieflusse
- Biodiversität: Variation, Ursachen, Gefährdung und Erhaltung
- Aktuelle Naturschutzprobleme und -massnahmen
- Evolutionäre Ökologie: Methodik, Spezialisierung, Koevolution

Prerequisites / notice
The lecture is the first in a series of two lectures given over two semesters for students with biology as a basic subject.

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 1334 of 1434
Lecture notes Unterlagen, Vorlesungsfolien und relevante Literatur sind in der Lehrdokumentenablage abrufbar. Die Unterlagen für die nächste Vorlesung stehen jeweils spätestens am Freitagmorgen zur Verfügung.

Literature

701-0025-00L Earth and Natural Production Systems W+ 5 credits 4V C. Schär, E. Frossard, C. Garcia, M. Sonneveld, B. Wehrli, S. Willett


- Students learn to apply selected concepts and tools from computer science for working on interdisciplinary projects. The following topics are covered: publishing over the internet, processing and visualizing time series, visualizing multi-dimensional data, managing data with lists and tables and with relational databases, introduction to macro programming, universal methods for algorithm design.

Objective
The students learn to
- choose and apply appropriate tools from computer science,
- process and analyze real-world data from their subject of study,
- handle the complexity of real-world data,
- know universal methods for algorithm design.

Content
1. Simulation and Modeling
2. Visualizing multidimensional data
3. Data management with lists and tables
4. Data management with a relational database
5. Introduction to macro programming
6. Introduction to programming with Python

Lecture notes All materials for the lecture are available at www.evim.ethz.ch

Prerequisites / notice
This course is based on application-oriented learning. The students spend most of their time working through electronic tutorials and discussing their results with teaching assistants.

529-0030-00L Laboratory Course: Elementary Chemical Techniques O 3 credits 6P N. Kobert, M. Morbidelli

This practical course provides an introduction to elementary laboratory techniques. The experiments cover a wide range of techniques, including analytical and synthetic techniques (e.g. investigation of soil and water samples or the preparation of simple compounds). Furthermore, the handling of gaseous substances is practised.

Objective
This course is intended to provide an overview of experimental chemical methods. The handling of chemicals and proper laboratory techniques represent the main learning targets. Furthermore, the description and recording of laboratory processes is an essential part of this course.
The classification and analysis of natural and artificial compounds is a key subject of this course. It provides an introduction to elementary laboratory techniques, and the experiments cover a wide range of analytic and synthetic tasks:

Selected samples (e.g. soil and water) will be analysed with various methods, such as titrations, spectroscopy or ion chromatography. The chemistry of aqueous solutions (acid-base equilibria and solvation or precipitation processes) is studied.

The synthesis of simple inorganic complexes or organic molecules is practised.

Furthermore, the preparation and handling of environmentally relevant gaseous species like carbon dioxide or nitrogen oxides is a central subject of the Praktikum.

**Lecture notes**

The script will be published on the web.

**Literature**

A thorough study of all script materials is requested before the course starts.

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**Basic Courses II**

**Examination Blocks**

**Examination Block 1**

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>402-0063-00L</td>
<td>Physics II</td>
<td>O</td>
<td>5</td>
<td>3V+1U</td>
<td>A. Vaterlaus</td>
</tr>
<tr>
<td>Abstract</td>
<td>Introduction to the &quot;way of thinking&quot; and the methodology in Physics, with the help of demonstration experiments. The Chapters treated are Electromagnetism, Refraction and Diffraction of Waves, Elements of Quantum Mechanics with applications to Spectroscopy, Thermodynamics, Phase Transitions, Transport Phenomena. Whenever possible, examples relevant to the students' main field of study are given.</td>
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<tr>
<td>Objective</td>
<td>Introduction to the scientific methodology. The student should develop his/her capability to turn physical observations into mathematical models, and to solve the latter.</td>
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<tr>
<td>Content</td>
<td>Elektromagnetismus, Elektromagnetische Wellen, Wellenoptik, Strahlenoptik, Quantenoptik, Quantenmechanik, Thermische Eigenschaften, Transportphänomene, Wärmestrahlung</td>
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<tr>
<td></td>
<td>Physik in Experimenten und Beispielen Carl Hanser Verlag, München, 2002, 1068 S.</td>
<td></td>
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<tr>
<td></td>
<td>Physik A. Tipler Physik für Ingenieure und Naturwissenschaftler Spektrum Akademischer Verlag, 1998, 1522 S., ca Fr. 120.-</td>
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<tr>
<td></td>
<td>dazu gratis Online Ressourcen (z.B. Simulationen): halliday.de</td>
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</tbody>
</table>

| 752-4001-00L| Microbiology      | O    | 2    | 2V    | M. Ackermann, M. Schuppler, J. Vorholt-Zambelli |
| Abstract    | Teaching of basic knowledge in microbiology with main focus on Microbial Cell Structure and Function. Molecular Genetics, Microbial Growth, Metabolic Diversity, Phylogeny and Taxonomy, Prokaryotic Diversity, Human-Microbe Interactions, Biotechnology. |      |      |                    |
| Objective   | Teaching of basic knowledge in microbiology. |      |      |                    |
| Content     | Der Schwerpunkt liegt auf den Themen: Bakterielle Zellbiologie, Molekulare Genetik, Wachstumsphysiologie, Biochemische Diversität, Phylogenie und Taxonomie, Prokaryotische Vielfalt, Interaktion zwischen Menschen und Mikroorganismen sowie Biotechnologie. |      |      |                    |
| Lecture notes | Die Behandlung der Themen erfolgt auf der Basis des Lehrbuchs Brock, Biology of Microorganisms |      |      |                    |
| Literature  | Wird von den jeweiligen Dozenten ausgegeben. |      |      |                    |

| 701-0255-00L| Biochemistry      | O    | 2    | 2V    | H.P. Kohler |
| Abstract    | Building on the biology courses in the 1st and 2nd semesters, this course covers basic biochemical knowledge in the areas of enzymology and metabolism. Those completing the course are able to describe and understand fundamental cellular metabolic processes. |      |      |                    |
Students are able to understand
- the structure and function of biological macromolecules
- the kinetic bases of enzyme reactions
- thermodynamic and mechanistic basics of relevant metabolic processes

Students are able to describe the relevant metabolic reactions in detail

Introduction, basics, composition of cells, biochemical units, repetition of relevant organic chemistry

Structure and function of proteins
Carbohydrates
Lipids and biological membranes
Enzymes and enzyme kinetics
Catalytic strategies
Metabolism: Basic concepts and design. Repetition of basic thermodynamics
Glycolysis, fermentation
The citric acid cycle
Oxidative phosphorylation
Fatty acid metabolism

Horton et al. (Pearson) serves as lecture notes.

Written information will be supplied.

701-0245-00L Introduction to Evolutionary Biology

Objective
This course introduces important questions about the evolutionary processes involved in the generation and maintenance of biological diversity across all domains of life and how evolutionary science investigates these questions.

Content
Topics likely to be covered in this course include research methods in evolutionary biology, adaptation, evolution of sex, evolutionary transitions, human evolution, infectious disease evolution, life history evolution, macroevolution, mechanisms of evolution, phylogenetic analysis, population dynamics, population genetics, social evolution, speciation and types of selection.

Literature
- 1. Water as resource, 2. Water and climate
- ground water use
- hydrochemistry and tracer
- aquifers and their properties
- hydrochemistry and tracer
- ground water use

Case studies
- 1. Water as resource, 2. Water and climate

Suggested literature.

The exam is based on lecture and textbook.

701-0023-00L Atmosphere

Abstract
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

Objective
Understanding of basic physical and chemical processes in the atmosphere. Understanding of mechanisms of and interactions between: weather - climate, atmosphere - ocean - continents, troposphere - stratosphere. Understanding of environmentally relevant structures and processes on vastly differing scales. Basis for the modelling of complex interrelations in the atmosphere.

Content
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

Lecture notes
Written information will be supplied.

Literature

701-0401-00L Hydrosphere

Abstract
Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.

Objective
Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.

Content
Topics of the course.
Physical properties of water (i.e. density and equation of state)
- global water resources
- exchange at boundaries
- energy (thermal & kinetic), gas exchange
Mixing and transport processes in open waters
- vertical stratification, large scale transport
- turbulence and mixing
- mixing and exchange processes in rivers
Groundwater and its dynamics
- ground water as part of the terrestrial water cycle
- ground water hydraulics, Darcy's law
- aquifers and their properties
- hydrochemistry and tracer
- ground water use
Case studies
- 1. Water as resource, 2. Water and climate

Lecture notes
In addition to the suggested literature handouts are distributed.

Literature
Suggested literature.

701-0501-00L Pedosphere

Abstract

Objective

Content

Lecture notes

Literature

Prerequisites / notice

The case studies and the analysis of the questions and problems are integral part of the course.
Abstract
Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

Objective
Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

Content
Definition of the pedosphere, soil functions, rocks as parent materials, minerals and weathering, soil organisms, soil organic matter, physical soil properties and functions, chemical soil properties and functions, soil formation, principles of soil classification, global soil regions, soil fertility, land use and soil degradation.

Lecture notes
Lecture notes can be purchased during the first lecture (15.- SFr)

Literature

Prerequisites / notice
Prerequisites: Basic knowledge in chemistry, biology and geology.

701-0071-00L  Mathematics III: Systems Analysis  O  4 credits  2V+1U  N. Gruber, P. Landschützer

Abstract
The objective of the systems analysis course is to deepen and illustrate the mathematical concepts on the basis of a series of very concrete examples. Topics covered include: linear box models with one or several variables, non-linear box models with one or several variables, time-discrete models, and continuous models in time and space.

Objective
Learning and applying of concepts (models) and quantitative methods to address concrete problems of environmental relevance. Understanding and applying the systems-analytic approach, i.e., Recognizing the core of the problem - simplification - quantitative approach - prediction.

Content
Content of lectures:
http://www.up.ethz.ch/education/system_analysis/index_DE

Homework:
http://www.up.ethz.ch/education/system_analysis/SA2/index_DE

Lecture notes
Overhead slides:
http://www.up.ethz.ch/education/system_analysis/index_DE

Literature


Additional Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0035-00L</td>
<td>Integrated Practical Observation Networks</td>
<td>O</td>
<td>1.5 credits</td>
<td>4P</td>
<td>B. Sierau, J. Henneberger, T. Tormann</td>
</tr>
</tbody>
</table>

Abstract
Observation networks - the combination of individual instruments - are the starting point of quantitative environmental studies. The structure and idiosyncrasies of existing observation networks are shown. When working in individual experiments on practical problems, various types of observation networks are dealt with; questions related to data quality and data availability are discussed.

Objective
Getting acquainted with existing networks. Insight into problems related to measuring and interpreting multi-dimensional fields of atmospheric physical, atmospheric chemical, and geophysical parameters.

Content
Observation networks for atmospheric physical, atmospheric chemical, geophysical, hydrological and climatological parameters on different scales (synoptic: 1000 km; mesoscale: 100 km, and microscale: 100 m). Combination of surface observation with remotely sensed data (satellite, radar). Solving interpolation problems in multi-dimensional fields of the observed variables. Assessing the representativity of local values, i.e., the directly observed variable in an observation network.

Lecture notes
The script is published anew every year. Apart from the description of the scientific problems to be worked on in individual experiments, it contains some theoretical chapters on observation networks, as well as guidelines for writing and publishing scientific papers. The script can be downloaded as pdf from the course webpage.

Literature
Literature is listed in the script.

Social Sciences and Humanities Module

Module Economics
### Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>363-0387-00L</td>
<td>Corporate Sustainability</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>V. Hoffmann</td>
</tr>
</tbody>
</table>

**Abstract**

We introduce the concept of corporate sustainability; discuss its implications focusing on strategy, technology, and financial markets; and offer e-modules to train relevant critical thinking skills. With this input, students explore the practical challenges of corporate sustainability in a group project, focusing on one of the four sustainability challenges of water, energy, mobility, and food.

**Objective**

Understand the limits and the potential of corporate sustainability for sustainable development

Develop critical thinking skills that are useful for corporate sustainability (argumentation, communication, evaluative judgment)

Be able to recognize and realize opportunities for corporate sustainability in a business environment

Content

Overview of the grand sustainability challenges of Water, Energy, Mobility, and Food

Business implications of sustainable development, in particular for corporate strategy, marketing & leadership, technology & innovation, and financial markets.

Critical thinking skills for corporate sustainability

In-depth case study of concrete corporate sustainability challenge in the group project phase, such as: How to deal with environmental pressure groups? How to use the strengths of business to solve pressing sustainability problems? How to catalyze radical innovations for sustainability? How to invest money in a sustainable way?

Lecture notes

Presentation slides will be distributed prior to lectures.

Literature

Literature recommendations will be distributed during the lecture

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>751-1551-00L</td>
<td>Ressourcen- und Umweltökonomie</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>L. Bretschger, A. Müller</td>
</tr>
</tbody>
</table>

**Abstract**

Relationship between economy and environment, market failure, external effects and public goods, contingent valuation, internalisation of externalities; economics of non-renewable resources, economics of renewable resources, cost-benefit analysis, sustainability, and international aspects of resource and environmental economics.

**Objective**

Understanding of the basic issues and methods in resource and environmental economics; ability to solve typical problems in the field using the appropriate tools, which are concise verbal explanations, diagrams or mathematical expressions.

Topics are:

- Introduction to resource and environmental economics
- Importance of resource and environmental economics
- Main issues of resource and environmental economics
- Normative basis
- Utilitarianism
- Fairness according to Rawls
- Economic growth and environment
- Externalities in the environmental sphere
- Governmental internalisation of externalities
- Private internalisation of externalities: the Coase theorem
- Free rider problem and public goods
- Types of public policy
- Efficient level of pollution
- Tax vs. permits
- Command and Control Instruments
- Empirical data on non-renewable natural resources
- Optimal price development: the Hotelling-rule
- Effects of exploration and Backstop-technology
- Effects of different types of markets.
- Biological growth function
- Optimal depletion of renewable resources
- Social inefficiency as result of over-use of open-access resources
- Cost-benefit analysis and the environment
- Measuring environmental benefit
- Measuring costs
- Concept of sustainability
- Technological feasibility
- Conflicts sustainability / optimality
- Indicators of sustainability
- Problem of climate change
- Cost and benefit of climate change
- Climate change as international ecological externality
- International climate policy: Kyoto protocol
- Implementation of the Kyoto protocol in Switzerland

**Content**

Economy and natural environment, welfare concepts and market failure, external effects and public goods, measuring externalities and contingent valuation, internalising external effects and environmental policy, economics of non-renewable resources, renewable resources, cost-benefit-analysis, sustainability issues, international aspects of resource and environmental problems, selected examples and case studies.

Lecture notes

The script and lecture material are provided at:

https://moodle-app2.let.ethz.ch/course/view.php?id=140

Literature


### Core Courses

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-0763-00L</td>
<td>Basic Concepts of Management</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>R. Schwarzenbach</td>
</tr>
</tbody>
</table>

This course deals with fundamental and proven management concepts. The lecturers emphasize the practical applicability of concepts. The course was designed in close cooperation with practitioneers; e.g. will Mr. S. Baldenweg, mechanical engineer ETH, MBA Insead, share his experience in several guest lectures.
Overview on environmental management and environmental management systems, general methods and principles.

Discovering Management offers an integrated learning system, which combines in an innovate format a set of lectures, an advanced introduction to environmental management / environmental sciences, and experiential learning outcomes result from the interrelated group activities: 1) the interactive case studies and exercises, 2) the business game simulation and a set of group exercises involving industry speakers (ranging from leading venture capitalists to executives at established corporations). Unlike more traditional courses, the learning model for Discovering Management involves 'learning by doing'.

While the 13 different lectures, in-class discussions and assigned readings provide the theoretical and conceptual foundations, the experiential learning outcomes result from the interrelated group activities: 1) the interactive case studies and exercises, 2) the business game simulation.

By discovering the key aspects of entrepreneurial management, the purpose of the course is to advance students' understanding of factors driving company success, where success is understood as a broad construct including financial return, employee, customer and supplier satisfaction as well as social and ecological responsibility.

Discovering Management is designed to suit the needs and expectations of Bachelor students at all levels as well as Master and PhD students not belonging to D-MTEC. By providing an overview of Entrepreneurial Management, this course is an ideal enrichment of the standard curriculum at ETH Zurich. No prior knowledge of business or economics is required to successfully complete this course.
Content
The lectures for Discovering Management are designed to broaden the participant's understanding of the principles of entrepreneurial management, emphasizing the interdependence of various specialties in the development and management of a firm. For this reason, the lectures are structured on the basis of a coherent business model and will be presented by the respective area specialists at D-MTEC. The lectures broaden the view and the understanding of technology by interlinking it with society. Corporate sustainability, for example, introduces economic, ecological and social issues that are relevant to all engineering disciplines. Practical examples stimulate the students to assess these issues and be aware of their responsibilities as engineers. Technology and innovation management, to mention a second example, focuses on the interplay of technical and organizational change, and how these often neglected interactions explain why many new technologies are never used. It fosters the students' ability to see the business and social consequences of their 'technical' decisions. Critical skills will be trained by the case study exercise, a participant-centered learning activity, which provides students with the opportunity to place themselves in the role of the decision maker, as they learn more about the specific case and identify the challenge they are faced with. Students will be presented real case scenarios by industry guests from established corporations and will have to critically analyze specific issues. The case study exercise will provide an insight into the context of a managerial problem-solving and enhance the participant's appreciation for the complex tasks companies deal with.

Prerequisites / notice
Discovering Management is designed to suit the needs and expectations of Bachelor students at all levels as well as Master and PhD students not belonging to D-MTEC. By providing an overview of Business Management, this course is an ideal enrichment of the standard curriculum at ETH Zurich. 

No prior knowledge of business or economics is required to successfully complete this course.

351-0778-01L
Discovering Management (Exercises) W 1 credit 1U P. Frauenfelder
Complementary exercises for the module Discovering Management.
Prerequisite: Participation and successful completion of the module Discovering Management (351-0778-00L) is mandatory.

Abstract
This course is offered complementary to the basic course 351-0778-00L, "Discovering Management". The course offers additional exercises and case studies.

Objective
This course is offered to complement the course 351-0778-00L. The course offers additional exercises and case studies.

Content
The course offers additional exercises and case studies concerning Strategic Management; Technology and Innovation Management; Operations and Supply Chain Management; Finance and Accounting; Marketing and Sales.

Please refer to the course website for further information on the content, credit conditions and schedule of the module: www.dm.ethz.ch

363-0503-00L
Principles of Microeconomics W 3 credits 2G M. Filippini
The course introduces basic principles, problems and approaches of microeconomics.

Objective
The course includes the following main topics:
- Basic principles of demand and supply, market and state in a modern economy, externalities, cost analysis, consumer behaviour,
- economies of scale and economies of scope, perfect competition, monopoly, oligopoly, monopolistic competition, mathematical treatment of some basic concepts.
- Lecture notes, exercises and reference material can be downloaded from Moodle.
- The book can also be used for the course ‘Principles of Microeconomics’ (Sturm)
- For students taking only the course ‘Principles of Microeconomics’ there is a shorter version of the same book:
- Complementary:

751-1101-00L
Finances and Accounting System W 2 credits 2G M. Dumondel
To understand accounting as a component of the complex system of the enterprise

Objective
To understand accounting not as an isolated discipline, but as a part of the complex system of the enterprise

Content
Accounting system as a part of management economics.
- The different steps for scheduling and evaluation of the accountancy will be studied. The main part of the lecture is dedicated to the financial accounting nevertheless the fundamentals of the internal cost-accounting will also be presented. The lecture will also include the clarification of concrete cases and the calculation of practical exercises.

Lecture notes
Course documentation and specified educational books

751-1651-00L
World Food Economy and Agricultural Markets W 2 credits 2V R. Jörin
Following microeconomic courses we teach in this course economic aspects of the world food situation and the international and national agricultural markets. It contains aspects of supply, demand, price determination, market structures and instruments of the agricultural trade.

Objective
Economic understanding of agricultural markets and the aspects of the world food problem.

Content
Part I: Principles of agricultural economics
- Microeconomic analysis of supply, demand, and price determination in agricultural markets.
- Part II: Aspects of globalization, development, natural resources and public health.

Lecture notes
Handouts (power point presentations)

Literature
Southgate. D. et al., 2010. The World Food Economy, Blackwell Publishing, Malden MA,USA

851-0626-01L
International Aid and Development Does not take place this semester.
Prerequisites: Basic knowledge of economics
The course gives economic and empirical foundations for a sound understanding of the instruments, prospects and limitations of international development aid.

Students have a theoretically and empirically sound understanding of the prospects and limitations of international development aid.

Introduction to the Determinants of Underdevelopment; History of Aid; Aid and Development: Theories and Empirics; Political Economy of Aid; Experience and Impact of Aid; New Instruments of Aid; e.g. Micro-Finance, Budget-Support; Fair-Trade.

Articles and book abstracts will be uploaded to a course website.

### Module Political and Social Sciences

#### Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0747-00L</td>
<td>Environmental Policy of Switzerland I</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>E. Lieberherr</td>
</tr>
</tbody>
</table>

This course presents the basics of policy analysis and the specific characteristics of Swiss environmental policy. Political instruments, actors and processes are addressed both theoretically as well as by means of current Swiss environmental policy examples.

Beyond acquiring basic knowledge about policy analysis, this course teaches students how to analytically address current and concrete questions of environmental policy. Through exercises the students learn about political science concepts and frameworks as well as real-life political decision-making processes. The well-grounded examination of complex political conflict situations is an important precondition for the entry into the (environmental) policy workforce or a future research career.

The processes of change, overuse or destruction of the natural environment through humans have historically placed high demands on social and political institutions. In the interplay between the environment, society and economy, the environmental policy field encompasses the sum of public measures that have the goal to eliminate, reduce or avoid environmental degradation. The course provides insight into the development of Swiss environmental policy and systematically presents the basics of environmental policy actors, instruments, programs and processes as well as their change over time. A key aspect is the distinction between politics and political science and specifically environmental policy.

Instead of lecture notes different texts on policy analysis and Swiss environmental policy are made available to the students.

Lecturers: E. Lieberherr

Hours: 2V+1U

S. Mohrenberg

Beyond acquiring basic knowledge about policy analysis, this course teaches students how to analytically address current and concrete questions of environmental policy. Through exercises the students learn about political science concepts and frameworks as well as real-life political decision-making processes. The well-grounded examination of complex political conflict situations is an important precondition for the entry into the (environmental) policy workforce or a future research career.

The processes of change, overuse or destruction of the natural environment through humans have historically placed high demands on social and political institutions. In the interplay between the environment, society and economy, the environmental policy field encompasses the sum of public measures that have the goal to eliminate, reduce or avoid environmental degradation. The course provides insight into the development of Swiss environmental policy and systematically presents the basics of environmental policy actors, instruments, programs and processes as well as their change over time. A key aspect is the distinction between politics and political science and specifically environmental policy.

The detailed semester program (syllabus) is made available to the students at the beginning of the semester.

Lecture notes: Environmental Policy of Switzerland I

Literature:


Prerequisites / notice: The detailed semester program (syllabus) is made available to the students at the beginning of the semester.

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>851-0577-00L</td>
<td>Principles of Political Science</td>
<td>O</td>
<td>4</td>
<td>2V+1U</td>
<td>S. Mohrenberg, Q. Nguyen</td>
</tr>
</tbody>
</table>

This course covers the basics questions, concepts, theories, methods, and empirical findings of political science.

This course covers the basics questions, concepts, theories, methods, and empirical findings of political science.


Lecture notes: Principles of Political Science

Literature:


Prerequisites / notice: Students attending this course and passing the required tests (one in the middle, the other at the end of the semester) will obtain 4 ECTS credit points.

### Core Courses

<table>
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<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-0727-00L</td>
<td>Politics of Environmental Problem Solving in Developing Countries</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>U. Scheidegger</td>
</tr>
</tbody>
</table>

The course focuses on processes and drivers of decision-making on natural resources management issues in developing countries. It gives insights into the relevance of ecological aspects in developing countries. It covers concepts, instruments, processes and actors in environmental politics at the example of specific environmental challenges of global importance.

After completion of the module, students will be able to:
- Identify and appraise ecological aspects in development cooperation, development policies and developing countries' realities
- Analyze the forces, components and processes, which influence the design, the implementation and the outcome of ecological measures
- Characterize concepts, instruments and drivers of environmental politics and understand, how policies are shaped, both at national level and in multilateral negotiations
- Study changes (improvements) in environmental politics over time as the result of the interaction of processes and actors, including international development organizations
- Analyze politics and design approaches to influence them, looking among others at governance, social organization, legal issues and institutions

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Content

Key issues and basic concepts related to environmental politics are introduced. Then the course predominantly builds on case studies, providing information on the context, specifying problems and potentials, describing processes, illustrating the change management, discussing experiences and outcomes, successes and failures. The analysis of the cases elucidates factors for success and pitfalls in terms of processes, key elements and intervention strategies.

Different cases not only deal with different environmental problems, but also focus on different levels and degrees of formality. This ranges from local interventions with resource user groups as key stakeholders, to country level policies, to multi- and international initiatives and conventions. Linkages and interaction of the different system levels are highlighted. Special emphasis is given to natural resources management.

The cases address the following issues:
- Land use and soil fertility enhancement: From degradation to sustainable use
- Common property resource management (forest and pasture): Collective action and property rights, community-based management
- Ecosystem health (integrated pest management, soil and water conservation)
- Payment for environmental services: Successes in natural resources management
- Climate change and agriculture: Adaptation and mitigation possibilities
- Biodiversity Convention: Implications for conservations and access to genetic resources
- Diversory as a means for more secure livelihoods: Agroforestry and intercropping
- The Millennium Development Goals: Interactions between poverty and the environment
- Poverty and natural resources management: Poverty reduction strategies, the view of the poor themselves
- Food security: Policies, causes for insecurity, the role of land grabbing
- Biofuels and food security: Did politics misfire?
- Strategy development at global level: IAASTD and World Development Report 2008

Lecture notes

Information concerning the case studies and specific issues illustrated therein will be provided during the course (uploaded on Moodle)

Literature


Prerequisites / notice

The performance assessment will consist of an individual essay to be written by each student based on at least five references in addition to the sources provided in the course. Students can choose from a list of topics. Criteria for assessment will be communicated at the beginning of the course.

701-0731-00L

Environmental Sociology

W 2 credits

2S H. Bruderer Enzler

Abstract

This introductory class in environmental sociology covers different theoretical approaches but the main focus is on recent empirical research on topics such as environmental behavior, environmental concern, social dilemmas, social norms, environmental justice, and risk perception.

Objective

Basic knowledge of environmental sociology

Overview on current fields of research in environmental sociology and their relevance for environmental protection

Basic notion of the structure of empirical research papers in social sciences

Content

Das Seminar führt in die Umweltsoziologie ein. Dabei werden verschiedene theoretische Ansätze besprochen (Fokus: Rational Choice). Der Schwerpunkt des Kurses liegt auf aktuellen empirischen Untersuchungen zu Themen wie Umweltverhalten, Umweltbewusstsein, soziale Dilemmata, soziale Normen, Umweltgerechtigkeit und Risikowahrnehmung.

Fragen, die uns dabei beispielsweise beschäftigen: Wer belastet die Umwelt besonders stark oder ist besonders starken Umweltbelastungen ausgesetzt? Was beeinflusst das Umweltverhalten der Menschen? Welche Rolle spielen äussere Faktoren (Möglichkeiten, Kosten etc.)? Welchen Einfluss haben soziale Aspekte oder Einstellungen? Wovon hängt es ab, ob eine Technologie als risikoreich eingestuft wird?


Literature


701-0985-00L

Social Intercourse with Current Environmental Risks

W 1 credit

1V B. Nowack, C. M. Som-Koller

Abstract

The lecture treats the social intercourse with risks of technical systems. The notion of risk and the perception of risk are discussed by case studies (e.g. nanotechnology) and socio-political instruments for decision-making are presented. Methods are presented that can be applied to deal with environmental risks and how they can be used for sustainable innovation.

Objective

- Getting acquainted to the extended risk concept
- Evaluation of the risks caused by technology within the societal context
- Knowledge about the mode science and society handle current environmental risks (examples gene- and nanotechnology)
- Knowledge about handling risks (e.g. precautionary principle, protection goal, damage definition, ethics)
- Knowledge about possibilities for sustainable innovation
- Risks and technical systems (risk categories, risk perception, risk management)
- Illustration with case studies (nanotechnology)
- Implementation (politics, science, media, etc.)
- Decision making (technology assessment, cost/benefit analysis etc.)
- The role of the media
- prospects for future developments

Lecture notes

Copies of slides and selected documents will be distributed

Prerequisites / notice

The lecture is held biweekly (for 2 hours). The dates are 21.9., 28.9 (attention, out of schedule) ; 19.10, 2.11, 16.11, 30.11, 14.12

227-0802-02L

Sociology

W 2 credits

2V A. Diekmann

Abstract

Various studies are used to introduce basic sociological concepts, theories and empirical research methods, along with selected sociological topics. The goal of the course is to provide participants with an understanding of working practice in empirical sociology and the central findings of sociological studies.

Objective

To learn about methods of empirical social research and key results of classic and modern sociological studies.
Content
Sociology benefits from the regular research on social order and part of societal questions. The students receive an overview of current developments and research accessible by empirical research methods. The course will cover the following topics: (1) Social Theory, (2) Theories of Change in Society, (3) Social Inequality, (4) Social Change, (5) Social Movements.

Folgende Themen werden behandelt:


Gruppenarbeiten
- Schriftliche Arbeit in Soziologie (Durchführung einer kleinen empirischen Studie, Konstruktion eines Simulationsmodells sozialer Prozesse oder Diskussion einer vorliegenden soziologischen Untersuchung).

Literature
Folien der Vorlesung im Internet

851-0591-00L Digital Sustainability in the Knowledge Society
Particularly suitable for students of D-INFK, D-ITET, D-MATL, D-MAVT, D-MTEC, D-USYS

Abstract
How do various interest groups influence the methods of production, distribution, and use of digital resources? Current models focusing on strong intellectual property rights are contrasted with open models like, e.g. Open Source/Content/Access. The course discusses the consequences from different models and introduces «digital sustainability» as an alternative vision for society.

Objective
At the heart of the discourse is the handling of digital goods and intellectual property in society. Digitization and the Internet allow handling knowledge in a way, which directly contrasts with the traditional understanding of "intellectual property" and the industries based on it. Starting from economic and legal basics, we compare proprietary and open/free models. Sustainable development as a concept is transferred to digital goods, taking into account the particular nature of digital stuff.

After the lecture, you should (hopefully) be able to
- characterize the nature of digital goods vs. physical goods
- critique the basic concepts of copyright and patent rights
- explain the political/legal and economic differences between proprietary and open approaches to the production and use of digital goods
- extend an example, explain the meaning of digital sustainability and argue why it is relevant for a knowledge society
- transfer the ideas of the free/open source software model to other digital goods (e.g., open content, open access)

Content
Technical reality: Within minutes you can make perfect copies of high-value digital goods of knowledge or culture (as text, audio, video, image or software) and distribute them around the globe -- for free. «Digitization plus Internet» allows for the first time in human kind's history the (theoretically) free access and global exchange of knowledge at minimal cost. A tremendous opportunity for societal development, in north and south. «Cool, so what's the problem?»

The problem is, that this reality poses a fundamental threat to today's business model of the knowledge and culture industries (starting from the music label and Hollywood, via publishers, up to software vendors). Powerful commercial interests are at stake as «knowledge» (the fourth factor of production) will become ever more important in the 21st century. Accordingly, «piracy» and «file-sharing» are attacked with all means. At the core lies the question about the design of property in digital assets. For that, we apply a concept of «intellectual property», which is several hundred years old and does not address digital reality in an adequate manner, sometimes leading to absurd situations. Its original goal seems to get forgotten: to help society develop by spreading knowledge as much as possible.

Using the PC becomes the new cultural technique of the 21st century. In contrast to «reading, writing and arithmetic», this new cultural technique cannot exist in isolation, but depends on a hard- and software infrastructure. This dependency extends to the provider of the infrastructure, who can define technical rules, which can take away or restrict the user's freedom. Even advanced users may have difficulties in recognizing these often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible consequences we need to understand and investigate, because they decide about access, distribution and usage of digital knowledge.

Comparative to the environmentalist movement of the 60s and 70s, a growing political movement for «Free Software» exists today, with «GNU/Linux» as its most popular symbol. The movement fights against treating software code as private property but as a central cultural infrastructure, who can define technical rules, which can take away or restrict the user's freedom. Even advanced users may have difficulties in recognizing these often hidden, restrictions and in evaluating their societal relevance. But exactly these invisible consequences we need to understand and investigate, because they decide about access, distribution and usage of digital knowledge.

Prerequisites / notice
For administrative and didactic reasons (high level of interaction and credit group assignments on current hot topics), the number of participants is limited to 45.

Lecture notes
Slides and other material (both usually in English) will be made available on a weekly basis as the lecture proceeds.

Data: 06.02.2019 13:00
Autumn Semester 2015
Page 1344 of 1434
This course deals with how and why international cooperation in environmental politics emerges, and under what circumstances such cooperation is effective and efficient. Based on theories of international political economy and theories of government regulation various examples of international environmental politics are discussed: the management of international water resources, the problem of unsafe nuclear power plants in eastern Europe, political responses to global warming, the protection of the stratospheric ozone layer, the reduction of long-range transboundary air pollution in Europe, the prevention of pollution of the oceans, etc.

The course is open to all ETH students. Participation does not require previous coursework in the social sciences.

After passing an end-of-semester test (requirement: grade 4.0 or higher) students will receive 4 ECTS credit points. The workload is around 120 hours (meetings, reading assignments, preparation of test).

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory (http://www.rektorat.ethz.ch/students/admission/auditors/specialstudents_uzh/index_EN; see menu on left side of that webpage for students from other universities).

Lecture notes
Slides and reading material will be made available at www.ib.ethz.ch (teaching, materials, then menu on the left side of the screen). They are password protected. Use your Netzhz username and password to access the material.

Literature
See www.ib.ethz.ch (teaching, materials)

Prerequisites / notice
Students from ETH will receive 4 ECTS credit points if they attend classes regularly and obtain a grade of 4.0 or higher for the written exam in the final week of the semester. Students who obtain a grade of less than 4.0 for the end-of-semester test will have a second chance in the first week of the following semester. The rules of the game are defined in detail on the course syllabus. Students who do not participate in the end of semester test will not have access to the repeat exam unless they submit compelling and documented reasons for why they were unable to participate in the first test. Except for language dictionaries, no additional materials and no laptops and mobile phones are allowed during the exam.

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory (http://www.rektorat.ethz.ch/students/admission/auditors/specialstudents_uzh/index_EN; see menu on left side of that webpage for students from other universities).

The workload for this course is approx. 120 hours (all inclusive).

Module Individual Sciences

Compulsory Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0721-00L</td>
<td>Psychology</td>
<td>O</td>
<td>3</td>
<td>2V</td>
<td>R. Hansmann, C. Keller, M. Siegrist</td>
</tr>
</tbody>
</table>

Abstract
This course provides an introduction to psychological research and modelling, focusing on cognitive psychology and the psychological experiment. Participants learn to formulate problems for psychological investigation and apply basic forms of psychological experiment.

Objective
Students are able to:
- describe the processes, theories, methods and findings of psychology.
- differentiate psychological psychology from "everyday" psychology.
- structure the conclusions and significance of an experiment. according to a theory of psychology.
- formulate a problem for psychological investigation.
- apply basic forms of psychological experiment.

Content
Einführung in die psychologische Forschung und Modellbildung unter besonderer Berücksichtigung der kognitiven Psychologie und des psychologischen Experimentierens. Themen sind u.a.: Wahrnehmung; Lernen und Entwicklung; Denken und Problemlösen; Kognitive Sozialpsychologie; Risiko und Entscheidung.

752-2120-00L  | Consumer Behaviour I                                       | O    | 2     | 2V    | M. Siegrist, C. Keller, B. S. Sütterlin |

Abstract
Introduction in consumer research. The following aspects will be emphasized in the course: Consumer decision making, individual determinants of consumer behavior, environmental influences on consumer behavior, influencing consumer behavior in environmental communication.

Objective
You learn how to handle tools and concepts in environmental communication. And you can evaluate communication projects. We also discuss the evolution of consciousness.

Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0771-00L</td>
<td>Environmental Consciousness and Public Relations</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>R. Locher</td>
</tr>
</tbody>
</table>

Abstract
Number of participants limited to 60. Please describe your expectations. Why do want to attend this special topic? Do you have any pre-information about the integral model? Do you have any practical experience in environmental communication?

"Environmental Consciousness and Public Relations" shows how to communicate about environment and sustainability successfully. We look at campaigns, exhibitions and other public relations measures to learn, how to design and realize good communication.

Objective
You learn how to handle tools and concepts in environmental communication. And you can evaluate communication projects. We also discuss the evolution of consciousness.

Content
- Methods and tools in environmental communication.
- Marketing mix
- Examples of campaigns, events, print products, media relations.
- Integral sustainability

Lecture notes
Handouts

Literature
- Integral Vision; Ken Wilber, 2005

Prerequisites / notice
We will discuss new trends in environmental communication with the focus on integral solutions.

701-0785-00L  | Environmental and Science Communication                     | W    | 4     | 2V    | M. Schäfer                 |

Abstract
The course gives an introductionary overview in research questions, theoretical perspectives and empirical results of science communication and environmental communication. They will be illustrated by concrete examples and via lectures from external guests.

Objective
Goals: Learning to understand structures and processes of environmental and science communication, becoming more sensitive for problems of science public relations, getting an insight into public debates about environmental issues.

Methods: Case studies, invitation of media practitioners and experts, discussions, lectures on key theoretical concepts of communication.

Topics: Concrete communication instruments like media conferences, theoretical perspectives of public relations, basic principles and examples of information campaigns, environment and science as media topics, functions and structures of science communication, relations between science, media and politics.
### Module Humanities

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0701-00L</td>
<td>Philosophy of Science</td>
<td>O</td>
<td>3 credits</td>
<td>2V</td>
<td>G. Hirsch Hadorn, C. J. Baumberger</td>
</tr>
</tbody>
</table>

**Abstract**
The lecture explores various strands in philosophy of science in a critical way, focusing on the notion of rationality in science, especially with regards to environmental research. It addresses the significance and limits of empirical, mathematical and logical methods, as well as problems and ethical issues raised by the use of science in society.

**Objective**
Students learn to engage with problems in the philosophy of science and to relate them to natural and environmental sciences, thus developing their skills in critical thinking about science and its use. They know the most important positions in philosophy of science and the objections they face. They can identify, structure and discuss issues raised by the use of science in society.

**Content**
1. Core differences between classical Greek and modern conceptions of science.
2. Classic positions in the philosophy of science in the 20th century: logical empiricism and critical rationalism (Popper); the analysis of scientific concepts and explanations.
3. Objections to logical empiricism and critical rationalism, and further developments: What is the difference between the natural sciences, the social sciences and the arts and humanities? What is progress in science (Kuhn, Fleck, Feyerabend)? Is scientific knowledge relativistic? What is the role of experiments and computer simulations?
4. Issues raised by the use of science in society: The relation between basic and applied research; inter- and transdisciplinarity; ethics and accountability of science.

**Lecture notes**
A reader will be available for students.

**Prerequisites / notice**
Voraussetzungen: Die Vorlesung wendet sich auch an Studierende der Publizistikwissenschaft der Universität Zürich

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### Compulsory Courses

<table>
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</thead>
<tbody>
<tr>
<td>701-0703-00L</td>
<td>Environmental Ethics</td>
<td>O</td>
<td>2 credits</td>
<td>2V</td>
<td>M. Huppenbauer</td>
</tr>
</tbody>
</table>

**Abstract**
The lecture begins with an introduction to applied ethics in general. The main focus is on environmental ethics. Students learn to handle important concepts and positions of environmental ethics. They achieve a deeper understanding of these concepts and positions in applying them to ecological problems and discussing them in case studies.

**Objective**
On completion of this lecture course you will have acquired the ability to identify and process general and environmental ethical problems. You will be capable of recognising and analysing environmental ethical problems and of working towards a solution. You will have acquired a fundamental knowledge of standpoints and arguments to be found within the field of environmental ethics and will have practised these in small case studies.

**Content**
- Introduction to general and applied ethics.
- Overview and discussion of ethical theories relevant to the environment.
- Familiarisation with various basic standpoints within environmental ethics.
- Cross-section topics, such as sustainability, intergenerational justice, protection of species, etc.
- Practising of newly acquired knowledge in case studies (protection of species, climate change, etc.)

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**Literature**


Rödder, Simone / Franzen, Martina / Weingart, Peter (Hg.): The Sciences’ Media Connection - Public Communication and its Repercussions. Dordrecht, S. 95-89.


Rödder, Simone / Franzen, Martina / Weingart, Peter (Hg.): The Sciences’ Media Connection - Public Communication and its Repercussions. Dordrecht, S. 95-89.


Rödder, Simone / Franzen, Martina / Weingart, Peter (Hg.): The Sciences’ Media Connection - Public Communication and its Repercussions. Dordrecht, S. 95-89.


### Core Courses

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</tr>
</thead>
<tbody>
<tr>
<td>701-0701-01L</td>
<td>Philosophy of Science: Exercises</td>
<td>W</td>
<td>1</td>
<td>1U</td>
<td>G. Hirsch Hadorn, C. J. Baumberger</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
<td></td>
<td></td>
<td>The exercises in philosophy of science serve to develop skills in critical thinking by discussing seminal texts about the rationality of science. Topics discussed include the significance and limits of empirical, mathematical and logical methods, as well as problems and ethical issues raised by the use of science in society.</td>
</tr>
<tr>
<td></td>
<td>Objective</td>
<td></td>
<td></td>
<td></td>
<td>Students can engage with problems in the philosophy of science and to relate them to natural and environmental sciences. They learn to analyze and summarize philosophical texts. In this way, they develop their skills in critical thinking with a focus on the rationality of science.</td>
</tr>
<tr>
<td></td>
<td>Literature</td>
<td></td>
<td></td>
<td></td>
<td>A list of literature will be distributed to the students together with the reader.</td>
</tr>
</tbody>
</table>

### Compulsory Electives D-GESS (For All Modules Eligible)

- Political Science
- Law
- Sociology
- Economy
- Psychology, Pedagogics
- History
- Philosophy

### Science Research

### Natural Science and Technical Electives

### Natural Science Modules

### Biomedicine

<table>
<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>376-0151-00L</td>
<td>Anatomy I and Physiology I</td>
<td>W</td>
<td>6</td>
<td>4V</td>
<td>M. Ristow, M. Flück, L. Slomianka, C. Spengler, N. Wendroth, D. P. Wolfer</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td></td>
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<td></td>
<td>Basic knowledge of the anatomy and physiology of tissues, of the embryonal and postnatal development, of the basic terminology of pathology, the neuro-muscular system, the cardiovascular system and the respiratory system.</td>
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<td></td>
<td>Objective</td>
<td></td>
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<td></td>
<td>Basic knowledge of human anatomy and physiology and basics of clinical pathophysiology.</td>
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<tr>
<td></td>
<td>Content</td>
<td></td>
<td></td>
<td></td>
<td>Short overview of human anatomy, physiology and general pathology.</td>
</tr>
<tr>
<td></td>
<td>Anatomy and Physiology I (fall term)</td>
<td></td>
<td></td>
<td></td>
<td>Basics of cytology, histology, embryology, general pathology; nervous system, muscles, cardiovascular system, respiratory system</td>
</tr>
<tr>
<td></td>
<td>Anatomy and Physiology II (spring term)</td>
<td></td>
<td></td>
<td></td>
<td>digestive system, kidney and urinary tract, endocrine system, skin, thermoregulation, sensory organs, male and female reproductive system, pregnancy and child birth.</td>
</tr>
</tbody>
</table>
Hours
To introduce the students to the both macro- and micronutrients in relation to food and metabolism.

C. Wolfrum
Introduction to Nutritional Science

Anatomie:
- Introduction and historical background

W. Environmental Soil Physics/Vadose Zone Hydrology
Important topics include the structure and properties of clays and oxides, the chemistry of the soil solution, gas equilibria, dissolution and precipitation of mineral phases, cation exchange, surface complexation, chemistry of soil organic matter, redox reactions in flooded soils, soil acidification and soil salinization.

Handouts in lectures.

Introduction into structural and functional aspects of the immune system.

D. Or
Lecturers
2G+2U
There is no script. Powerpoint presentations will be made available.

M. Kopf

The course is divided into two parts. The lectures on micronutrients are given by Prof. Zimmermann and the lectures on macronutrients are given by Prof. Wolfrum. Prof. Zimmermann discusses the micronutrients, including fat-soluble vitamins, water-soluble vitamins, minerals and trace elements. Prof. Wolfrum introduces basic nutritional aspects of proteins, fats, carbohydrates and energy metabolism. The nutrients are described in relation to digestion, absorption and metabolism. Special aspects of homeostasis and homeorhesis are emphasized.

Elmadfa I & Leitzmann C: Ernährung des Menschen

Soil Sciences

- explain links between physical processes in the vadose-zone and major societal and environmental challenges
- conduct and interpret a limited number of experimental studies
- apply modern measurement methods and analytical tools for hydrological data collection
- explain links between physical processes in the vadose-zone and major societal and environmental challenges

Voraussetzungen: 1. Jahr, naturwissenschaftlicher Teil

Prerequisites / notice

551-0317-00L
Immunology I

Immunology I (WS) and Immunology II (SS) will be examined as one learning entity in a "Sessionsprüfung".

A. Oxenius, M. Kopf

A. Immunology I

Introduction into structural and functional aspects of the immune system.

Basic knowledge of the mechanisms and the regulation of an immune response.

A. Oxenius

Objective

Content

Lecture notes
Electronic access to the documentation will be provided. The link can be found at "Lernmaterialien"

Literature

572-6001-00L
Introduction to Nutritional Science

This course introduces basic concepts of micro- and macronutrient nutrition. Micronutrients studied include fat-soluble and water-soluble vitamins, minerals and trace elements. Macronutrients include proteins, fat and carbohydrates. Special attention is given to nutrient digestion, bioavailability, metabolism and excretion with some focus on energy metabolism.

M. B. Zimmermann, C. Wolfrum

Objective

To introduce the students to the both macro- and micronutrients in relation to food and metabolism.

A. Introduction to Nutritional Science

The course is divided into two parts. The lectures on micronutrients are given by Prof. Zimmermann and the lectures on macronutrients are given by Prof. Wolfrum. Prof. Zimmermann discusses the micronutrients, including fat-soluble vitamins, water-soluble vitamins, minerals and trace elements. Prof. Wolfrum introduces basic nutritional aspects of proteins, fats, carbohydrates and energy metabolism. The nutrients are described in relation to digestion, absorption, and metabolism. Special aspects of homeostasis and homeorhesis are emphasized.

A. Introduction to Nutritional Science

There is no script. Powerpoint presentations will be made available.

Elmadfa I & Leitzmann C: Ernährung des Menschen

UTB Ulmer, Stuttgart, 4. überarb. Ausgabe 2004

Garrow JS and James WPT: Human Nutrition and Dietetics
Churchill Livingstone, Edinburgh, 11th rev. ed. 2005

3 credits
3 credits
3 credits
3 credits
3 credits
3 credits
2G
2G+2U
R. Kretzschmar, D. I. Christl
R. Kretzschmar, D. I. Christl
R. Kretzschmar, D. I. Christl
R. Kretzschmar, D. I. Christl

701-0533-00L
Soil Chemistry

This course discusses chemical and biogeochemical processes in soils and their influence on the behavior and cycling of nutrients and pollutants in terrestrial systems. Approaches for quantitative modeling of the processes are introduced.

R. Kretzschmar, D. I. Christl

Abstract

Understanding of important chemical soil properties and processes and their influence on the behavior (e.g., speciation, bioavailability, mobility) of nutrients and pollutants.

Content

Important topics include the structure and properties of clays and oxides, the chemistry of the soil solution, gas equilibria, dissolution and precipitation of mineral phases, cation exchange, surface complexation, chemistry of soil organic matter, redox reactions in flooded soils, soil acidification and soil salinization.

Lecture notes
Handouts in lectures.

Literature

701-0535-00L
Environmental Soil Physics/Vadose Zone Hydrology

The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.

D. Or

Abstract

Students are able to:
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media,
- quantify driving forces and resulting fluxes of water, solute, and heat in soils,
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges

Handouts in lectures.

Literature
This introductory course starts from a description of the behavior and phenomena of soils and rocks under near surface loading conditions.

**Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and time domain reflectometry; soil water storage and water balance.**

**Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity**

**Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing**

**Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:**
- Part 1 - Laminar flow in tubes (Poiseuille's Law); Darcy's Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement.
- Part 2 - Unsaturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.
- Midterm exam
- Part 2 - Measurement of saturated hydraulic conductivity in uniform and layered soil columns using the constant head method.
- Part 3 - Use of Hydrus model for simulation of unsaturated flow

**Additional topics:**
- Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.
- Biological Processes in the Vadose Zone - An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

**Lecture notes**
- Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller (available at the beginning of the semester)
- http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology

**Literature**
- Supplemental textbook (not mandatory) - Environmental Soil Physics, by: D. Hillel
- http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology


### Methods of Statistical Data Analysis

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
---|---|---|---|---|---
701-0105-00L | Applied Statistics for Environmental Sciences | W | 3 credits | 2G | U. Brändle, C. Bigler, M. Kalisch, L. Meier

**Abstract**

Statistical methods from current publications in environmental sciences are presented and applied. Students are enabled to understand the methods, clean datasets, analyse them using the software package R and present the results in a suitable form. They will be able to describe strengths and weaknesses of the methods for given fields of application.
Objective
Students are able to
- use suitable statistical methods for data analysis in their subject area.
- characterize data sets using explorative methods
- check the suitability of data sets to answer a given question, prepare data sets for import to a statistical program and conduct the analysis.
- interpret statistical analyses and process them graphically for use in presentations and publications.
- describe the basics of statistical methods used in current publications.
- use the software package R for statistical analysis

Content
Statistische Methoden: Regression (lineare Modelle; generalisierte lineare Modelle; GLMs); Varianzanalyse; gemischte Modelle für gruppierte Daten (mixed-effects models); Fragebogenstatistik; Tests (t Test; Chi quadrat Test; Fisher Test); Power-Analyse

Workzeug: Explorative Datenanalyse für Hypothesenbildung; Auswahlverfahren für geeignete statistische Verfahren; Datenaufbereitung (Excel -> R; Datenbereinigung); graphische Darstellung von Resultaten; statistische Verfahren in Publikationen erkennen
Wir arbeiten mit dem Softwarepaket R.

Form: Im Wochenrhythmus finden alternierend Einführungen in eine neue Methode und Übungsstunden zum Thema statt.
Besuch von "Mathematik IV: Statistik" oder vergleichbare Lehrveranstaltung

Prerequisites / notice

701-1671-00L Sampling Techniques for Forest Inventories W 3 credits 2V D. Mandallaz

Objective
Students should have a good understanding of the concepts of general sampling theory in a modern framework. They should also master the specific problems arising in forest inventory and be able, if necessary, to read more specialized books or research papers.

Content

Lecture notes
Sampling techniques for forest inventories. Daniel Mandallaz, Chapman and Hall. A free electronic copy of the book is also available. A PDF file containing parts of the book will be mailed to the participants.

Literature
Sampling methods, remote sensing and GIS multisource forest inventory. M. Köhl, S. Magnussen, M. Marchetti, 2006, Springer.

Prerequisites / notice
A simulation software will be used throughout the lectures to test the theoretical developments. Upon request a half day field demonstration can be organized at the WSL outside the lecture time. A repetitorm for the exam is also offered.

401-6215-00L Using R for Data Analysis and Graphics (Part I) W 1 credit 1G A. J. Papritz, C. B. Schwierz

Objective
The students will be able to use the software R for simple data analysis.

Content
The course provides the first part of an introduction to the statistical software R for scientists. R is free software that contains a huge collection of functions with focus on statistics and graphics. If one wants to use R one has to learn the programming language R - on very rudimentary level. The course aims to facilitate this by providing a basic introduction to R.

Part I of the course covers the following topics:
- What is R?
- R Basics: reading and writing data from/to files, creating vectors & matrices, selecting elements of dataframes, vectors and matrices, arithmetics.
- Types of data: numeric, character, logical and categorical data, missing values;
- Simple (statistical) functions: summary, mean, var, etc., simple statistical tests;
- Writing simple functions;
- Introduction to graphics: scatter-, boxplots and other high-level plotting functions, embellishing plots by title, axis labels, etc., adding elements (lines, points) to existing plots.

The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www.rstudio.org

Lecture notes
An Introduction to R. http://stat.ethz.ch/CRAN/doc/contrib/Lam-IntroductionToR_LHL.pdf

Prerequisites / notice
The course resources will be provided via the Moodle web learning platform. Please login (with your ETH (or other University) username+password) at https://moodle-app2.let.ethz.ch/enrol/users.php?id=1149
Choose the course "Using R for Data Analysis and Graphics" and follow the instructions for registration.

401-6217-00L Using R for Data Analysis and Graphics (Part II) W 1 credit 1G A. J. Papritz, C. B. Schwierz

Objective
The students will be able to use the software R efficiently for data analysis.

Content
The course provides the first part of an introduction to the statistical software R for scientists. R is free software that contains a huge collection of functions with focus on statistics and graphics. If one wants to use R one has to learn the programming language R - on very rudimentary level. The course aims to facilitate this by providing a basic introduction to R.

Part II of the course builds on part I and covers the following additional topics:
- Elements of the R language: structure, overview of R objects, attributes of R objects;
- More on R functions;
- Applying functions to elements of vectors, matrices and lists;
- Object oriented programming with R: classes and methods;
- Tailoring R: options;
- Extending basic R: packages.

The course focuses on practical work at the computer. We will make use of the graphical user interface RStudio: www.rstudio.org
Participants will be able to plan and analyze efficient experiments in the fields of natural sciences. They will gain practical experience by using the software R. A script will be available.


The students are familiar with important topics in animal ecology, with an emphasis on birds and mammals. They are able to link theoretical concepts with visible ecological phenomena, and view them against an evolutionary backdrop. They can thus appraise applied aspects of the conservation and the use of animal populations, such as the influence of larger predators on prey populations or of herbivores on vegetation, the effects of hunting, landscape change, or of other human influences on animal populations. They understand the biogeographical characteristics of the Central European vertebrate fauna and its temporal and spatial dynamics.

The exercises, but also the classes will be based on procedures from the freely available, open-source statistical software package R, for which an introduction will be held.

In the Mathematics Bachelor and Master programmes, the two course units 401-0649-00L "Applied Statistical Regression" and 401-3622-00L "Regression" are mutually exclusive. Registration for the examination of one of these two course units is only allowed if you have not registered for the examination of the other course unit.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>Credits</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>401-0625-01L</td>
<td>Applied Analysis of Variance and Experimental Design</td>
<td>W</td>
<td>5 credits</td>
<td>2V+1U</td>
<td>M. Meier</td>
<td></td>
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<tr>
<td>401-0649-00L</td>
<td>Applied Statistical Regression</td>
<td>W</td>
<td>5 credits</td>
<td>2V+1U</td>
<td>M. Dettling</td>
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</thead>
<tbody>
<tr>
<td>701-0305-00L</td>
<td>Vertebrate Ecology</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>W. Suter, J. Senn</td>
<td></td>
</tr>
</tbody>
</table>

Literature
- Everybody will be expected to present a scientific paper in class, to be chosen from a list given.

The course resources will be provided via the Moodle web learning platform. Please login (with your ETH (or other University) username+password) at https://moodle-app2.let.ethz.ch/enrol/users.php?id=1145 Choose the course "Using R for Data Analysis and Graphics" and follow the instructions for registration.
Carsten Schmuck, Basisbuch Organische Chemie, Pearson

Abstract
In this course the important freshwater ecosystems, on a global perspective, will be presented. The foci of the lectures are basic ecological properties of these aquatic systems, their anthropogenic influences and subsequent modifications. The learning is organized along case studies, for which conflicting interests, as well as concepts and methods for sustainable management will be discussed.

Objective
- basics concerning the functioning of the most important freshwater ecosystems
- basics of the sustainable management of aquatic ecosystems
- application of these principles with case studies
- critical analyses, organization of discussion groups

Content
1. Globaler Zustand der Binnengewässer und Entwicklungen
2. Globale Wasserkonflikte
3. Stauhaltungen und downstream Effekte
4. Restwasser und Schwalm-Sunk Management, Thermische Verunreinigung
5. Renaturierung von Fließgewässern
6. Interessenkonflikte bei Renaturierung: Trinkwasser, Hochwasserschutz und Biodiversität
7. Feuchtgebiete
8. Management urbaner Gewässer, wasserbürige Krankheiten
9. Gewässerschutz und gesetzliche Grundlagen
10. Invasion ortsstremer Arten und Biodiversität
11. Europäische Wasserrahmenrichtlinie

Lecture notes

Literature

Prerequisites / notice
Basic ecology lectures of the first four semesters. Students will organize discussion groups.

Environmental Chemistry/Ecotoxicology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>701-0201-00L</td>
<td>Introduction to Environmental Organic Chemistry</td>
<td>W</td>
<td>5</td>
<td>4G</td>
<td>M. Sander, E. Janssen, K. McNeill</td>
</tr>
</tbody>
</table>

Abstract
This course presents significant organic environmental pollutants and the physical-chemical bases required to understand their environmental behavior, and deepens this knowledge through exercises. The most important analytical methods for the qualitative and quantitative determination of organic pollutants in environmental samples are discussed.

Objective
- The students are able to:
  - name and recognise the most important classes of environmentally-relevant anthropogenic chemicals.
  - explain, on the basis of physical-chemical foundations, the most important processes which determine the environmental behavior of organic pollutants.
  - name fundamental methods of trace analysis of organic pollutants in environmental sampling.
  - propose experimental methods for determining substance-specific properties.
  - identify, on the basis of chemical structure, the processes relevant for the environmental behavior of a compound.
  - critically evaluate published work and data.

Content
- Overview of the most important classes of environmental organic pollutants
- Molecular interactions that determine the partitioning behavior (adsorption and absorption processes) of organic compounds between different environmental compartments (gas, liquid, solid)
- Physical-chemical properties (vapor pressure, aqueous solubility, air-water partition constant, organic solvent-water partition constants, etc) and partitioning behavior of organic compounds between environmentally relevant phases (air, aerosols, soil, water, biota)
- Basics of trace analytical methods to determine organic compounds (enrichment techniques, separation (chromatography), detection)
- Chemical transformation reactions of organic pollutants in aquatic and in terrestrial systems (reactions with nucleophiles incl. hydrolysis, elimination, addition)

Lecture notes
Script will be distributed

Literature

Prerequisites / notice
Die Lehrveranstaltung richtet sich nicht nur an jene Studierenden, welche sich später chemisch vertiefen wollen, sondern ausdrücklich auch an alle jene, welche sich mit der Problematik von organischen Schadstoffen in der Umwelt vertraut machen wollen, um dieses Wissen in anderen Vertiefungen anzuwenden

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</thead>
<tbody>
<tr>
<td>701-0225-00L</td>
<td>Organic Chemistry</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>K. McNeill</td>
</tr>
</tbody>
</table>

Abstract
Introduction to Isomerism.
Reaction mechanisms in organic chemistry (substitutions, additions, eliminations condensations)
Biosynthesis of Terpenes.

Objective
- The students are able to differentiate between structural and stereoisomers.
- The students know the basic reaction mechanisms in organic chemistry. They are able to understand and formulate simple biochemical reactions.
- They know the basics of the biosynthesis of terpenes.

Content
- Isomerism (structural isomers, stereoisomers)
- Descriptive chemistry of natural products (glycerides, peptides, saccharides).
- Reaction mechanisms (substitutions, additions, eliminations, condensations).
- The citric acid cycle, the gloxylate cycle.
- Biosynthesis of terpenes

Literature
Carsten Schmuck, Basisbuch Organische Chemie, Pearson

Prerequisites / notice
Der Stoff der Basischemie wird vorausgesetzt.

<table>
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<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-0297-00L</td>
<td>Applied Ecotoxicology</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>K. Fent</td>
</tr>
</tbody>
</table>

Abstract
Besides regarding basic concepts, this lecture focus on applied aspects of ecotoxicology. Case studies and effects of environmental chemicals on cells, organisms up to ecosystems are regarded. In a multidisciplinary approach based on toxico logical concepts, pollutants are analysed, in particular hormonally active compounds and their effects on reproduction.
This lecture focuses on basic concepts of ecotoxicology and their application to environmental chemicals and environmental pollution problems. Basic concepts are regarded with respect to their consequences for the environment. Toxicological effects on organisms are analysed at different levels of organisation, from the molecular to the ecosystem level. Case studies are regarded in order to understand chemical’s actions and their effects. In addition bioaccumulation and their consequences, the methods in ecotoxicology and environmental effects of various compounds will be regarded. Emphasis will be placed on hormonally active compounds and their effects to aquatic organisms. Furthermore, methods of environmental risk assessment of environmental pollutants will be discussed.


Script and collection of problems available


The course teaches the basics of hydromechanics, relevant for civil and environemental engineers.

101-0479-00L Environmental Fluid Dynamics

<table>
<thead>
<tr>
<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-0479-00L</td>
<td>Environmental Fluid Dynamics</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>D. Günther, M.O. Ebert, R. Zenobi</td>
</tr>
</tbody>
</table>

Abstract

Introduction into the most important spectroscopical methods and their applications to gain structural information.

Objective

Knowledge about the necessary theoretical background of spectroscopical methods and their practical applications.

Content

Application oriented basics of organic and inorganic instrumental analysis and of the empirical employment of structure elucidation methods:

- Mass spectrometry: Ionization methods, mass separation, isotope signals, rules of fragmentation, rearrangements.
- NMR spectroscopy: Experimental basics, chemical shift, spin-spin coupling.
- IR spectroscopy: Revisiting topics like harmonic oscillator, normal vibrations, coupled oscillating systems (in accordance to the basics of the related lecture in physical chemistry); sample preparation, acquisition techniques, law of Lambert and Beer, interpretation of IR spectra; Raman spectroscopy.
- UV/VIS spectroscopy: Basics, interpretation of electron spectra, Circular dichroism (CD) and optical rotation dispersion (ORD).

Notice

Script will be for the production price

Environmental Physics

This course covers the basic physical concepts and mathematical equations used to describe environmental fluid systems on the rotating Earth. Fundamental concepts (e.g. vorticity dynamics and waves) are formally introduced, applied quantitatively and illustrated using examples. Exercises help to deepen knowledge of the material.

Prerequisites /

Excercises are integrated in the lectures. In addition, attendance in the lecture 529-0289-00 "Instrumental analysis of organic compounds" (4th semester) is recommended.

Objective

Students are able

- to name the bases, concepts and methods of environmental fluid dynamics.
- to understand and discuss the components of the basic physical equations in fluid dynamics.
- to apply basic mathematical equations to simple problems of environmental fluid dynamics.

Content

Basic physical terminology and mathematical laws:

- Continuum hypothesis, forces, constitutive laws, state equations and basic principles of thermodynamics, kinematics, laws of mass and momentum on rotating earth.
- Concepts and illustrative flow systems: vorticity dynamics, boundary layers, instability, turbulence - with respect to environmental fluid systems.
- Scale analysis: dimensionless variables and dynamical similarity, simplification of the fluid system, e.g. shallow water assumption, geostrophic flow.
- Waves in environmental fluid systems.

Literature

In English language

Will be presented in class.

See also: web-site.

101-0203-01L Hydraulics I

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<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>101-0203-01L</td>
<td>Hydraulics I</td>
<td>W</td>
<td>5</td>
<td>3+1U</td>
<td>R. Stocker</td>
</tr>
</tbody>
</table>

Abstract

The course teaches the basics of hydromechanics, relevant for civil and environmental engineers.

Objective

Familiarization with the basics of hydromechanics of steady state flows.

Content

Properties of water, hydrostatics, continuity, Euler equation of motion, Navier Stokes equation, similarity, Bernoulli principle, momentum equation for finite volumes, potential flows, ideal fluids-real fluids, boundary layer, pipe flow, open channel flow, flow in porous media, flow measurements, demonstration experiments in the lecture hall and in the laboratory.

Literature

Script and collection of problems available

Bohlin, Technische Hydromechanik 1, Verlag Bauwesen, Berlin

102-0455-01L Groundwater I

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>102-0455-01L</td>
<td>Groundwater I</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>M. Willmann</td>
</tr>
</tbody>
</table>

Abstract

The course provides an introduction into quantitavie analysis of groundwater flow and transport. It is focussed on formulating flow and transport problems in groundwater, which are to be solved analytically or numerically.

Objective

a) Students understand the basic concepts of flow and contaminant transport processes and boundary conditions in groundwater.

b) Students are able to formulate simple practical flow and transport problems.

c) Students are able to understand and apply simple analytical solutions to simple flow and transport problems.

d) Students are able to use simple numerical codes to adequately solve simple flow (and transport) problems.
Content

Introduction, aquifers, groundwater use, sustainability, porosity.

Properties of porous media.
Exercises: Groundwater use, porosity, grain size analysis.

Flow properties, Darcy's law, filter.

Flow equations, stream function.
Exercises: Darcy's law.

Analytical solutions, confined aquifers, steady-state flow.
Exercises: Head isolines.

Use of superposition principles, transient flow, free surface flow.
Exercises: Analytical solutions to flow problems.

Finite difference solutions to flow problems I.
Exercises: Analytical solutions to flow problems.

Finite difference solutions to flow problems II.
Exercises: Finite difference formulations to flow problems.

Transport processes.
Exercises: Computer workshop using PMWIN.

Analytical solutions to transport problems I.
Exercises: Computer workshop using PMWIN.

Analytical solutions to transport problems II.
Exercises: Analytical solutions to transport problems.

Path lines, groundwater protection.
Exercises: Analytical solutions to transport problems.

Groundwater remediation, groundwater management.
Exercises: Groundwater remediation.

Lecture notes

Folien auf Internet unter www.ihw.ethz.ch/GWH/education/index
Altes Skript auf Internet www.ihw.ethz.ch/GWH/education/index
Weitere Texte auf Internet www.ihw.ethz.ch/GWH/education/index
Didaktische Software auf Internet unter www.ihw.ethz.ch/GWH/education/index

Literature

W. Kinzelbach, R. Rausch, Grundwassermodellierung, Gebrüder Bornträger, Stuttgart, 1995
Krusemann, de Ridder, Untersuchung und Anwendung von Pumpversuchen, Verl. R. Müller, Köln, 1970
G. de Marsily, Quantitative Hydrogeology, Academic Press, 1986

651-3561-00L

Cryosphere W 3 credits 2V M. Funk, M. Huss, K. Steffen

Abstract
This course introduces the different parts of the cryosphere - snow, glaciers, sea ice, permafrost - and their role in the climate system. A significant physical aspect is the focus in each part. Those completing the course are able to describe the dynamics of cryosphere components both formally and using examples.

Objective
Students are able
- to qualitatively describe the main components of the cryosphere and their role in the climate system
- to formally describe the relevant physical processes which determine the state of cryosphere components

Content
Introduction into the different components of the Cryosphere: Snow, glaciers, sea ice and permafrost, and their roles in the climate system. Each part is use to emphasized on one specific physical aspect: material qualities of ice, mass balance and dynamics of glaciers and energy balance of sea ice.

Lecture notes
handouts will be distributed during the teaching semester
Contents

The course covers the following topics:
- What is GIS? What are spatial data?
- The representation of reality by means of spatial data models: vector, raster, TiN
- The four phases of data modelling: Spatial, conceptual, logical and physical model
- Basic concepts of database management systems and spatial databases
- Possibilities of data collection
- Transition of reference frame
- Spatial Analysis I: query and manipulation of vector data
- Spatial Analysis II: operators and functions with raster data
- Digital elevation models and derived products
- Process modelling with vector and raster data
- Presentation possibilities of spatial data

References to technical literature will be included in the course script. An additional list of literature will be given during the course.

The course covers the following topics:

Project development in renewable Energies

Hours

- Fundamentals of railroad technology and interactions between track and vehicles, network development and infrastructure planning,
- Planning of rail infrastructure, planning and design of railway stations, construction and dimensioning of tracks, track stability.
- (5) Approval and beginning service on complex infrastructure facilities: Definitions and limitations; fundamentals of the legal situation; test and approval processes; processes of putting railway systems into operation. (6)
- Maintenance of rail infrastructures: Fundamentals of infrastructure maintenance; kinds of depreciation; supervision methods; steps of infrastructure maintenance; estimation of maintenance need; methods to minimize maintenance costs.

Prerequisites / notice

2 credits

W

A. W. Weidmann

Railway Infrastructures (Transportation II)

W

3 credits

2G

U. A. Weidmann

Fundamentals of railroad technology and interactions between track and vehicles, network development and infrastructure planning,

Abstract

Teaches the basic principles of public transport network and topology design, geometrical design, dimensioning and construction as well as the maintenance of rail infrastructures. Teaches students to recognize the interactions between the infrastructure design and the production processes. Provides the background for Masters degree study.

Content

(1) Fundamentals: Infrastructures of public transport systems; interaction between track and vehicles; passengers and goods as infrastructure users; management and financing of networks; railway standards and norms. (2) Infrastructure planning: Planning processes and decision levels in network development and infrastructure planning, planning of railway tracks and rail topologies; planning of the passenger parts of stations. (3) Infrastructure design: Fundamentals of the layout of a line; track geometry; switches and crossings; design of station platforms. (4) Construction of railway infrastructures: Assembly and evolution of the railway track; elements of the railway track; dimensioning of the track; track stability. (5) Approval and beginning service on complex infrastructure facilities: Definitions and limitations; fundamentals of the legal situation; test and approval processes; processes of putting railway systems into operation. (6)

Objective

Teaches the basic principles of public transport network and topology design, geometrical design, dimensioning and construction as well as the maintenance of rail infrastructures. Teaches students to recognize the interactions between the infrastructure design and the production processes. Provides the background for Masters degree study.

Lecture notes

Course notes will be provided in German. Slides are made available some days before each lecture.

Literature

Course notes will be included in the course script. An additional list of literature will be given during the course.

Prerequisites / notice

No remarks.

Renewable Energy

Number of participants limited to 30.

W

2 credits

2G

R. Rechsteiner, A. Appenzeller, A. Wanner

Project Development in Renewable Energies

Number of participants limited to 30.

Abstract

Realization of projects in the field of renewable energies, analysis of frame conditions and risks. The students learn basics of renewable energy project realization from acknowledged experts active in the field. They identify the different tasks of various investor types. They develop sample projects in practice within groups.

Objective

You become acquainted with the regulative, juridical and economic requirements of project development in renewable energies.

You learn to launch and judge projects by exercises in groups

You recognize chances and risks of renewable energy projects

Content

(1) Fundamentals: Infrastructures of public transport systems; interaction between track and vehicles; passengers and goods as infrastructure users; management and financing of networks; railway standards and norms. (2) Infrastructure planning: Planning processes and decision levels in network development and infrastructure planning, planning of railway tracks and rail topologies; planning of the passenger parts of stations. (3) Infrastructure design: Fundamentals of the layout of a line; track geometry; switches and crossings; design of station platforms. (4) Construction of railway infrastructures: Assembly and evolution of the railway track; elements of the railway track; dimensioning of the track; track stability. (5) Approval and beginning service on complex infrastructure facilities: Definitions and limitations; fundamentals of the legal situation; test and approval processes; processes of putting railway systems into operation. (6)

Lecture notes

PPT presentation will be distributed (in German) special frames:

http://www.rechsteiner-basel.ch/Lehrmittel.27.0.html

Number

Type

ECTS

Hours

Lecturers

701-0967-00L

Project Development in Renewable Energies

W

2 credits

2G

R. Rechsteiner, A. Appenzeller, A. Wanner

Abstract

Project development in renewable Energies

Realization of projects in the field of renewable energies, analysis of frame conditions and risks. The students learn basics of renewable energy project realization from acknowledged experts active in the field. They identify the different tasks of various investor types. They develop sample projects in practice within groups.

Objective

You become acquainted with the regulative, juridical and economic requirements of project development in renewable energies.

You learn to launch and judge projects by exercises in groups

You recognize chances and risks of renewable energy projects

Content

Introduction of market trends, market structure, technical trends and regulation in Switzerland and in the EU internal energy market

Necessary frame conditions for profitable projects

Project development samples and exercises in wind power

hydro power

photovoltaics
due diligence and country assessment.

Exact Program in German below

http://www.rechsteiner-basel.ch/index.php?id=27

Lecture notes

PPT presentation will be distributed (in German) special frames:

http://www.rechsteiner-basel.ch/Lehrmittel.27.0.html


REN21

Renewables GLOBAL STATUS REPORT

http://www.ren21.net

Mit einer grünen Anlage schwarze Zahlen schreiben

http://www.rechsteiner-basel.ch/uploads/media/Mit_einer_gruenen_Anlage_schwarze_Zahlen_schreiben.pdf

UNEP

Global Trends in Renewable Energy Investments

http://fs-unep-centre.org

Renewable Energy World: Market Status

http://www.renewableenergyworld.com/reapublication/renewable-energy-world


http://emp.lbl.gov/sites/all/files/lbnl-6356e.pdf

http://emp.lbl.gov/sites/all/files/lbnl-6356e.pdf

EPIA

Global Market Outlook for Photovoltaics


Bundesamt für Energie: Perspektiven für die Grosswasserkraft in der Schweiz

http://www.bes-bas.ch/uploads/media/Mit_einer_gruenen_Anlage_schwarz_Zahlen_schreiben.pdf

Mit einer grünen Anlage schwarze Zahlen schreiben

http://www.rechsteiner-basel.ch/Lehrmittel.27.0.html

special frames:

http://www.rechsteiner-basel.ch/index.php?id=27

Prerequisites / notice

For group exercise and presentation reasons the number of participants is limited to 30 students. For exercises students build learning and presentational groups.
The lectures Renewable Energy Technologies I (529-0193-00L) and Renewable Energy Technologies II (529-0191-01L) can be taken independently from one another.

Abstract
Scenarios for world energy demand and CO2 emissions, implications for climate. Methods for the assessment of energy chains. Potential and technology of renewable energies: Biomass (heat, electricity, biofuels), solar energy (low temp. heat, solar thermal and photovoltaic electricity), wind and ocean energy, heat pumps, geothermal energy, heat, CO2 sequestration.

Objective
Scenarios for the development of world primary energy consumption are introduced. Students know the potential and limitations of renewable energies for reducing CO2 emissions, and their contribution towards a future sustainable energy system that respects climate protection goals.

Content

Lecture notes
Lecture notes will be distributed during the course.

Literature

Prerequisites / notice
Fundamentals of chemistry and physics are a prerequisite for this course.

Topics are available to carry out a Project Work (Semesterarbeit) on the contents of this course.

#### Individual Subjects

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>701-0317-00L</td>
<td>Identification of Woody Plants in Winter</td>
<td>W</td>
<td>1</td>
<td>1G</td>
<td>A. Rudow</td>
</tr>
<tr>
<td>051-0159-00L</td>
<td>Urban Design I</td>
<td>W</td>
<td>1</td>
<td>2V</td>
<td>H. Klumpner, A. Brillembourg</td>
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</table>

**Identification of Woody Plants in Winter**

**Abstract**
Woodly plants are important elements of forest ecosystems and landscapes. The practical characterization of forest stands often requires the identification of woody plants in winter. The course focuses on the practical identification of native tree and shrub species to be used for the characterization of forest stands.

**Objective**
Knowledge of selected native tree and shrub species in winter. Understanding relationships of trees and forest ecosystems by in situ observation of woody plants and forest stands. Introduction into the characterization of forest stands.

**Content**
Four half-day excursions in the surroundings of Zurich and Baden the identification of native tree and shrub species is treated. The course aims at broadening and application of species knowledge towards the identification of woody plants during the leafless phase and their identification from distance (selected native species). By the application in characterization of forest stands the relationships of trees and forest ecosystems as well as forestry aspects are elucidated. In the context of an individual work the students will practically train and deepen their acquired knowledge.

**Lecture notes**
Rudow, A., 2013: Dendrologie Grundlagen - Bestimmungshilfe (in German, will be provided for registered students on an online-platform)

**Literature**
Rudow 2011 (betaversion): EBot Dendrologie E-learning-Tool for the support of dendrology courses at ETHZ, integrated into online-application eBot.

**Prerequisites / notice**
Half-day excursions into forests. Weatherproof clothes are presupposed.

**Urban Design I**

**Abstract**
The lecture series will introduce tools for reading contemporary urban conditions, urban models and operational modes. Urban development will be deciphered, presented as operational tools, extracted from cities where they have been tested and became exemplary samples, most relevant for providing the understanding of how urban landscape has taken shape as well as inspiration for future practice.

**Objective**
How can a glossary of tools be used as a basis for reading cities and recognizing in them current trends and urban phenomena? The lectures series will produce a glossary of operational urban tools with collected urban knowledge that provides students with an 'improvised' manual to navigate theories. Urban Stories is a lecture series that aims to amplify your repertoire of urban instruments and empowers you to read cities and to critically reflect on the urban environment. The course will approach a series of case studies, employing an analytical, research-based model for crosscutting scale, political, economical and social components. Through this lens, and with our toolbox, we aim to tell the fundamental story of our cities from today and provide information, analysis and knowledge to help students prepare for justifiable own contributions and interventions in the future. Also the aspect of knowledge transfer will be considered in order to sensibilize the students to understand how to operate in an international context.

**Content**
How did cities develop into the cities we live in now? Which urban plans, instruments, visions, political decisions, economic reasonings, cultural inputs and social organization have been used to operate in urban settlements in specific moments of change? Which cities are exemplary in illustrating how these instruments have been implemented and how they have shaped urban environments? Can these instruments be transcribed into urban operational tools that we recognize within existing tested cases in contemporary cities across the globe? The form cannot be reduced to the physical space. Cities are the result of social construction, under the influence of technologies, ecology, culture, the impact of experts and accidents. Urban unconcluded processes respond to political interests, economic pressure, cultural inclinations, along with the imagination of architects and planers and the informal powers at work in complex adaptive systems. Current urban phenomena are the result of an urban evolution. The facts stored in urban environments include contributions from its entire lifecycle. That is true for the physical environment, but also for non-physical aspects, the imaginary city that exists along with its potentials and problems and with the conflicts that have evolved over time. Knowledge and understanding along with a critical observation of the actions and policies are necessary to understand the diversity and instability present in the contemporary city and to understand how urban form evolved to its current state. This lecture series will introduce urban knowledge and the way it has introduced urban models and operational modes within different concrete realities, therefore shaping cities. Urban knowledge will be translated into operational tools, extracted from cities where they have been tested and become exemplary samples, most relevant for providing the understanding of how urban landscape has taken shape. Case studies will be identified to compile documents and an archive, that we use as templates to read the fundamental story of our cities from today and provide information, analysis and knowledge to help students prepare for justifiable own contributions and interventions in the future. Also the aspect of knowledge transfer will be considered in order to sensibilize the students to understand how to operate in an international context.

**Lecture notes**
The skript can be downloaded from the student-server.

**Literature**
The learning material can be downloaded from the student-server: afp://brillembourg-klumpner-server.ethz.ch

Please check also the Chair website: http://u-tt.arch.ethz.ch
**Understanding of important chemical soil properties and processes and their influence on the behavior (e.g., speciation, bioavailability, soil acidification and soil salinization).**

The Exercise tasks are a valuable preparation for the Exam (Exam only relevant for the “Semesterkurs” students) therefore it is highly recommendable to finalize all weekly Exercise tasks, as an individually conducted piece of work.

Course of the Specialisation in an Environmental System

**Specialization in an Environmental System**

**Biogeochemistry**

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
701-0216-00L | Biogeochemical Cycles | W | 3 credits | 2G | B. Wehrli

*Abstract*

Biogeochemical cycles in aquatic systems are discussed from a global or regional perspective. Important methods to determine reaction rates and pathways are introduced and typical mechanisms are discussed on a molecular level.

*Objective*

The course aims at

* connecting global and molecular ideas;
* informing the students how to determine rates and pathways of biogeochemical cycles;
* providing insights on coupling mechanisms between biological and geochemical processes.

*Content*

Biogeochemical cycles in aquatic systems will be discussed from three perspectives: 1) Case studies with a global or regional point of view will document the relevant background information on rates, time-scales and reservoirs of selected element cycles such as C, N, P, S, Fe, Mn Cd, Cu, Mo and As. 2) From a practical perspective we will compare the potential and limits of different methods to quantify biogeochemical processes in aquatic systems. 3) On a molecular level we will discuss mechanisms and pathways of relevant reactions.

*Lecture notes*

Lecture notes and assignments will be available in German

*Literature*


**Prerequisites / notice**

Basic knowledge in chemistry and systems analysis

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**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
701-0419-01L | Seminar for Bachelor Students: Biogeochemistry | O | 2 credits | 2S | G. Furrer, R. Kretzschmar, B. Wehrli

*Abstract*

The seminar provides an introduction to the literature in biogeochemistry of aquatic and terrestrial systems. The students present their summary and review of recent or classical papers. Therefore they get familiar with online-access tools and improve their communication and presentation skills.

*Objective*

Getting to know relevant journals in the field of biogeochemistry. Reading, assessing and discussing scientific publications. Improving of presentation skills. Exercising and Improving of moderation skills.

*Content*


Part 2: Common literature study; online-exchange of information. Presentation and discussion moderated by the students.

*Lecture notes*

Selected handouts will be distributed in class.

https://moodle-app2.let.ethz.ch/auth/shibboleth/login.php

*Prerequisites / notice*

Deadline for enrollment is the FIRST day of the semester. Late enrollment can only be accepted in exceptional cases and under certain conditions (e.g., restricted choice of topics and dates).

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**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
701-0423-00L | Chemistry of Aquatic Systems | W | 3 credits | 2G | L. Winkel

*Abstract*

This course gives an introduction to chemical processes in aquatic systems and shows applications to various systems. The following topics are treated: acid-base reactions and carbonate system, solubility of solids and weathering, redox reactions, complexation of metals, reactions at the solid/water interface, applications to lakes, rivers and groundwater.

*Objective*

Understanding of chemical processes in aquatic systems. Quantitative application of chemical equilibria to processes in natural waters. Evaluation of analytical data from aquatic systems.

*Content*

Introduction to the chemistry of aquatic systems. Regulation of the composition of natural waters by chemical, geochemical and biological processes. Quantitative application of chemical equilibria to processes in natural waters. The following topics are treated: acid-base reactions, carbonate system; solubility of solid phases and weathering; complexation of metals and metal cycling in natural waters; redox reactions; reactions at the interface solid phase-water; applications to lakes, rivers, groundwater.

*Lecture notes*

Script is distributed.

*Literature*


---

**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
701-0533-00L | Soil Chemistry | W | 3 credits | 2G | R. Kretzschmar, D. I. Christl

*Abstract*

This course discusses chemical and biogeochemical processes in soils and their influence on the behavior and cycling of nutrients and pollutants in terrestrial systems. Approaches for quantitative modeling of the processes are introduced.

*Objective*

Understanding of important chemical soil properties and processes and their influence on the behavior (e.g., speciation, bioavailability, mobility) of nutrients and pollutants.

*Content*

Important topics include the structure and properties of clays and oxides, the chemistry of the soil solution, gas equilibria, dissolution and precipitation of mineral phases, cation exchange, surface complexation, chemistry of soil organic matter, redox reactions in flooded soils, soil acidification and soil salinization.

*Lecture notes*

Handouts in lectures.

*Literature*


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**Number** | **Title** | **Type** | **ECTS** | **Hours** | **Lecturers**
--- | --- | --- | --- | --- | ---
701-0535-00L | Environmental Soil Physics/Vadose Zone Hydrology | W | 3 credits | 2G+2U | D. Or
The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.

### Abstract

**Objective**

Students are able to:
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media,
- quantify driving forces and resulting fluxes of water, solute, and heat in soils,
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges

**Content**

Weeks 1 to 3: Physical Properties of Soils and Other Porous Media. Units and dimensions, definitions and basic mass-volume relationships between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay behavior

**Lecture notes**

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components; properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements; parametric models; hysteresis. Modern aspects of capillarity

**Demo-Lab:** Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing

Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:

- Part 1: Laminar flow in tubes (Poiseuille's Law); Darcy's Law, conditions and states of flow; saturated flow; hydraulic conductivity and its measurement.
- Part 2: Unsaturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.; approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.

Midterm exam

- Lab #1: Measurement of saturated hydraulic conductivity in uniform and layered soil columns using the constant head method.
- Lab #2: Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip's approximations; infiltration rates and wetting front propagation.
- Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter estimation.

**Additional topics:**

Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal properties; engineering applications.

Biological Processes in the Vadose Zone - An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller (available at the beginning of the semester)

http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology

**Literature**

Supplemental textbook (not mandatory) - Environmental Soil Physics, by: D. Hillel

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### Atmosphere and Climate

**Number**

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<tr>
<th>701-0459-00L</th>
<th>Seminar for Bachelor Students: Atmosphere and Climate</th>
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</thead>
</table>

**Abstract**

In this seminar all students in the realm of atmospheric and climate science convene to train presentation techniques (talks, posters) by means of classic and modern scientific articles.

**Objective**

In this seminar all students in the realm of atmospheric and climate science convene to train presentation techniques (talks, posters) by means of classic and modern scientific articles.

**Content**

1st week: course organisation and presentation of the institute
2nd and 3rd week: introduction to oral presentation technique
week 4 to 10: students talks
11th week: introduction to poster presentation technique
12th and 13th week: poster design
14th week: concluding poster presentation

**Lecture notes**

Documents are offered via the course's web page.

**Literature**

Documents are offered via the course's web page.

**Prerequisites / notice**

This course can only be offered to a limited number of students, however, in any case for everybody having to attend it compulsory. We beg you to sign in to this course early.

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**Number**

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<th>701-0461-00L</th>
<th>Numerical Methods in Environmental Sciences</th>
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**Abstract**

This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.
This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.

Classification of numerical problems, introduction to finite-difference methods, time integration schemes, non-linearity, conservative numerical techniques, an overview of spectral and finite-element methods. Examples and exercises from a diverse cross-section of Environmental Science.

Three obligatory exercises, each two hours in length, are integrated into the lecture. The implementation language is Matlab (previous experience not necessary: a Matlab introduction is given). Example programs and graphics tools are supplied.

Is provided (CHF 10.- per copy).

Vorlesungsunterlagen (Folien) werden laufend während des Semesters jeweils mind. 2 Tage vor der Vorlesung zur Verfügung gestellt.

W 2G 2V

Abstract

- Origin and properties of the atmosphere: structure, large scale dynamics, UV radiation
- Thermodynamics and kinetics of gas phase reactions: enthalpy and free energy of reactions, rate laws, mechanisms of bimolecular and termolecular reactions.
- Tropospheric photochemistry: Photolysis reactions, photochemical C3 formation, role and budget of HOx, dry and wet deposition
- Aerosols and clouds: chemical properties, primary and secondary aerosol sources
- Multiphase chemistry: heterogeneous kinetics, solubility and hygroscopicity, N2O5 chemistry, SO2 oxidation, secondary organic aerosols
- Air quality: role of planetary boundary layer, summer- versus winter-smog, environmental problems, legislation, long-term trends
- Stratospheric chemistry: Chapman cycle, Brewer-Dobson circulation, catalytic ozone destruction cycles, polar ozone hole, Montreal protocol
- Global aspects: global budgets of ozone, methane, CO and NOx, air quality - climate interactions

Lecture notes

Lecture notes and slides

Environmental Biology

This course provides the ecological systems’ knowledge needed to question applied solutions to current environmental issues. Our central aim is to balance participants’ respect for complexity with a sense of possibility by providing examples from the vast solution space offered by ecological systems, such as e.g. green infrastructure to manage water.
### Objective
At the end of the course...
...you know how to structure your inquiry and how to proceed the analysis when faced with a complex environmental issue. You can formulate the relevant questions, find answers (supported by discussions, input from the lecturers and the literature), and you are able to present your conclusions clearly and cautiously.  
...you understand the complexity of interactions and structures in ecosystems. You know how ecosystem processes, functions and services interact and feed back across multiple spatio-temporal scales (in general, plus in depth case examples).  
...you understand that biodiversity and the interaction between organisms are an integral part of ecosystems. You are aware that the link between biodiversity and process/function/service is rarely fully understood. You know how to honestly deal with this lack of understanding and can nevertheless find, critically analyse and communicate solutions.  
...you understand the importance of ecosystem services for society.  
...you have an overview of the methods of ecosystem research and have a deeper insight into some of them, e.g. ecosystem observation, manipulation and modelling.  
...you have reflected on ecology as a young discipline at the heart of significant applied questions.

### Content
This course provides the ecological systems' knowledge needed to question applied sustainability solutions. We will critically assess the complexity of current environmental issues, illustrating basic ecological concepts and principles. Our central aim is to balance participants' respect for complexity with a sense of possibility by providing examples from the vast solution space offered by ecological systems, such as e.g. green infrastructure to manage water.

The course is structured around four larger topical areas: (1) Integrated Water Management -- Green infrastructure (land management options) as an alternative to engineered solutions (e.g. large reservoirs) in flood and drought management; (2) Fire dynamics, the water cycle and biodiversity -- The surprising dynamics of species life cycles and populations in arid landscapes; (3) Rewilding, e.g. re-introducing apex predators (e.g. wolves), or large ungulates (e.g. bisons) in protected areas -- A nature conservation trend with counterintuitive effects; (4) Coupling of aquatic and terrestrial systems: carbon, nitrogen and phosphorus transfers of global importance on landscape scale.

### Literature
It is not essential to borrow/buy the following books. We will continuously provide excerpts and other literature during the course.

- Schulze et al. (2005) Plant Ecology; Springer.

### Prerequisites / notice
The course combines elements of a classic lecture, group discussions and problem based learning. It is helpful, but not essential to be familiar with the "seven stages" method (see e.g. course 701-0352-00L "Analysis and Assessment of Environmental Sustainability" by Christian Pohl et al.).

### 701-0320-00L Seminar for Bachelor Students: Environmental Biology

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<th>Lecture notes</th>
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</table>
| Students will acquire skills in: | In the seminar, students explore a specific topic in environmental biology (ecology, evolution, health). They find and read scientific articles, structure contents around core questions, talk to specialists about them, prepare a scientific presentation and lead a discussion. They are introduced to literature search and scientific presentations. | Week 1: Choice of topics and tutors  
Week 3: Literature search  
Week 5: course for presentation techniques  
Weeks 1 - 7: Meetings with tutors, preparation of presentations  
Weeks 8 - 14: Presentations and discussions | Will be handed out during classes |

### 701-0323-00L Plant Ecology

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| Students will be able to: | This class focuses on ecological processes involved with plant life, mechanisms of plant adaptation, plant-animal and plant-soil interactions, plant strategies and implications for the structure and function of plant communities. The discussion of original research examples familiarises students with research questions and methods; they learn to evaluate results and interpretations. | Plants represent the matrix of natural communities. The structure and dynamics of plant populations drives the function of ecosystems. This course presents essential processes and plant traits involved with plant life. We focus on research questions that have been of special interest to plant ecologists as well as current topical questions. We use original research examples to discuss how ecological questions are studied and how results are interpreted.  
- Growth: what determines the production of a plant?  
- Nutrients: consumption or recycling; opposite strategies and feedbacks on soils;  
- Clonality: collaboration and division of labour in plants;  
- Plasticity: benefits and costs of plant intelligence;  
- Flowering and pollination: how expensive is sex?  
- Seed types, dispersal, seed banks and germination: strategies and trade-offs in the persistence of plant populations;  
- Development and structure of plant populations;  
- Stress, disturbance and competition as drivers of different plant strategies;  
- Herbivory: plant-animal feedbacks and functioning of grazing ecosystems  
- Fire impacts on plants, vegetation and ecosystems.  
- Plant functional types and rules in the assembly of plant communities. | Handouts and further reading will be available electronically at the beginning of the semester. |
This course is an introduction to the rapidly developing fields of population and quantitative genetics, emphasizing the major concepts and ideas over mathematical formalism. An overview is given of how mutation, genetic drift, gene flow, mating systems, and selection affect the genetic structure of populations. Evolutionary processes affecting quantitative and Mendelian characters are discussed.

Objective

Students are able to:
- describe types and sources of genetic variation.
- describe fundamental concepts and methods of quantitative genetics.
- use basic mathematical formalism to describe major population genetic concepts.
- discuss the main topics and developments in population and quantitative genetics.

Content

Population Genetics:
Types and sources of genetic variation; randomly mating populations and the Hardy-Weinberg equilibrium; effects of inbreeding; natural selection; random genetic drift and effective population size; gene flow and hierarchical population structure; molecular population genetics: neutral theory of molecular evolution and basics of coalescent theory.

Quantitative Genetics:
Continuous variation; measurement of quant. characters; genes, environments and their interactions; measuring their influence; response to selection; inbreeding and crossbreeding, effects on fitness; Fisher's fundamental theorem.

Lecture notes
Handouts

Literature

Prerequisites
There will be 5 optional extra sessions for the population genetics part (following lectures 2-6) for computer simulations, designed to help understand the course material.

701-1413-00L Population and Quantitative Genetics W 3 credits 2V T. Städler, P. C. Brunner

Abstract
This course provides an introduction to the concepts and methods used in ecological genetics. Topics covered include genetic diversity, adaptation, reproductive isolation, hybridization and speciation.

Objective
To understand how knowledge from individual disciplines can be combined to understand how organisms interact with each other and their environment.

Content
Concepts and methods for the study of genetic diversity, adaptation, reproductive isolation, hybridization and speciation.

Lecture notes
Handouts of lectures

Literature
Recommended:

701-1413-01L Ecological Genetics W 3 credits 2V A. Widmer, M. C. Fischer, A. Guggisberg

701-1415-00L Population Biology W 3 credits 2V

Abstract
This course provides an understanding of the basic concepts of population biology. It presents models regarding the dynamics and evolution of populations, and experimental designs for investigating population biology hypotheses (e.g., population growth, species interactions, epidemiology, metapopulations, life history evolution, local adaptation, evolution of sex, and coevolution).

Objective
Students are able:
- to describe and apply population biology models (e.g. growth, species interactions)
- to describe and apply epidemiological models
- to substantiate evolutionary concepts (e.g., life history evolution, coevolution, evolution of sex) using population biology arguments and provide examples
- to propose population biology experiments

Content
Population growth, population regulation, predator-prey interactions, host-pathogen interactions, competition, metapopulations, life history evolution, local adaptation, mating systems, sexual selection, coevolution.

Lecture notes
Handouts of lectures

Literature

Human-Environment Systems

Number Title Type ECTS Hours Lecturers
701-0651-00L Coevolution between Society and Environment: Analysis and Influence W 3 credits 2V J. Minsch

Abstract
Analysis of central mechanisms of the anthroposphere: ecological economics, theory of institutions and innovation, development economics.

Objective
Introduction to the theoretical foundations of the analysis of central mechanisms of the anthroposphere in a sustainable development perspective.

Knowledge of the different scientific and political discussions on sustainable development.

Knowledge of selected analytical tools (Ecological Economics, economic analysis of institutions, innovation theory, Ordnungstheorie, Theory of liberal economic policy).

Ability to identify central non sustainable mechanisms and policies, to formulate adequate research questions, to choose and to use adequate analytical tools, and to elaborate solutions.
The structure of the course is as follows:

- Quantification of anthropogenic resource, energy and material flows
- Mathematical modeling of anthropogenic resource, energy and material flows based on "Systemanalyse"
- Introduction into concepts for integrating material flow models with approaches from social sciences

Approaches for decision modeling

- describe approaches for modelling (collective) human behavior and concepts and methods for integrating scientific and social-scientific models.

Students are able to

- describe approaches for modelling (collective) human behavior and concepts and methods for integrating scientific and social-scientific models.
- analyse, as an example, the interaction of nutrition and climate change as a human-environment system.
- observe human-environment systems from the stakeholder perspective.
- name the most important resource, energy and material flows and utilize mathematical models for their quantitative description.
- systematically analyse resource problems in the anthroposphere on various levels company, region, nation.
- name the most important resource, energy and material flows and utilize mathematical models for their quantitative description.
The course will focus on integrated landscape approaches for the management of tropical forest landscapes, by addressing the complex interactions between ecological processes, stakeholders’ strategies and public policies. Dedicated tools such as games and simulation models to improve knowledge and foster collective decision-making processes will be explored.

Objective

Through the course the students will learn:

Section 1: Concepts and Methods
1. To master definitions and concepts: SES; Vulnerability; Resilience, Environmentalist Paradox.
2. To gain exposure to methods for assessing stakeholders perceptions/practices/knowledge.

Section 2: Recognising diversity & Interdisciplinarity
1. To understand points of views/normative views and how these shape management objectives and practices.
3. To explore interdisciplinary approaches to natural resources management.

Section 3: Topics and Arenas
1. To understand links between Forest, Trees and Livelihoods - poverty, food security & well-being.
2. Gain familiarity with drivers of deforestation; degradation; reforestation.
3. Knowledge of global arenas affecting the international forest regime, and their impact at the local level.
4. To recognise and understand trade-offs between conservation and development in a forest/agroforest context;

A major objective of the course is to encourage students to develop a critical analysis of existing conservation and development narratives within the frame of agroforestry and forested agricultural landscapes. The course will also provide students with methods and tools to assess stakeholders perceptions/practices and knowledge, that will be of use in their professional life.

Content

The course will address:

1. Definitions of forests and agroforests, deconstructing the rigid historical divisions between these two, and showing the complexities and implications legal definitions will have on the management systems. We will also address the definitions of Social and Ecological System (SES) and Resilience, useful for the entire course. We will provide insights on how to describe the SES using the ARDI methodological framework (Actors, Resources, Dynamics and Interactions).

2. Methodological frameworks to understand drivers and coping strategies of stakeholders (Sustainable livelihood framework & Vulnerability; Ecosystem Services & trade-offs; Companion Modelling and Adaptive Management; Surveys and Participatory Appraisals)

Building upon this, and introducing the Forest Transition curve as guiding framework for the course, a series of case studies will be presented, highlighting the different drivers and issues at each stage of the transition curve (Kanninen et al. 2007).

1. Tropical Forestry - including Reduced Impact Logging, Forest Certification, and International Timber Market.
2. Secondary forests and Agroforests - landscape mosaics, forest fragments, non timber forest products, slash and burn systems, small holder production systems.
3. Conversions and Deforestation: Global trends, Biofuel extensions .
5. Conclusion - Future trends; Global Arenas and Local Governance.

The course will tackle new and emerging topics such as the role of forests and trees in adaptation to climate change, the links between forest, poverty and food security, and the need to mainstream conservation of biodiversity outside protected areas. The course will draw from diverse disciplines, from ecology, economy, sociology, political sciences and legal studies as the most preeminent ones.

The course will enlarge the scope of the students to the social and political components of tropical social and ecological systems. It will address topics and case studies that the students will have little opportunity to address elsewhere, linking them to issues of global relevance in environmental sciences.

Literature


Forest and Landscape

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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>701-0553-00L</td>
<td>Landscape Ecology</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>F. Kienast, L. Pellissier</td>
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Abstract
This course offers an introduction to landscape ecology and an insight into its various practical applications in nature and landscape management. The course identifies the products which can provide sustainable landscape management (e.g. landscape parks, visually attractive landscapes, renaturalised spaces for species protection, revitalised rivers).

Objective
Students are able to
- explain and apply the concepts and methods of landscape analysis using examples.
- explain the causes and effects of altering the landscape using examples and simulations.
- describe the practical applications of landscape ecology in nature and landscape management.
- explain sustainable landscape management using various examples.

Content
A. Theoretical aspects
- Introduction to Landscape Ecology as a discipline
- Methodological tools of Landscape Ecology
- Landscape analysis I: Qualitative landscape description; landscape patterns and ecological significance for fauna and flora
- Landscape analysis II: Spatial patterns, landscape metrics with practical examples
- Landscape analysis III: Human landscape perception and habitat requirements of fauna and flora with practical examples
- Landscape change I: The role of landscape change for plants and humans; measuring landscape change; simulation of disturbances on ecological communities
- Landscape change II: Simulating landscape development with various models

B. Applied landscape ecology in nature and landscape management and corresponding products
- Simulating spatial distribution of selected plant and animal species. Applying distribution models in nature and landscape management, dealing with risks and scenarios.
- Modern river management: flood protection and river restoration (guest lecture)
- Landscape and habitat Inventories: Traditional methods, types of inventories, problems of up-dating, new methods of analyzing landscape potentials, new methods for landscape indicators
- Large conservation areas GIS assisted search strategies with landscape ecological data

Lecture notes
Lecture notes will be delivered (in English and partially in German).

Literature
Master students seeking recognition of this course in the Bologna process have to show adequate knowledge of the landscape ecology topics described above and have to read selected chapters of


Prerequisites / notice
Lecture with some exercises. For this course and the part landscape ecology in the Systempraktikum Forest and Landscape (summer semester) it is highly recommended to acquire basic skills in Geographic Information Systems (GIS).

701-0559-00L Seminar for Bachelor Students: Forest and Landscape O 2 credits 2S O. Holdénrieder, C. Bigler, E. Lieberherr, P. Rotach

Abstract
Interdisciplinary seminar on forest and landscape issues with particular emphasis on the key processes shaping the development of forest ecosystems and landscapes.

Objective
To analyze scientific original articles and other complex materials critically and to present the results in an understandable way.
- To understand selected processes, cases and methods related to forest and landscape issues.
- To be able to analyze problems related to forest ecosystems and landscape from the viewpoint of various disciplines.

Content
Biological, ecological, physical and technical processes with impacts on the community, ecosystem and landscape scale. Social processes

Lecture notes
No script available. The seminar papers will be made available to all participants in electronic form.

Literature
Literature references will be provided by the lecturers.

Prerequisites / notice
The credits are given if the following requirements are met
a) oral presentation (15-20 Min + discussion)
b) seminar paper (up to approx. 5 pages, with references, no powerpoint printout).

701-0561-00L Forest Ecology W 3 credits 2V C. Bigler

Abstract
This course conveys the basics of forest ecology with an emphasis on trees as those organisms that dominate the physiognomy and the quantitative importance of forest ecosystems at the global and regional scales, with a focus on central Europe.

Objective
Students are able to
- summarize the fundamentals of forest ecology at the autecological, demecological and synecological level
- explain, how trees dominate the physiognomy and dynamics of forest ecosystems
- describe the qualitative and quantitative importance of forest ecosystems at the global and regional scales, with an emphasis on central Europe and the European Alps.

Content
Introduction and overview of the forests of the world
Forest ecosystem ecology: Production ecology of forests
Autecology: light, temperature, wind, water, and nutrients
Demecology: regeneration ecology, forest growth, mortality
Synecology: Fundamentals of trophic interactions (forest-ungulate interactions, herbivory by insects), succession
Lecturers

Students are able to

By developing the bachelor’s thesis, students learn to (a) analyse a problem using scientific methods and concepts, (b) write a report according to scientific standards and (c) correctly cite scientific literature. Depending on the chosen orientation of the thesis, the students learn these skills through an empirical analysis, a literature review, via design tasks or through an applied project.

Objective

Content

Lecturers


Prerequisites / notice

The contents of the following courses of the 2nd year of the USYS BSc are required:

NONE.

Knowledge from the following courses of the 2nd year of the USYS BSc are an asset:

Prerequisites / notice

Lecturer's notes

Handouts (mixture of overhead slides and full text chapters) are sold at cost

Lecture slides are available in electronic form.

Handouts (mixture of overhead slides and full text chapters) are sold at cost

Handouts (mixture of overhead slides and full text chapters) are sold at cost

Knowledge from the following courses of the 2nd year of the USYS BSc are an asset:

701-0312-00L Pflanzen- und Vegetationsökologie
701-0314-00L Systematische Botanik

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>701-0563-00L</td>
<td>Forest and Tree Diseases</td>
<td>W</td>
<td>3</td>
<td>3G</td>
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</tbody>
</table>

**Abstract**

Diseases and abiotic damage influence the use and maintenance of forest ecosystems, tree populations and individual trees. This course provides a basic overview of important infectious diseases and abiotic damage in woody plants, with a focus on Central Europe.

**Objective**

Students are able to:
- describe the basic processes of pathogenesis in trees.
- explain methods of disease diagnosis and control.
- name and identify ecologically or economically significant tree and forest diseases.

**Content**

The concept of 'Forest Health', history of forest pathology, environment and disease, pathogenesis and defence, basics of epidemiology, Principles of tree management. Morphology, biology, diagnosis and control of selected pathogens (parasiticphanerogams, fungi, bacteria, viruses and viroids). Morphology of mycorrhiza. Damages to woody plants caused by abiotic environmental factors.

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<th>Number</th>
<th>Title</th>
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<tbody>
<tr>
<td>701-0565-00L</td>
<td>Fundamentals of Natural Hazards Management</td>
<td>W</td>
<td>3</td>
<td>3G</td>
</tr>
</tbody>
</table>

**Abstract**

Risks to life and human assets result when settlement areas and infrastructure overlap regions where natural hazard processes occur. This course utilizes case studies to teach how a future natural hazards-specialist should analyze, assess and manage risks.

**Objective**

Concepts will be explained step-by-step through a set of case studies, and applied in lab by the students. The following principal steps are used when coping with natural hazard-risks. At each step, students will learn and apply the following skills:
- Risk analysis - What can happen?
- Characterize the processes and environmental measures that lead to a natural hazard and integrate modeling results of these processes.
- Identify threats to human life and assets exposed to natural hazards and estimate possible drawbacks or damages.
- Risk assessment - What are the acceptable levels of risk?
- Apply principles to determine acceptable risks to human life and assets in order to identify locations which should receive added protection.
- Explain causes for conflicts between risk perception and risk analysis.
- Risk management - What steps should be taken to manage risks?
- Explain how various hazard mitigation approaches reduce risk.
- Describe hazard scenarios as a base for adequate dimensioning of control measures.
- Identify the best alternative from a set of thinkable measures based on an evaluation scheme.
- Explain the principles of risk-governance.

**Content**

Die Vorlesung besteht aus folgenden Blöcken:

1) Einführung ins Vorgehenskonzept (1W)
2) Risikobewertung (6W + Exkursion) mit:
   - Systemabgrenzung
   - Gefahrenbeurteilung
   - Expositions- und Folgenanalyse
3) Risikobewertung (2W)
4) Risikomanagement (4W + Exkursion)
5) Abschlussbesprechung (1W)

Bachelor Thesis

Students can choose between one Bachelor thesis of 10 KP or two Bachelor theses of 5 KP each.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>701-0010-02L</td>
<td>Short Bachelor’s Thesis in Social Sciences and Humanities</td>
<td>W</td>
<td>5</td>
<td>11D</td>
</tr>
</tbody>
</table>

**Abstract**

By developing the bachelor's thesis, students learn to (a) analyse a problem using scientific methods and concepts, (b) write a report according to scientific standards and (c) correctly cite scientific literature. Depending on the chosen orientation of the thesis, the students learn these skills through an empirical analysis, a literature review, via design tasks or through an applied project.

**Objective**

By developing the bachelor's thesis, students learn to (a) analyse a problem using scientific methods and concepts, (b) write a report according to scientific standards and (c) correctly cite scientific literature.

**Content**

A bachelor's thesis in the domain “Social sciences and humanities” usually deals with an issue at the interface of those sciences, the environment and sustainability. Methods of data collection, analysis and interpretation stemming from the social sciences are applied. A short bachelor's thesis should consist of a text, with graphs and figures, of 15-20 pages.

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
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<tbody>
<tr>
<td>701-0010-03L</td>
<td>Short Bachelor’s Thesis in Natural Sciences and Engineering</td>
<td>W</td>
<td>5</td>
<td>11D</td>
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</table>

**Abstract**

By developing the bachelor's thesis, students learn to (a) analyse a problem using scientific methods and concepts, (b) write a report according to scientific standards and (c) correctly cite scientific literature. Depending on the chosen orientation of the thesis, the students learn these skills through an empirical analysis, a literature review, via design tasks or through an applied project.

**Objective**

By developing the bachelor's thesis, students learn to (a) analyse a problem using scientific methods and concepts, (b) write a report according to scientific standards and (c) correctly cite scientific literature.
Content

A bachelor's thesis in "Natural sciences" deals with a topic at the interface of natural sciences, the environment and sustainability. The methods of data collection, analysis and interpretation appropriate to the natural sciences are used. A thesis in "Engineering" deals with the environmental effects of use and application. The thesis may take the form of an analysis or review of a current technology, or the design of a future technological application. In an inter- or transdisciplinary thesis, knowledge from various fields and disciplines would be merged on the basis of an overarching question, or developed via the input of key societal actors. A short bachelor's thesis should consist of a text, with graphs and figures, of 15-20 pages.

701-0010-10L Bachelor's Thesis  W  10 credits  21D Lecturers

Abstract
By developing the bachelor's thesis, students learn to (a) analyse a problem using scientific methods and concepts, (b) write a report according to scientific standards and (c) correctly cite scientific literature. Depending on the chosen orientation of the thesis, the students learn these skills through an empirical analysis, a literature review, via design tasks or through an applied project.

Objective
By developing the bachelor's thesis, students learn to (a) analyse a problem using scientific methods and concepts, (b) write a report according to scientific standards and (c) correctly cite scientific literature.

Content
The BA is written either under the "Social sciences and humanities" or the "Natural sciences and technology" modules. The thesis may also be inter- and transdisciplinary.

A bachelor's thesis in the domain "Social sciences and humanities" usually deals with an issue at the interface of those sciences, the environment and sustainability. Methods of data collection, analysis and interpretation stemming from the social sciences are applied. A bachelor's thesis in "Natural sciences" deals with a topic at the interface of natural sciences, the environment and sustainability. The methods of data collection, analysis and interpretation appropriate to the natural sciences are used. A thesis in "Technology" deals with the environmental effects of use and application. The thesis may take the form of an analysis or review of a current technology, or the design of a future technological application. In an inter- or transdisciplinary thesis, knowledge from various fields and disciplines would be merged on the basis of an overarching question, or developed via the input of key societal actors.

A bachelor's thesis should consist of a text, with graphs and figures, of 30-40 pages.

Environmental Sciences Bachelor - Key for Type

<table>
<thead>
<tr>
<th>Key for Type</th>
<th>Compulsory</th>
<th>Eligible for credits and recommended</th>
<th>Eligible for credits</th>
<th>Recommended, not eligible for credits</th>
<th>Courses outside the curriculum</th>
<th>Suitable for doctorate</th>
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<tbody>
<tr>
<td>O</td>
<td>W+</td>
<td>W</td>
<td>E-</td>
<td>E+</td>
<td>Z</td>
<td>Dr</td>
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</table>

Key for Hours

<table>
<thead>
<tr>
<th>Key</th>
<th>Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>V</td>
<td>lecture</td>
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<td>G</td>
<td>lecture with exercise</td>
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<td>U</td>
<td>exercise</td>
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<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
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<tr>
<td>R</td>
<td>revision course / private study</td>
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</table>

ECTS
European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
## Prerequisites

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-0471-01L</td>
<td>Atmospheric Chemistry</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>M. Ammann, D. W. Brunner</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>The lecture provides an introduction to atmospheric chemistry at bachelor level. It introduces the kinetics of gas phase and heterogeneous reactions on aerosols and in clouds and explains the chemical and physical mechanisms responsible for global (e.g. stratospheric ozone depletion) as well as regional (e.g. urban air pollution) environmental problems.</td>
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<td></td>
<td>The students will understand the basics of gas phase and heterogeneous reactions and will know the most relevant atmospheric chemical processes taking place in the gas phase as well as between different phases including aerosols and clouds. The students will also acquire a good understanding of atmospheric environmental problems including air pollution, stratospheric ozone destruction and changes in the oxidative capacity of the global atmosphere.</td>
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<td></td>
<td><strong>Content</strong></td>
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<td></td>
<td>- Origin and properties of the atmosphere: structure, large scale dynamics, UV radiation</td>
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<td></td>
<td>- Thermodynamics and kinetics of gas phase reactions: enthalpy and free energy of reactions, rate laws, mechanisms of bimolecular and termolecular reactions.</td>
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<td>- Tropospheric photochemistry: Photolysis reactions, photochemical O3 formation, role and budget of HOx, dry and wet deposition</td>
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<td>- Aerosols and clouds: chemical properties, primary and secondary aerosol sources</td>
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<td></td>
<td>- Multiphase chemistry: heterogeneous kinetics, solubility and hygroscopicity, N2O5 chemistry, SO2 oxidation, secondary organic aerosols</td>
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<td>- Air quality: role of planetary boundary layer, summer- versus winter-smog, environmental problems, legislation, long-term trends</td>
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<td>- Stratospheric chemistry: Chapman cycle, Brewer-Dobson circulation, catalytic ozone destruction cycles, polar ozone hole, Montreal protocol</td>
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<td>- Global aspects: global budgets of ozone, methane, CO and NOx, air quality - climate interactions</td>
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<tr>
<td>Lecture notes</td>
<td>Vorlesungsunterlagen (Folien) werden laufend während des Semesters jeweils mind. 2 Tage vor der Vorlesung zur Verfügung gestellt.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Attendance of the lecture &quot;Atmosphäre&quot; LV 701-0023-00L or equivalent is a pre-requisite.</td>
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<tr>
<td>701-0473-00L</td>
<td>Weather Systems</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>M. A. Sprenger, C. Grams</td>
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<td></td>
<td><strong>Abstract</strong></td>
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<td>This lecture introduces the theoretical principles and the observational and analytical methods of atmospheric dynamics. Based on these principles, the following aspects are discussed: the energetics of the global circulation, the basic synoptic- and meso-scale flow phenomena, in particular the dynamics of extratropical cyclones, and the influence of mountains on the atmospheric flow.</td>
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<td><strong>Objective</strong></td>
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<td>The students are able to</td>
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<td></td>
<td>- explain up-to-date meteorological observation techniques and the basic methods of theoretical atmospheric dynamics</td>
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<td>- to discuss the mathematical basis of atmospheric dynamics, based on selected atmospheric flow phenomena</td>
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<td></td>
<td>- to explain the basic dynamics of the global circulation and of synoptic- and meso-scale flow features</td>
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<td>- to explain how mountains influence the atmospheric flow on different scales</td>
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<tr>
<td>Content</td>
<td>Satellite observations; analysis of vertical soundings; geostrophic and thermal wind; cyclones at mid-latitude; global circulation; north-atlantic oscillation; atmospheric blocking situations; Eulerian and Lagrangian perspective; potential vorticity; Alpine dynamics (storms, orographic wind); planetary boundary layer</td>
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<tr>
<td>Lecture notes</td>
<td>Lecture notes and slides</td>
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<tr>
<td>Literature</td>
<td>Atmospheric Science, An Introductory Survey</td>
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<td></td>
<td>John M. Wallace and Peter V. Hobbs, Academic Press</td>
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<tr>
<td>701-0475-00L</td>
<td>Atmospheric Physics</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>U. Lohmann, A. A. Mensah</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>This course covers the basics of atmospheric physics, which consist of: cloud and precipitation formation, thermodynamics, aerosol physics, radiation as well as the impact of aerosols and clouds on climate and artificial weather modification.</td>
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<td>Students are able to</td>
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<td>- to explain the mechanisms of cloud and precipitation formation using knowledge of humidity processes and thermodynamics.</td>
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<td>- to evaluate the significance of clouds and aerosol particles for climate and artificial weather modification.</td>
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<tr>
<td>Content</td>
<td>Moist processes/thermodynamics; aerosol physics; cloud formation; precipitation processes, storms; importance of aerosols and clouds for climate and weather modification, clouds and precipitation</td>
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<tr>
<td>Lecture notes</td>
<td>Powerpoint slides and script will be made available</td>
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<tr>
<td>Literature</td>
<td>Rogers and Yau, A Short Course in Cloud Physics, Pergamon Press, 1989; Wallace and Hobbs, Atmospheric Science: An Introductory Survey, Elsevier, 2006</td>
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<tr>
<td>Prerequisites / notice</td>
<td>50% of the time we use the concept of &quot;flipped classroom&quot; (en.wikipedia.org/wiki/Flipped_classroom), which we introduce at the beginning. We offer a lab tour, in which we demonstrate with some instruments how some of the processes, that are discussed in the lectures, are measured.</td>
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<td>There is a additional tutorial right after each lecture to give you the chance to ask further questions and discuss the exercises. The participation is recommended but voluntary.</td>
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<tr>
<td>701-0461-00L</td>
<td>Numerical Methods in Environmental Sciences</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>C. Schär, O. Fuhrer</td>
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<tr>
<td></td>
<td><strong>Abstract</strong></td>
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<td></td>
<td>This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.</td>
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<td><strong>Objective</strong></td>
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<td>This lecture imparts the mathematical basis necessary for the development and application of numerical models in the field of Environmental Science. The lecture material includes an introduction into numerical techniques for solving ordinary and partial differential equations, as well as exercises aimed at the realization of simple models.</td>
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<tr>
<td>Content</td>
<td>Classification of numerical problems, introduction to finite-difference methods, time integration schemes, non-linearity, conservative numerical techniques, an overview of spectral and finite-element methods. Examples and exercises from a diverse cross-section of Environmental Science.</td>
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<tr>
<td>Lecture notes</td>
<td>Is provided (CHF 10.- per copy).</td>
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<tr>
<td>Literature</td>
<td>List of literature is provided.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Die Vorlesung verlangt Vorkenntnisse in Linearer Algebra, Analysis und Physik (z.B. komplexe Zahlen, Beschreibung von ebenen Wellen, einfache gewöhnliche Differentialgleichungen)</td>
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### Weather Systems and Atmospheric Dynamics

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td></td>
<td><strong>Objective</strong></td>
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<tr>
<td></td>
<td>The students will understand the basics of gas phase and heterogeneous reactions and will know the most relevant atmospheric chemical processes taking place in the gas phase as well as between different phases including aerosols and clouds. The students will also acquire a good understanding of atmospheric environmental problems including air pollution, stratospheric ozone destruction and changes in the oxidative capacity of the global atmosphere.</td>
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<td></td>
<td><strong>Content</strong></td>
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<td>- Origin and properties of the atmosphere: structure, large scale dynamics, UV radiation</td>
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<td></td>
<td>- Thermodynamics and kinetics of gas phase reactions: enthalpy and free energy of reactions, rate laws, mechanisms of bimolecular and termolecular reactions.</td>
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<td></td>
<td>- Tropospheric photochemistry: Photolysis reactions, photochemical O3 formation, role and budget of HOx, dry and wet deposition</td>
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<td></td>
<td>- Aerosols and clouds: chemical properties, primary and secondary aerosol sources</td>
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<td></td>
<td>- Multiphase chemistry: heterogeneous kinetics, solubility and hygroscopicity, N2O5 chemistry, SO2 oxidation, secondary organic aerosols</td>
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<td></td>
<td>- Air quality: role of planetary boundary layer, summer- versus winter-smog, environmental problems, legislation, long-term trends</td>
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<td>- Stratospheric chemistry: Chapman cycle, Brewer-Dobson circulation, catalytic ozone destruction cycles, polar ozone hole, Montreal protocol</td>
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<td></td>
<td>- Global aspects: global budgets of ozone, methane, CO and NOx, air quality - climate interactions</td>
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Data: 06.02.2019 13:00
Autumn Semester 2015
Page 1367 of 1434
Physics and chemistry of clouds

Abstract
Dynamic, synoptic Meteorology

Objective
Understanding the dynamics of large-scale atmospheric flow

Content
Dynamical Meteorology is concerned with the dynamical processes of the
Earth's atmosphere. The fundamental equations of motion in the atmosphere will be discussed along with the dynamics and interactions of
synoptic system - i.e. the low and high pressure systems that determine our weather. The motion of such systems can be understood in
terms of quasi-geostrophic theory. The lecture course provides a derivation of the mathematical basis along with some interpretations and
applications of the concept.

Lecture notes
Dynamics of large-scale atmospheric flow

Literature
Picther H., Dynamik der Atmosphäre, Bibliographisches Institut, 456 pp. 1997

Prerequisites / notice
Physics I, II, Environmental Fluid Dynamics

701-1221-00L
Dynamics of Large-Scale Atmospheric Flow
W 4 credits 2V+1U H. Wernli, S. Pfahl

Number Title Type ECTS Hours Lecturers
701-1235-00L Cloud Microphysics W 4 credits 2V+1U U. Lohmann, B. Sierau

Abstract
Clouds are a fascinating climate phenomenon central to the hydrological cycle and the Earth's surface. Theory on transport
processes in the PBL and their dynamics is provided. This course treats theoretical background and idealized concepts. These are
correlated to real world applications and current research issues.

Objective
Overall goals of this course are given below. Focus is on the theoretical background and idealised concepts.

Content
- Introduction
- Turbulence
- Statistical treatment of turbulence, turbulent transport
- Stabilities in a turbulent flow
- Closure problem and closure assumptions
- Scaling and similarity theory
- Spectral characteristics
- Concepts for non-ideal boundary layer conditions

Lecture notes
Powerpoint slides will be made available

Literature

Prerequisites / notice
At least one introductory course in Atmospheric Science or Instructor's consent.

701-1251-00L Land-Climate Interactions
W 3 credits 2G S. I. Seneviratne, E. L. Davin

Abstract
The purpose of this course is to provide fundamental background on the role of land surface processes (vegetation, soil moisture
dynamics, land energy and water balances) for the climate system. The course consists of 2 contact hours per week, including 2 computer
exercises.

Objective
Students will gain an appreciation and understanding of the complex processes in clouds and the necessary physical phenomenon that are
involved and need to be accounted for in order to study cloud and precipitation formation.

Content
Microstructure of clouds and precipitation, aerosol activation to form cloud droplets, ice crystal nucleation (homogeneous freezing of
supercooled aerosol and heterogeneous freezing), precipitation formation

Lecture notes
Powerpoint slides will be made available

Literature

Prerequisites / notice
At least one introductory course in Atmospheric Science or Instructor's consent.

701-1299-00L Physics and chemistry of clouds
W 4 credits 3G U. Lohmann

Abstract
Only for Environmental Sciences MSc, Major in Atmosphere and Climate.
Clouds are a fascinating climate phenomenon central to the hydrological cycle and the Earth's radiation balance. Interactions between cloud particles can result in precipitation, glaciation or evaporation of the cloud depending on its microstructure and microphysical processes. In this course the sought-after topic of ice formation in clouds is studied from a theoretical and empirical perspective.

Objective
Students will be able to understand the microphysics cloud and precipitation formation. To this end, we will discuss the relevant chapters in the textbook of Lamb & Verlinde with the same title as this lecture.

Literature

Prerequisites / notice
An introductory course to Atmospheric Science

### Atmospheric Composition and Cycles

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<tr>
<td>701-1233-00L</td>
<td>Stratospheric Chemistry</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>T. Peter, A. Stenke</td>
</tr>
</tbody>
</table>

Abstract

Objective
The lecture gives an overview on the manifold reactions which occur in the gas phase, in stratospheric aerosol droplets and in polar cloud particles. The focus is on the chemistry of stratospheric ozone and its influence through natural and anthropogenic effects. Especially the intercontinental air traffic and the ozone depletion caused by FCKW CFC in the mid-latitude and the polar regions as well as coupling with the greenhouse effect.

Content
Short presentation of thermodynamical and kinetic basics of chemical reactions: bi- and terthermo rmolecular reactions, photo-dissociation. Introduction to the chemical family concept: active species, their source gases and reservoir gases. Detailed treatment of the pure oxygen family (odd oxygen) according to the Chapman chemistry. Radical reactions of the oxygen species with nitric oxide, active halogens (chlorine and bromine) and odd hydrogen. Ozone depletion cycles. Methane depletion and ozone production in the lower stratosphere (photo-smog reactions). Heterogeneous chemistry on the background aerosol and its significance for heavy air traffic. Chemistry and dynamics of the ozone hole: Formation of polar stratospheric clouds and chlorine activation.

Lecture notes
Documents are provided in the contact hours.

Literature

Prerequisites / notice
Prerequisites: Basics in physical chemistry are required and an overview equivalent to the bachelor course in atmospheric chemistry (lecture 701-0471-01) is expected.

701-1233-00 V starts in the first week of the semester. The exercises 701-1233-00 U will start only in the 2nd week of the semester.

### Climate History and Paleoclimatology

<table>
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<tr>
<th>Number</th>
<th>Title</th>
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<tbody>
<tr>
<td>651-4049-00L</td>
<td>Conceptual and Quantitative Methods in Geochemistry</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>O. Bachmann, M. Schönbachler, D. Vance, M. Ellwood</td>
</tr>
</tbody>
</table>

Abstract
This course will introduce some of the main quantitative methods available for the quantitative treatment of geochemical data, as well as the main modelling tools. Emphasis will both be on conceptual understanding of these methods as well as on their practical application, using key software packages to analyse real geochemical datasets.

Objective
Development of a basic knowledge and understanding of the main tools available for the quantitative analysis of geochemical data. The following approaches will be discussed in detail: major and trace element modelling of magmas, with application to igneous systems; methods and statistics for calculation of isochrons and model ages; reservoir dynamics and one-dimensional modelling of ocean chemistry; modelling speciation in aqueous (hydrothermal, fresh water sea water) fluids.

We will discuss how these methods are applied in a range of Earth Science fields, from cosmochemistry, through mantle and crustal geochemistry, volcanology and igneous petrology, to chemical oceanography. A special emphasis will be put on dealing with geochemical problems through modeling. Where relevant, software packages will be introduced and applied to real geochemical data.

Lecture notes
Slides of lectures will be available.

Pre-requisites / notice
Pre-requisite: Geochemistry (651-3400-00L), Isotope Geochemistry and Geochronology (651-3501-00L).

### Climate History and Palaeoclimatology

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<tr>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>651-4057-00L</td>
<td>Climate History and Palaeoclimatology</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>G. Haug, A. Martinez-Garcia</td>
</tr>
</tbody>
</table>

Abstract
The course "Climate history and palaeoclimatology gives an overview on climate through geological time and it provides insight into methods and tools used in palaeoclimatic research. The student will have an understanding of evolution of climate and its major forcing factors -orbital, atmosphere chemistry, tectonics-through geological time. He or she will understand interaction between life and climate and he or she will be familiar with the use of most common geochanical climate "proxies", he or she will be able to evaluate quality of marine and terrestrial sedimentary palaeoclimatic archives. The student will be able to estimate rates of changes in climate history and to recognize feedbacks between the biosphere and climate.
The course presents advanced hydrological analyses of rainfall-runoff processes. The course is given in English.

The purpose of this course is to provide fundamental background on the role of land surface processes (vegetation, soil moisture, hydrology, and climate) in the hydrological cycle. Observation networks and numerical climate and forecasting models deliver large primary datasets. The use of this data in practice and in research requires specific techniques of statistical data analysis. This lecture introduces a range of frequently used techniques, and enables students to apply them and to properly interpret their results.

The lecture also provides an introduction into R, a programming language and graphics tool frequently used for data analysis in meteorology and climatology. During hands-on computer exercises the student will become familiar with the practical application of the methods.

Topics: exploratory methods, hypothesis tests, analysis of climate trends, measuring the skill of climate and forecasting models, analysis of extreme events, principal component analysis and maximum covariance analysis.

Suggested literature:

Prerequisites / notice
- Hydrology II: Atmospheric Physics, Climatology
- Geology, Stratigraphy
- Palaeoecology
- Climate archives, palaeoceanography
- Statistics I: probability theory, distribution functions, statistics

Content
- Monitoring hydrological systems (point and space monitoring, remote sensing).
- General concepts of watershed modelling, infiltration, IUH models.
- Event based rainfall-runoff modelling, continuous rainfall-runoff models.
- Modelling of the PRMS model.
- Flood routing (unsteady flow, hydrologic routing, examples).

All material is made available via the lecture web-page.

Additional literature is presented during the course.
The colloquium is a series of scientific talks by prominent invited speakers assembling interested students and researchers from around Zürich. Students take part of the scientific discussions.

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<tbody>
<tr>
<td>701-1213-00L</td>
<td>Introduction Course to Master Studies Atmosphere and Climate</td>
<td>O</td>
<td>2 credits</td>
<td>2G</td>
<td>E. M. Fischer, T. Peter</td>
</tr>
<tr>
<td>651-4095-01L</td>
<td>Colloquium Atmosphere and Climate 1</td>
<td>O</td>
<td>1 credit</td>
<td>1K</td>
<td>U. Lohmann, E. M. Fischer, N. Gruber, R. Knutti, T. Peter, C. Schär, S. I. Seneviratne, H. Wernli, M. Wild</td>
</tr>
<tr>
<td>651-4095-03L</td>
<td>Colloquium Atmosphere and Climate 3</td>
<td>O</td>
<td>1 credit</td>
<td>1K</td>
<td>U. Lohmann, E. M. Fischer, N. Gruber, R. Knutti, T. Peter, C. Schär, S. I. Seneviratne, H. Wernli, M. Wild</td>
</tr>
<tr>
<td>701-1211-01L</td>
<td>Master's Seminar: Atmosphere and Climate 1</td>
<td>O</td>
<td>3 credits</td>
<td>2S</td>
<td>E. M. Fischer, T. Ewen, O. Stebler, M. A. Wüest</td>
</tr>
<tr>
<td>701-1211-02L</td>
<td>Master's Seminar: Atmosphere and Climate 2</td>
<td>O</td>
<td>3 credits</td>
<td>2S</td>
<td>E. M. Fischer, T. Ewen, O. Stebler, M. A. Wüest</td>
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</table>

**Objective**

Overall goals of this course are given below. Focus is on the theoretical background and idealised concepts. Students have basic knowledge on atmospheric turbulence and theoretical as well as practical approaches to treat Planetary Boundary Layer flows. They are familiar with the relevant processes (turbulent transport, forcing) within, and typical states of the Planetary Boundary Layer. Idealized concepts are known as well as their adaptations under real surface conditions (as for example over complex topography).

**Content**

- Introduction
- Turbulence
- Statistical treatment of turbulence, turbulent transport
- Conservation equations in a turbulent flow
- Closure problem and closure assumptions
- Scaling and similarity theory
- Spectral characteristics
- Concepts for non-ideal boundary layer conditions

**Lecture notes**

available (i.e. in English)

**Literature**


**Prerequisites / notice**

Umwelt-Fluiddynamik (701-0479-00L) (environment fluid dynamics) or equivalent and basic knowledge in atmospheric science options in general.

**Electives**

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 1371 of 1434
Climate Processes and Feedbacks

<table>
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<tr>
<th>Number</th>
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<tbody>
<tr>
<td>701-1221-00L</td>
<td>Dynamics of Large-Scale Atmospheric Flow</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>H. Wernli, S. Pfahl</td>
</tr>
</tbody>
</table>

Abstract
Dynamical Meteorology is concerned with the dynamical processes of the earth's atmosphere. The fundamental equations of motion in the atmosphere will be discussed along with the dynamics and interactions of synoptic system - i.e. the low and high pressure systems that determine our weather. The motion of such systems can be understood in terms of quasi-geostrophic theory. The lecture course provides a derivation of the mathematical basis along with some interpretations and applications of the concept.

Lecture notes
Dynamics of large-scale atmospheric flow

Literature
- Pichler H., Dynamik der Atmosphäre, Bibliographisches Institut, 456 pp. 1997

Prerequisites / notice
Physics I, II, Environmental Fluid Dynamics

Climate History and Palaeoclimatology

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<td>Climate History and Palaeoclimatology</td>
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Abstract
The course "Climate history and palaeoclimatology gives an overview on climate through geological time and it provides insight into methods and tools used in palaeoclimatology research.

Objective
The student will have an understanding of evolution of climate and its major forcing factors -orbital, atmosphere chemistry, tectonics- through geological time. He or she will understand interaction between life and climate and he or she will be familiar with the use of most common geochronological climate "proxies" he or she will be able to evaluate quality of marine and terrestrial sedimentary palaeoclimate archives. The student will be able to estimate rates of changes in climate history and to recognize feedbacks between the biosphere and climate.

Content
Climate system and earth history - climate forcing factors and feedback mechanisms of the geosphere, biosphere, and hydrosphere.

Geological time, stratigraphy, geological archives, climate archives, palaeoclimatic proxies

Climate through geological time: "lessons from the past"

Cretaceous greenhouse climate

The Late Paleocene Thermal Maximum (PETM)

Cenozoic Cooling

Onset and Intensification of Southern Hemisphere Glaciation

Onset and Intensification of Northern Hemisphere Glaciation

Pliocene warmth

Glacial and Interglacials

Millennial-scale climate variability during glaciations

The last deglaciation(s)

The Younger Dryas

Holocene climate - climate and societies

Atmospheric Composition and Cycles

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<tr>
<td>701-1235-00L</td>
<td>Cloud Microphysics</td>
<td>W</td>
<td>4</td>
<td>2V+1U</td>
<td>U. Lohmann, B. Sierau</td>
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</table>

Abstract
Clouds are a fascinating climate phenomenon central to the hydrological cycle and the Earth’s radiation balance. Interactions between cloud particles can result in precipitation, glaciation or evaporation of the cloud depending on its microstructure and microphysical processes. In this course the sought-after topic of ice formation in clouds is studied from a theoretical and empirical perspective.

Objective
Students will gain an appreciation and understanding of the complex processes in clouds and the necessary physical phenomenon that are involved and need to be accounted for in order to study cloud and precipitation formation.

Content
Microstructure of clouds and precipitation, aerosol activation to form cloud droplets, ice crystal nucleation (homogeneous freezing of supercooled aerosol and heterogeneous freezing), precipitation formation

Lecture notes
Powerpoint slides will be made available

Literature

Prerequisites / notice
At least one introductory course in Atmospheric Science or Instructor's consent.

102-0635-01L Air Pollution Control

Abstract
The lecture provides in the first part an introduction to the formation of air pollutants by technical processes, the emission of these chemicals into the atmosphere and their im pact on air quality. The second part covers different strategies and techniques for emission reduction. The basic knowledge is deepened by the discussion of specific air pollution problems of today's society.

Objective
The students gain general knowledge of the factors resulting in air pollution and the techniques used for air pollution control. The students can identify major air pollution sources and understand the methods for measurement, data collection and analysis. The students can evaluate possible control methods and equipment, design a control system and estimate the efficiency and cost. The students know the different techniques of air pollution control and their scientific basements. They are able to incorporate goals concerning the air quality into their engineering work.

Autumn Semester 2015
**Content**

Part 1 Emission, Immission, Transmission
- Fluxes of pollutants and their environmental impact
- physical and chemical processes leading to emission of pollutants
- mass and energy of processes
- Emission measurement techniques and concepts
- quantification of emissions from individual and aggregated sources
- extent and development of the emissions (Switzerland and global)
- propagation and transport of pollutants (transmission)
- meteorological parameters influencing air pollution dispersion
- deterministic and stochastic models, describing the air pollution dispersion
- dispersion models (Gaussian model, box model, receptor model)
- measurement concepts for ambient air (immission level)
- extent and development of ambient air mixing ratios
- goal and instrument of air pollution control

Part 2 Air Pollution Control Technologies
- The reduction of the formation of pollutants is done by modifying the processes (process-integrated measures) and by different engineering operations for the cleaning of waste gas (downstream pollution control). It will be demonstrated, that the variety of these procedures can be traced back on the application of a few basic principles of physical chemistry.
- Procedures for the removal of particles (inertial separator, filtration, electrostatic precipitators, scrubbers) with their different mechanisms (field forces, impaction and diffusion processes) and the modelling of these mechanisms.
- Procedures for the removal of gaseous pollutants and the description of the driving forces involved, as well as the equilibrium and the kinetics of the relevant processes (absorption, adsorption as well as thermal, catalytic and biological conversions).
- Discussion of the technical possibilities to solve the actual air pollution problems.

**Lecture notes**
- Brigitte Buchmann, Air pollution control, Part I
- Peter Hofer, Air pollution control, Part II
- Lecture slides and exercises

**Literature**
List of literature included in script

**Prerequisites / notice**
College lectures on basic physics, chemistry and mathematics

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**Boundary Layer Meteorology**

**Number**
651-4053-05L

**Abstract**
The Planetary Boundary Layer (PBL) constitutes the interface between the atmosphere and the Earth's surface. Theory on transport processes in the PBL and their dynamics is provided. This course treats theoretical background and idealized concepts. These are contrasted to real world applications and current research issues.

**Objective**
Overall goals of this course are given below. Focus is on the theoretical background and idealised concepts.

Students have basic knowledge on atmospheric turbulence and theoretical as well as practical approaches to treat Planetary Boundary Layer flows. They are familiar with the relevant processes (turbulent transport, forcing) within, and typical states of the Planetary Boundary Layer. Idealized concepts are known as well as their adaptations under real surface conditions (as for example over complex topography).

**Content**
- Introduction
- Turbulence
- Statistical treatment of turbulence, turbulent transport
- Conservation equations in a turbulent flow
- Closure problem and closure assumptions
- Scaling and similarity theory
- Spectral characteristics
- Concepts for non-ideal boundary layer conditions

**Lecture notes**
available (i.e. in English)

**Literature**

**Prerequisites / notice**
Umwelt-Fluiddynamik (701-0479-00L) (environment fluid dynamics) or equivalent and basic knowledge in atmospheric science

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**Environmental Soil Physics/Vadose Zone Hydrology**

**Number**
701-0535-00L

**Abstract**
The course provides theoretical and practical foundations for understanding and characterizing physical and transport properties of soils/near-surface earth materials, and quantifying hydrological processes and fluxes of mass and energy at multiple scales. Emphasis is given to land-atmosphere interactions, the role of plants on hydrological cycles, and biophysical processes in soils.

**Objective**
Students are able to
- characterize quantitative knowledge needed to measure and parameterize structural, flow and transport properties of partially-saturated porous media,
- quantify driving forces and resulting fluxes of water, solute, and heat in soils,
- apply modern measurement methods and analytical tools for hydrological data collection
- conduct and interpret a limited number of experimental studies
- explain links between physical processes in the vadose-zone and major societal and environmental challenges

**Data:** 06.02.2019 13:00  **Autumn Semester 2015**  **Page 1373 of 1434**
The course presents an integrated view of the river basin and fluvial system. The fluvial system is viewed in terms of the dynamics in the
soil water and water balance.

Weeks 4 to 5: Soil Water Retention and Potential (Hydrostatics) - The energy state of soil water; total water potential and its components;
properties of water (molecular, surface tension, and capillary rise); modern aspects of capillarity in porous media; units and calculations
and measurement of equilibrium soil water potential components; soil water characteristic curves definitions and measurements;
parametric models; hysteresis. Modern aspects of capillarity

Demo-Lab: Laboratory methods for determination of soil water characteristic curve (SWC), sensor pairing

Weeks 6 to 9: Water Flow in Soil - Hydrodynamics:

Part 1 - Laminar flow in tubes (Poiseuille's Law); Darcy's Law, conditions and states of flow; saturated flow; hydraulic conductivity and its
measurement.

Lab #1: Measurement of saturated hydraulic conductivity in uniform and layered soil columns using the constant head method.

Part 2 - Unsaturated steady state flow; unsaturated hydraulic conductivity models and applications; non-steady flow and Richards Eq.;
approximate solutions to infiltration (Green-Ampt, Philip); field methods for estimating soil hydraulic properties.

Midterm exam

Lab #2: Measurement of vertical infiltration into dry soil column - Green-Ampt, and Philip's approximations; infiltration rates and wetting
front propagation.

Part 3 - Use of Hydrus model for simulation of unsaturated flow

Week 10 to 11: Energy Balance and Land Atmosphere Interactions - Radiation and energy balance; evapotranspiration definitions and
estimation; transpiration, plant development and transpiration coefficients small and large scale influences on hydrological cycle; surface
evaporation.

Week 12 to 13: Solute Transport in Soils - Transport mechanisms of solutes in porous media; breakthrough curves; convection-dispersion
eq.; solutions for pulse and step solute application; parameter estimation; salt balance.

Lab #3: Miscible displacement and breakthrough curves for a conservative tracer through a column; data analysis and transport parameter
estimation.

Additional topics:

Temperature and Heat Flow in Porous Media - Soil thermal properties; steady state heat flow; nonsteady heat flow; estimation of thermal
properties; engineering applications.

Biological Processes in the Vadose Zone - An overview of below-ground biological activity (plant roots, microbial, etc.); interplay between
physical and biological processes. Focus on soil-atmosphere gaseous exchange; and challenges for bio- and phytoremediation.

Weeks 1 to 3: Physical Properties of Soils and Other Porous Media - Units and dimensions, definitions and basic mass-volume relationships
between the solid, liquid and gaseous phases; soil texture; particle size distributions; surface area; soil structure. Soil colloids and clay
behavior

Soil Water Content and its Measurement - Definitions; measurement methods - gravimetric, neutron scattering, gamma attenuation; and
time domain reflectometry; soil water storage and water balance.

Lecture notes

Classnotes on website: Vadose Zone Hydrology, by Or D., J.M. Wraith, and M. Tuller (available at the beginning of the semester)
http://www.step.ethz.ch/education/active-courses/vadose-zone-hydrology

Literature

Supplemental textbook (not mandatory) - Environmental Soil Physics, by: D. Hillel
1. Introduction to groundwater problems. Concepts to quantify properties of aquifers.

2. Flow equation. The generalized Darcy law.

3. The water balance equation.


5. Analytical solutions to flow problems I

6. Analytical solutions to flow problems II

7. Finite difference solution to flow problems.


12. Analytical solutions to transport problems I.

13. Analytical solutions to transport problems II


Lecture notes

Handouts of slides.

Literature


de Marsily G., Quantitative Hydrogeology, Academic Press, 1986

Additional Elective Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<tr>
<td>701-1237-00L</td>
<td>Solar Ultraviolet Radiation</td>
<td>W</td>
<td>1 credit</td>
<td>1V</td>
<td>J. Gröbner</td>
</tr>
</tbody>
</table>

Abstract

The lecture will introduce the student to the thematics of solar ultraviolet radiation and its effects on the atmosphere and the biosphere. The lecture will cover the modeling and the measurement of solar ultraviolet radiation. The instruments used for solar radiation measurements will also be introduced.

Objective

The lecture should enable the student to understand the specific problematics related to solar ultraviolet radiation and its interaction with the atmosphere and the biosphere.
1) Einführung in die Problematik  Motivation
Begriffe (UV-C, UV-B, UV-A, ...)
Einfluss der UV Strahlung auf Biosphäre (Mensch, Tier, Pflanzen)
Positive und schädliche Effekte
Wirkungsspektrum, Konzept, Beispiele
UVIndex

2) Geschichtlicher Rückblick
Rayleigh - Himmelsblau
1907: Dorno, PMOD
1970: Bener, PMOD
1980: Berger, Erythemal sunburn meter
1990-: State of the Art

3) Extraterrestrische UV Strahlung
Spektrum
Energieverteilung
Variabilität (Spektral, zeitlich, relativ zu Totalstrahlung)
Satellitenmessungen, Übersicht

4) Einfluss der Atmosphäre auf die solare UV Strahlung
Atmosphärenaufbau
Beinflussende Parameter (Ozon, Wolken, ...)
Ozon, Stratosphärisches versus troposphärisches
Geschichte: Ozondepletion, Polare Ozonlöcher und Einfluss auf die UV Strahlung
Wolken
Aerosole
Rayleighstreuung
Trends (Ozon, Wolken, Aerosole)
Radiation Amplification Factor (RAF)

5-6) Strahlungstransfer
Strahlungstransfergleichung
Modellierung, DISORT
libRadtran, TUV, FASTRT
Parameter
Sensitivitätsstudien
Vergleiche mit Messungen
3-D Modellierung (MYSTIC)
Beer-Lambert Gesetz

7) Strahlungsmessungen
Instrumente zur Strahlungsmessung
Messgrössen: Irradiance (global, direct, diffus), radiance, aktinischer Fluss
Horizontale und geneigte Flächen
Generelle Problematic: Freiluftmessungen...
Qualitätssicherung

8) Solare UV Strahlungsmessungen
Problematic: Dynamik, Spektrale Variabilität, Alterung
Stabilität
Spezifische Instrumente: Filterradiometer, Spektroradiometer, Dosimetrie
Übersicht Aufbau und Verwendung

9-10) Solare UV Strahlungsmessgeräte
Spektroradiometer, Filterradiometer (Breit und schmalbandig)
Charakterisierung
Kalibriermethoden (Im Labor, im Feld)
Qualitätssicherung, Messkampagnen

11-12) Auswerteverfahren
Atmosphärische Parameter aus Strahlungsmessungen
Ozon, SO2
Albedo (Effektiv versus Lokal)
Aerosol Parameter (AOD, SSA, g, Teilchenverteilungen)
Zusammenspiel Messungen - Modellierung
Aktinische UV-Strahlungsflüsse und Bestimmung von atmosphärischen Photolysefrequenzen

13) UV Klimatologie
Trends
UV Klimatologie durch Messnetze
UV Klimatologie durch Satellitenmessungen am Beispiel von TOMS
Modellierung am Beispiel Meteosat-JRC
UV Rekonstruktionen

14) Aktuelle Forschungen
Internationale Projekte, Stand der Forschung

651-4273-00L Numerical Modelling in Fortran
W 3 credits 2V P. Tackley

Abstract
This course gives an introduction to programming in FORTRAN95, and is suitable for students who have only minimal programming experience. The focus will be on Fortran 95, but Fortran 77 will also be covered for those working with already-existing codes. A hands-on approach will be emphasized rather than abstract concepts.

Objective
FORTRAN 95 is a modern programming language that is specifically designed for scientific and engineering applications. This course gives an introduction to programming in this language, and is suitable for students who have only minimal programming experience, for example with MATLAB scripts. The focus will be on Fortran 95, but Fortran 77 will also be covered for those working with already-existing codes. A hands-on approach will be emphasized rather than abstract concepts, using example scientific problems relevant to Earth science.

Lecture notes
See http://jupiter.ethz.ch/~pjt/FORTRAN/FortranClass.html
Numerical Modelling in Fortran (Project)  
Prerequisite: 651-4273-00L Numerical Modelling in Fortran  
W 1 credit  1U  P. Tackley

Abstract  
This course gives an introduction to programming in FORTRAN95, and is suitable for students who have only minimal programming experience. The focus will be on Fortran 95, but Fortran 77 will also be covered for those working with already-existing codes. A hands-on approach will be emphasized rather than abstract concepts.

Objective  
FORTRAN 95 is a modern programming language that is specifically designed for scientific and engineering applications. This course gives an introduction to programming in this language, and is suitable for students who have only minimal programming experience, for example with MATLAB scripts. The focus will be on Fortran 95, but Fortran 77 will also be covered for those working with already-existing codes. A hands-on approach will be emphasized rather than abstract concepts, using example scientific problems relevant to Earth science.

Content  
The project consists of writing a Fortran program to solve a problem agreed upon between the instructor and student; the topic is often related to (and helps to advance) the student’s Masters or PhD research. The project is typically started towards the end of the main Fortran class when the student has acquired sufficient programming skills, and is due by the end of Semesterprüfung week.

Lecture notes  
See http://jupiter.ethz.ch/~pjt/FORTRAN/FortranProject.html

Major in Biogeochemistry and Pollutant Dynamics

Biogeochemical Processes

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-1313-00L</td>
<td>Isotopic and Organic Tracers in Biogeochemistry</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>R. Kipfer, C. Schubert</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course introduces the scientific concepts and typical applications of tracers in biogeochemistry. The course covers stable and radioactive isotopes, geochemical tracers and biomarkers and their application in biogeochemical processes as well as regional and global cycles. The course provides essential theoretical background for the lab course &quot;Isotopic and Organic Tracers Laboratory&quot;.</td>
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<tr>
<td>Objective</td>
<td>The course aims at understanding the fractionation of stable isotopes in biogeochemical processes. Students learn to know the origin and decay modes of relevant radiogenic isotopes. They discover the spectrum of possible geochemical tracers and biomarkers, their potential and limitations and get familiar with important applications</td>
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<tr>
<td>Content</td>
<td>Geogenic and cosmogenic radionuclides (sources, decay chains); stable isotopes in biogeochemistry (natural abundance, fractionation); geochemical tracers for processes such as erosion, productivity, redox fronts; biomarkers for specific microbial processes.</td>
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<tr>
<td>Lecture notes</td>
<td>Handouts will be provided for every chapter</td>
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<tr>
<td>Literature</td>
<td>A list of relevant books and papers will be provided</td>
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<tr>
<td>Prerequisites</td>
<td>Students should have a basic knowledge of biogeochemical processes (BSc course on Biogeochemical processes in aquatic systems or equivalent)</td>
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<th>Number</th>
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<tbody>
<tr>
<td>701-1315-00L</td>
<td>Biogeochemistry of Trace Elements</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>A. Voegelin, L. Winkel</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course addresses major biogeochemical processes that drive the cycling of different groups of trace elements (heavy metals, redox-sensitive trace elements, chalcophile elements) in the environment, and the chemical methods that are used to study the behavior of these elements in the geosphere.</td>
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<tr>
<td>Objective</td>
<td>The students gain a detailed understanding of the sources and the cycling of trace elements in the terrestrial and aquatic environment. The interaction of environmentally important trace elements with abiotic and biotic geosphere components as well as their abiotically and biotically driven transformations will be discussed. Relevant methods/techniques to study these processes will be presented.</td>
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<tr>
<td>Content</td>
<td>The course deals in-depth with the major biogeochemical processes controlling the cycling of different groups of trace elements (heavy metals, redox-sensitive and chalcophile elements) in the environment. Sources and cycling of trace elements as related to interactions with abiotic and biotic geosphere components, and abiotically and biotically driven transformations will be discussed. The techniques most commonly used to study these processes will be presented as well.</td>
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<tr>
<td>Lecture notes</td>
<td>Selected handouts (lecture notes, literature, exercises) will be distributed during the course.</td>
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<tr>
<td>Prerequisites</td>
<td>Students are expected to be familiar with the concepts of aquatic or soil chemistry covered in the respective classes at the bachelor level.</td>
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Applications

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<tbody>
<tr>
<td>701-1341-00L</td>
<td>Water Resources and Drinking Water</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>S. Hug, M. Berg, F. Hammes, U. von Gunten</td>
</tr>
<tr>
<td>Abstract</td>
<td>The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Natural processes, anthropogenic pollution, legislation of groundwater and surface water and of drinking water as well as water treatment will be discussed for industrialized and developing countries.</td>
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<tr>
<td>Objective</td>
<td>The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality.</td>
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<tr>
<td>Content</td>
<td>The various water resources, particularly groundwater and surface water, are discussed as part of the natural water cycle influenced by anthropogenic activities such as agriculture, industry, urban water systems. Furthermore legislation related to water resources and drinking water will be discussed. The lecture is focused on industrialized countries, but also addresses global water issues and problems in the developing world. Finally unit processes for drinking water treatment (filtration, adsorption, oxidation, disinfection etc.) will be presented and discussed.</td>
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<tr>
<td>Lecture notes</td>
<td>Handouts will be distributed</td>
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<tr>
<td>Literature</td>
<td>Will be mentioned in handouts</td>
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<tbody>
<tr>
<td>701-1346-00L</td>
<td>Carbon Mitigation</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>N. Gruber</td>
</tr>
<tr>
<td>Abstract</td>
<td>The reduction of CO2 emissions is the only option for keeping future climate change within reasonable bounds. In this course, we will discuss a portfolio of options involving the alteration of natural carbon sinks and carbon sequestration. The course includes introductory lectures, presentations from guest speakers from industry and the public sector, and final presentations by the students.</td>
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<tr>
<td>Objective</td>
<td>The goal of this course is to investigate, as a group, a particular set of carbon mitigation/sequestration options and to evaluate their potential, their cost, and their consequences.</td>
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<tr>
<td>Content</td>
<td>From the large number of carbon sequestration/mitigation options, a few options will be selected and then investigated in detail by the students. The results of this research will then be presented to the other students, the involved faculty, and discussed in detail by the whole group.</td>
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<tr>
<td>Lecture notes</td>
<td>None</td>
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<tr>
<td>Literature</td>
<td>Will be identified based on the chosen topic.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Exam: No final exam. Pass/No-Pass is assigned based on the quality of the presentation and ensuing discussion.</td>
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</table>
In this course, the students become familiar with some experimental approaches for the investigation of the biogeochemistry of trace elements. The course offers a practical introduction into the investigation of the biogeochemistry of trace elements. Laboratory experiments are designed and performed to study a selected environmental process. Advanced techniques for the analysis of total element contents and element speciation are used. The experimental findings are interpreted and discussed in the context of the studied environmental system. 

**Group work**

Case studies about specific nanomaterials in environmental systems, topics will be provided

Written report submitted and presentation at the end of the lecture

**Lecture notes**

Handouts will be provided

**Literature**

will be provided during lecture

### 701-1331-00L - Trace Elements Laboratory

#### Abstract

The course offers a practical introduction into the investigation of the biogeochemistry of trace elements. Laboratory experiments are performed to study a selected environmental process. Advanced techniques for the analysis of total element contents and element speciation are used. The experimental findings are interpreted and discussed in their environmental context.

#### Objective

- The students become familiar with some experimental approaches for the investigation of the biogeochemistry of trace elements. 
- Advanced techniques for the analysis of total element contents and element speciation are used. The experimental findings are interpreted and discussed in the context of the studied environmental system.

#### Content

The course offers a practical introduction into the investigation of the biogeochemistry of trace elements. Laboratory experiments are designed and performed to study a biogeochemical process. Advanced techniques for the analysis of total element contents and element speciation are used. The experimental findings are interpreted and discussed in the context of the environmental system under investigation.

#### Lecture notes

Selected handouts will be distributed during the course.

#### Prerequisites / notice

Prerequisite: Lecture Biogeochemistry of Trace Elements.

### 701-1333-00L - Isotopic and Organic Tracers Laboratory

#### Abstract

This course will illustrate how different tracers and isotopes are used in natural systems. Here especially the processes (transformation, timescales) that take place and can be revealed by tracers/isotopes will be demonstrated but also flux rates will be calculated using different tracers.

#### Objective

- Students know how to use tracers/isotopes to investigate/understand ecosystems
- They will understand the methods and analytical devices related to tracer/isotope work
- Have a feeling for timescales on which natural processes occur
- Students will be able to apply different sampling techniques in aquatic sciences

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</thead>
<tbody>
<tr>
<td>701-1331-00L</td>
<td>Trace Elements Laboratory ■</td>
<td>W</td>
<td>3 credits</td>
<td>4P</td>
<td>K. Barmettler, A. L. Atkins</td>
</tr>
<tr>
<td>701-1333-00L</td>
<td>Isotopic and Organic Tracers Laboratory ■</td>
<td>W</td>
<td>3 credits</td>
<td>4P</td>
<td>C. Schubert, R. Kipfer</td>
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</tbody>
</table>
Upon successful completion of this course students are able to:

1. Introduction to the ecological functions of Swiss forest soils
2. Measurement of soil CO2 efflux, carbon and nutrient leaching in a forest soil
3. Sampling and preparation of litter and soil samples from selected soil profiles under different land-uses
4. Setting-up laboratory experiments in microcosms. Measurement of soil respiration and leaching of carbon, nutrients and/or contaminants in climate chambers under different environmental conditions.
5. Analyses of litter, soil, and soil water for selected physical and chemical properties
6. Interpretation and final presentation of data

A manual will be distributed during the course.

Selected publications will be distributed during the course.

Prerequisites / notice
In order to allow for effective lab work not more than 12 students can join the course.

Useful preparatory courses are: “Soil Chemistry”, “Clay Mineralogy”, and “X-ray powder diffraction”.

Semester Paper and Seminar

Term Paper 2: Seminar
Prerequisite: Term Paper 1: Writing (701-1303-00L).

This is the 2nd part of a series and participation is conditional on the successful completion of the Term Paper Writing (701-1303-00L). The results from the term paper written during the winter term are presented to the other students and advisors.

The goal of the term paper seminars is to train the student’s ability to communicate the results to a wider audience and the ability to respond to questions and comments.

Each student presents the results of the term paper to the other students and advisors and responds to questions and comments from the audience.

There is no final exam. Grade is assigned based on the quality of the presentation and ensuing discussion.

The ability to critically evaluate original (scientific) literature and to summarize the information in a succinct manner is an important skill for any student. This course aims to practice this ability, requiring each student to write a term paper on a topic of relevance for research in the areas of biogeochemistry and pollutant dynamics.
The goal of the term paper is to train the student's ability to critically evaluate a well-defined set of research subjects, and to summarize the findings concisely in a paper of scientific quality. The paper will be evaluated based on its ability to communicate an understanding of a topic, and to identify key outstanding questions. Results from this term paper will be presented to the fellow students and involved faculty in the following term (Term paper seminars class).

Each student is expected to write a paper with a length of approximately 15 pages. The students can choose from a list of topics prepared by the supervisors, but the final topic will be determined based on a balance of choice and availability. The students will be guided and advised by their advisors throughout the term. The paper itself should contain the following elements: Motivation and context of the given topic (25%), Concise presentation of the state of the science (50%), Identification of open questions and perhaps outline of opportunities for research (25).

In addition, the accurate use of citations, attribution of ideas, and the judicious use of figures, tables, equations and references are critical components of a successful paper. Specialized knowledge is not expected, nor required, neither is new research.

Guidelines and supplementary material will be handed out at the beginning of the class.

The submission of a written review is a condition for obtaining the credit points.

There is no final exam. Grade is assigned based on the quality of the term paper and the submission of another student's review.

Students are expected to take Term Paper Writing and Term Paper Seminar classes in sequence.

### Electives

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<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tbody>
<tr>
<td>701-0534-00L</td>
<td>Chemical Kinetics in Terrestrial and Aquatic Systems</td>
<td>W</td>
<td>1</td>
<td>2G</td>
<td>S. Krämer</td>
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<tr>
<td></td>
<td>Introduction in mechanisms of kinetically controlled processes in terrestrial and aquatic systems and their quantitative treatment</td>
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<td>Mechanisms of kinetically controlled processes such as reactions in the aquatic phase (complexation, redox processes); mineral surface reactions (adsorption, dissolution, precipitation, redox processes); reactions at gas/water interfaces; photochemical reactions; microbial/enzymatic reactions; reactions in stratified environments (soils, sediments).</td>
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<td></td>
<td>Distribution during lecture and on a course web-page</td>
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<td>Lecture for advanced and doctoral students. Course language is English. Lecture will be taught as a block in February. Exact dates will be announced.</td>
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<tr>
<td>701-0536-00L</td>
<td>Advanced Topics in Environmental Interface Chemistry</td>
<td>W</td>
<td>1</td>
<td>2G</td>
<td>S. Krämer</td>
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<td>We will discuss interfacial processes and mechanisms by which microorganisms and plants interact with their extracellular environment, particularly with mineral surfaces.</td>
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<td>Students will become acquainted with interfacial biogeochemistry of bio-mineral Interactions.</td>
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<td>Reactions at mineral surfaces: precipitation, dissolution; redox reactions; photochemistry. Biological surfaces: structure of microbial cell surfaces; adsorption reaction at cell surfaces; structure of plant roots. Microbe / mineral interactions: recognition and chemotaxis; adhesion of microbes at mineral surfaces; enzymatic reactions at the cell/mineral interface; extracellular electron transfer; biomineralization; nutrient acquisition; interactions of nanoparticles with microbes; mineral weathering; microbial effects on contaminant mobility. Plant/mineral interactions: nutrient acquisition; mycorrhizal interactions with mineral surfaces.</td>
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<td></td>
<td>The Lecture will be taught as a 4-day block in February. Exact dates will be announced.</td>
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### Major in Ecology and Evolution

#### A. Principles

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<tbody>
<tr>
<td>551-1701-00L</td>
<td>Research Seminar: Ecological Genetics</td>
<td>W</td>
<td>2</td>
<td>1S</td>
<td>A. Widmer, S. Fior</td>
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<td>Minimum number of participants is 4.</td>
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<td>In this research seminar we will critically discuss current topics in Ecological Genetics using publications from the leading scientific journals in this field.</td>
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<td>It is our aim that participants gain insight into the current research topics and knowledge available in Ecological Genetics and learn to critically assess and appreciate scientific publications in this field.</td>
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<td>Active participation in the discussions is a prerequisite for this course.</td>
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<tr>
<td>636-0017-00L</td>
<td>Molecular Evolution, Phyllogenetics and Phylodynamics</td>
<td>W</td>
<td>4</td>
<td>3G</td>
<td>T. Stadler</td>
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<tr>
<td></td>
<td>The aim of the course is to provide up-to-date knowledge on how we can obtain an understanding of the evolution and population dynamics of organisms based on their genetic sequencing data, employing key concepts from molecular evolution, phyllogenetics and phylodynamics. Throughout the course, we tie the models and methods closely with applications, mainly in the field of epidemiology and evolution.</td>
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Attendees will learn what information is contained in genetic sequencing data and how this information is extracted from the sequencing data. The main concepts introduced are:

- models in molecular evolution
- phylogenetic & phylodynamic inference
- maximum likelihood and Bayesian statistics
- stochastic processes

Attendees will apply these concepts to a number of applications yielding biological insight into:

- epidemiology
- pathogen evolution
- macroevolution of species

The course consists of three parts. We first introduce mechanisms and concepts of molecular evolution, i.e. we discuss how genetic sequences change over time. Second, we employ these evolutionary concepts to infer ancestral relationships between organisms based on their genetic sequences, i.e. we discuss methods to infer genealogies and phylogenies. We finally introduce the field of phylodynamics. The aim of that field is to understand the spread and quantify the population dynamics of a pathogen based on genetic data. The course will be illustrated on different datasets giving insight into the epidemiology and evolution of a range of infectious diseases (e.g. HIV, HCV, influenza, Ebola). Applications of the methods to the field of macroevolution will provide insight into the evolution and ecology of different species clades.

Slides of the lecture will be available online.

The course is not based on any of the textbooks below, but they are excellent choices as accompanying material:

- Drummond, A. & Bouckaert, R. 2015. Bayesian evolutionary analysis with BEAST.

Basic knowledge in linear algebra, analysis, and statistics.

The online course ALPECOLe provides a global overview of the complex ecosystems of mountain regions, and of their great diversity of habitats and organisms. The course is strongly interdisciplinary and the various approaches are designed to help understand the past, present and future of mountain ecosystems.

Objective

Knowledge of alpine environments worldwide and their ecology

Content

- The online course is subdivided into:
  - 5 lessons on abiotic factors: geology, soils and their forming processes, climate, and disturbance factors
  - 12 lessons on plants: diversity, patterns and processes, treelines, water & nutrients, carbon cycle, atmospheric influences, sexual and clonal reproduction, and one specific lesson on aquatic environments
  - 5 lessons on animals: habitats and adaptations, origin of species, food ecology and impact of domestic livestock
  - 3 lessons on landscape evolution: quaternary paleoenvironments, methods like radiocarbon dating, pollen records, dendrochronology, stable isotopes, and historical data
  - 1 lesson on global change

Students can also follow a virtual walk through alpine areas where context-based information on alpine environments can be accessed. Moreover, all major alpine areas of the world can be selected on a map and then informative pictures of those landscapes and faunistic and floristic inhabitants will be shown.

Online exercises and tests allow to test the learned matter.

Additionally to the online lessons, three supplementary papers will be read and discussed during the tutorials.

The course is strongly interdisciplinary and the various approaches are designed to help understand the past, present and future of mountain ecosystems.

Objective

Knowledge of alpine environments worldwide and their ecology

Content

- The online course is subdivided into:
  - 5 lessons on abiotic factors: geology, soils and their forming processes, climate, and disturbance factors
  - 12 lessons on plants: diversity, patterns and processes, treelines, water & nutrients, carbon cycle, atmospheric influences, sexual and clonal reproduction, and one specific lesson on aquatic environments
  - 5 lessons on animals: habitats and adaptations, origin of species, food ecology and impact of domestic livestock
  - 3 lessons on landscape evolution: quaternary paleoenvironments, methods like radiocarbon dating, pollen records, dendrochronology, stable isotopes, and historical data
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Online exercises and tests allow to test the learned matter.

Additionally to the online lessons, three supplementary papers will be read and discussed during the tutorials.
The course requires 4 hours of preparatory reading of selected papers on landscape genetics. These papers will be distributed by e-mail. Grading will be according to a short written report (4 pages) on one of the themes of the course (workload: about 8 hours) and according to student contributions during the course.

Prerequisites: students should have basic knowledge in population genetics, GIS and R.

751-5101-00L Biogeochemistry and Sustainable Management
- W 2 credits 2G
- L. Merbold, N. Buchmann

Abstract
This course focuses on the interactions between ecology, biogeochemistry and management of agro- and forest ecosystems, thus, coupled human-environmental systems. Students learn how human impacts on ecosystems via management or global change are mainly driven by effects on biogeochemical cycles and thus ecosystem functioning, but also about feedback mechanisms of terrestrial ecosystems.

Objective
Students will know and understand the complex and interacting processes of ecology, biogeochemistry and management of agro- and forest ecosystems, be able to analyze and evaluate the various impacts of different management practices under different environmental conditions, search literature, write and evaluate scientific reports, and be able to coordinate and work successfully in small (interdisciplinary) teams.

Content
Agroecosystems and forest ecosystems play a major role in all landscapes, either for production purposes, ecological areas or for recreation. The human impact of any management on the environment is mainly driven by effects on biogeochemical cycles. Effects of global change impacts will also act via biogeochemistry at the soil-biosphere-atmosphere-interface. Thus, ecosystem functioning, i.e., the interactions between ecology, biogeochemistry and management of terrestrial systems, is the science topic for this course.

Students will gain profound knowledge about nutrient cycles and population dynamics in managed and unmanaged grassland, cropland and forest ecosystems in the field and in the lab. Responses of agro- and forest ecosystems to the environment, e.g., to climate, anthropogenic deposition, major disturbances, soil nutrients or competition of plants (including invasives) and microorganisms, but also feedback mechanisms of ecosystems on (micro)climate, soils or vegetation patterns will be studied. Different management practices will be investigated and assessed in terms of production and quality of yield (ecosystem goods and services), but also in regard to environmental regulations (including subsidies) and their effect on the environment, e.g., greenhouse gas budgets. Thus, students will learn about the complex interactions of a coupled human-environmental system.

Lecture notes
Handouts will be available on the webpage of the course.

Literature
Will be discussed in class.

Prerequisites / notice
Will be discussed in class.

751-4805-00L Recent Advances in Biocommunication
- W 2 credits 2S
- C. De Moraes

Number of participants limited to 25

Abstract
Students will gain insight into the role of sensory cues and signals in mediating interactions within and between species. There will be a primary, but not exclusive, focus on chemical signaling in interactions among plants, insects and microbes. The course will focus on the discussion of current literature addressing key conceptual questions and state-of-the-art research techniques and methods. Students will engage in discussion and critical analyses of relevant papers and present their evaluations in a seminar setting.

Objective
Students will gain insight into the role of sensory cues and signals in mediating interactions within and between species. There will be a primary, but not exclusive, focus on chemical signaling in interactions among plants, insects and microbes. The course will focus on the discussion of current literature addressing key conceptual questions and state-of-the-art research techniques and methods. Students will engage in discussion and critical analyses of relevant papers and present their evaluations in a seminar setting.

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B. Applications

Applications to Conservation and Management

Number Title Type ECTS Hours Lecturers
701-1453-00L Ecological Assessment and Evaluation W 3 credits 3G
- F. Knaus, U. Bollens Hunziker

Abstract
The course provides methods and tools for ecological evaluations dealing with nature conservation or landscape planning. It covers census methods, ecological criteria, indicators, indices and critically appraises objectivity and accuracy of the available methods, tools and procedures. Birds and plants are used as main example guiding through different case studies.

Objective
Students will be able to:
1) critically consider biological data books and local, regional, and national inventories;
2) evaluate the validity of ecological criteria used in decision making processes;
3) critically appraise the handling of ecological data and criteria used in the process of evaluation
4) perform an ecological evaluation project from the field survey up to the decision making and planning.

Lecture notes
Powerpoint slides are available on the webpage. Additional documents are handed out as copies.

Literature
Basic literature and references are listed on the webpage.

Prerequisites / notice
The course structure changes between lecture parts, seminars and discussions. The didactic atmosphere is intended as working group. Prerequisites for attending this course are skills and knowledge equivalent to those taught in the following ETH courses:
- Pflanzen- und Vegetationsökologie
- Systematische Botanik
- Raum- und Regionalentwicklung
- Naturschutz und Stadtbioökologie

701-1613-01L Advanced Landscape Research W 5 credits 3G
- M. Bürgi, J. Bolliger, U. Gimmi, M. Hunziker

Abstract
This course introduces landscapes as socially perceived, spatially and temporally dynamic entities that are shaped by natural and societal factors. Concepts and qualitative and quantitative methods to study landscapes from an ecological, societal and historical perspective are presented. In a term paper students work on a landscape-related topic of their choice.

Objective
Students will:
- learn about concepts and methods to quantify structural and functional connectivity in landscapes, particularly
- be introduced to the topic of landscape genetics and its benefits and (current) limitations for applied conservation
- learn about concepts and methods in scenario-based land-use change modelling
- approach an understanding of landscape as perceived environment
- learn about concepts of landscape preference and related measurement methods
- understand the role of landscape for human well-being
- be introduced into approaches of actively influencing attitudes and behavior as well as related scientific evaluation
- make use of various historical sources to study landscapes and their dynamics
- interpret landscapes as a result of ecological constraints and anthropogenic activities.
This course introduces the broad variety of conflicts that arise in projects focusing on sustainable management of natural resources. It encompasses concepts and approaches to ecosystem management and considers their practicability, their achievements and possible barriers to their uptake.

Traditionally, management systems focus on extraction of natural resources and their manipulation and governance. However, traditional management has frequently resulted in catastrophic failures such as the collapse of fish stocks and biodiversity loss. These failures have highlighted the development of alternative ecosystem management approaches that emphasise the functionality of human-dominated systems. Inherent to such approaches are system-wide perspectives and a focus on ecological processes and services, multiple spatial and temporal scales, as well as the need to incorporate diverse stakeholder interests in decision making. Thus, ecosystem management is the science and practice of managing natural resources, biodiversity and ecological processes, to meet multiple demands of society. It can be local, regional or global in scope, and addresses critical issues in developed and developing countries relating to economic and environmental security and sustainability.

This course provides an introduction to ecosystem management, and in particular the importance of integrating ecology into management systems to meet multiple societal demands. The course explores the extent to which human-managed terrestrial systems depend on underlying ecological processes, and the consequences of degradation of these processes for human welfare and environmental wellbeing. Building upon a theoretical foundation, the course will tackle issues in resource ecology and management, notably forests, agriculture and wild resources within the broader context of sustainability, biodiversity conservation and poverty alleviation or economic development. Case studies from tropical and temperate regions will be used to explore these issues. Dealing with ecological and economic uncertainty, and how this affects decision making, will be discussed. Strategies for conservation and management of terrestrial ecosystems will give consideration to landscape ecology, protected area systems, and community management, paying particular attention to alternative livelihood options and marketing strategies of common pool resources.

CT xx-xx-00L
Foundations of Ecosystem Management

W 5 credits J. Ghazoul, C. Garcia

Abstract: This course introduces the broad variety of conflicts that arise in projects focusing on sustainable management of natural resources. It explores case studies of ecosystem management approaches and considers their practicability, their achievements and possible barriers to their uptake.

Objective: Changes in the context of land and resource management.

Content: Traditional management systems focus on extraction of natural resources and their manipulation and governance. However, traditional management has frequently resulted in catastrophic failures such as the collapse of fish stocks and biodiversity loss. These failures have highlighted the development of alternative ecosystem management approaches that emphasise the functionality of human-dominated systems. Inherent to such approaches are system-wide perspectives and a focus on ecological processes and services, multiple spatial and temporal scales, as well as the need to incorporate diverse stakeholder interests in decision making. Thus, ecosystem management is the science and practice of managing natural resources, biodiversity and ecological processes, to meet multiple demands of society. It can be local, regional or global in scope, and addresses critical issues in developed and developing countries relating to economic and environmental security and sustainability.

Lecture notes: No Script

Literature:

Quantitative and Computational Expertise

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<tr>
<td>701-1419-00L</td>
<td>Analysis of Ecological Data</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>S. Güsewell</td>
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Abstract: This class provides students with an overview of techniques for data analysis used in modern ecological research, as well as practical experience in running these analyses with R and interpreting the results. Topics include linear models, generalized linear models, mixed models, model selection and randomization methods.

Objective: Students will be able to:
- describe the aims and principles of important techniques for the analysis of ecological data
- choose appropriate techniques for given problems and types of data
- evaluate assumptions and limitations
- implement the analyses in R
- represent the relevant results in graphs, tables and text
- interpret and evaluate the results in ecological terms

Content:
- Linear models for experimental and observational studies
- Model selection
- Introduction to likelihood inference and Bayesian statistics
- Analysis of counts and proportions (generalised linear models)
- Models for non-linear relationships
- Grouping and correlation structures (mixed models)
- Randomisation methods
This course combines Limnology (the study of inland waters in its broad sense) with Ecological and Evolutionary concepts. It deals with aquatic macroinvertebrates in Switzerland and the common sampling techniques.

### Laboratory and Field Expertise

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<tr>
<td>701-1437-00L</td>
<td>Limnoecology</td>
<td>W</td>
<td>8</td>
<td>10G</td>
<td>P. Spaak, F. Altermatt, T. Gonser, K. J. Räsänen, C. T. Robinson</td>
</tr>
</tbody>
</table>

#### Abstract
This course combines Limnology (the study of inland waters in its broad sense) with Ecological and Evolutionary concepts. It deals with aquatic macroinvertebrates in Switzerland and the common sampling techniques.

#### Objective
During this course you will get an overview of the typical aquatic macroinvertebrate groups in Switzerland. Beside a theoretical background on the different groups the focus was laid on the determination of the most important species groups and their identification traits, also using identification keys. Practical experience in benthic sampling techniques was collected during an excursion.

#### Content
The course contains a lecture part, an experimental part as well as 1-day excursions.

- During an excursion, you will apply the theoretical identification knowledge to field situations.
- After this course you will be able to identify the most important aquatic species groups at the level of order/family and know the most important identification traits.
- During the excursion you will apply the theoretical identification knowledge to field situations.

#### Prerequisites / notice
- Basic statistical training (e.g. Mathematik IV in D-USYS): Data distributions, descriptive statistics, hypothesis testing, linear regression, analysis of variance
- Basic experience in data handling and data analysis in R

#### Individual preparation
Students without the required knowledge are asked to contact the lecturer before Christmas for support with individual preparation.

### Expertise in Biological Diversity

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<tr>
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<tbody>
<tr>
<td>701-1425-01L</td>
<td>Genetic Diversity: Techniques</td>
<td>W</td>
<td>1</td>
<td>2U</td>
<td>A. M. Minder Pfy;</td>
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</table>
The taxonomic part will cover macroinvertebrates (e.g., Crustacean, aquatic insects). The goal is to get to know the most common aquatic taxa in Switzerland, and to identify them with commonly used identification literature, and to get an idea how these organisms are used in research and practice. (language: German, translation of the most important things during the course possible)

The fieldexcursion takes place Wednesday 21.10.2015.

701-1437-02L Practical Course Microinvertebrates and Cryptogames W 2 credits 2P J. Jokela

Abstract
This course gives an overview of the typical aquatic microinvertebrate groups and cryptogames in Switzerland. Beside a theoretical background of the different groups the focus was laid on the recognition of the most important species groups and their identification traits. Practical experience was collected during an excursion.

Objective
During this course you will get an overview of the typical aquatic microinvertebrates and algae in Switzerland. After this course you will know the most important aquatic species groups and the most important identification traits.

Content
The taxonomic part will cover microinvertebrates and cryptogames. The goal is to get to know the most common aquatic taxa in Switzerland, to identify them and to get an idea how these organisms are used in research and practice. (language: German, translation of the most important things during the course possible)

The excursion takes place Friday 03.10.2014 from 13-17.

C. Term Paper and Seminar

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Abstract
Individual writing of an essay-type review paper about a specialized topic in the field of ecology and evolution, based on substantial reading of original literature and discussions with a senior scientist.

Objective
- Students acquire a thorough knowledge on a topic in which they are particularly interested
- They learn to assess the relevance of original literature and synthesize information
- They make the experience of becoming "experts" on a topic and develop their own perspective
- They practise academic writing according to professional standards in English

Content
Topics for the essays are proposed by the professors and lecturers of the major in Ecology and Evolution at a joint meeting at the beginning of the semester (the date will be communicated by e-mail to registered students).

Students will:
- choose a topic
- search and read appropriate literature
- develop a personal view on the topic and structure their arguments
- prepare figures and tables to represent ideas or illustrate them with examples
- write a clear, logical and well-structured text
- refine the text and present the paper according to professional standards

In all steps, they will benefit from the advice and detailed feedback given by a senior scientist acting as personal tutor of the student.

Lecture notes
Reading of articles in scientific journals

Electives

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<tr>
<td>551-0205-00L</td>
<td>Challenges in Plant Sciences</td>
<td>W</td>
<td>2</td>
<td>2K</td>
<td>W. Gruissem, C. De Moraes, A. Rodriguez-Villalon, J. Six, further lecturers</td>
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</table>

Abstract
The colloquium introduces students to the disciplines in plant sciences and provides integrated knowledge from the molecular level to ecosystems and from basic research to applications, making use of the synergies between the different research groups of the PSC. The colloquium offers a unique chance to approach interdisciplinary topics as a challenge in the field of plant sciences.

Objective
- introduction of graduate students and Master students to the broad field of plant sciences
- promotion of an interdisciplinary and integrative teaching program
- promotion of active participation and independent work of students
- promotion of presentation and discussion skills
- increased interaction among students and professors

Content
Challenges in Plant Sciences will cover the following topics:
- Chemical communication among plants, insect and pathogens.
- Specificity in hormone signaling.
- Genetic networks.
- Plant-plant interactions.
- Resilience of tropical ecosystems.
- Regulatory factors controlling cell wall formation.
- Chlorophyll breakdown.
- Innate immunity.
- Disease resistance genes.
- Sustainable agroecosystems.
**Abstract**
Plant Pathology I will focus on pathogen-plant interactions, epidemiology, disease assessment, and disease development in agroecosystems. Themes will include: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems.

**Objective**
Students will understand: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems as a basis for implementing disease management strategies in agroecosystems.

**Content**
Course description: Plant Pathology I will focus on pathogen-plant interactions, epidemiology, disease assessment, and disease development in agroecosystems. Themes will include: 1) how pathogens attack plants and; 2) how plants defend themselves against pathogens; 3) factors driving the development of epidemics in agroecosystems. Topics under the first theme will include pathogen life cycles, disease cycles, and an overview of plant pathogenic nematodes, viruses, bacteria, and fungi. Topics under the second theme will include plant defense strategies, host range, passive and active defenses, and chemical and structural defenses. Topics under the third theme will include the disease triangle and cultural control strategies.

**Lecture Topics and Tentative Schedule**

**Week 1**  No Lecture: First day of autumn semester

**Week 2**  The nature of plant diseases, symbiosis, parasites, mutualism, biotrophs and necrotrophs, disease cycles and pathogen life cycles. Nematode attack strategies and types of damage.

**Week 3**  Viral pathogens, classification, reproduction and transmission, attack strategies and types of damage. Examples TMV, BYDV, plum pox virus. Bacterial pathogens and phytoplasmas, classification, reproduction and transmission. Bacterial attack strategies and symptoms. Example bacterial diseases: fire blight, Agrobacterium crown gall, soft rots.

**Week 4**  Fungal pathogens, classification, growth and reproduction, sexual and asexual spores, transmission. Fungal life cycles, disease cycles, infection processes, colonization, phytoalexins and mycotoxins. Attack strategies of fungal necrotrophs and biotrophs.

**Week 5**  Symptoms and signs of fungal infection. Example fungal diseases: potato late blight, wheat stem rust, grape powdery mildew, wheat Septoria leaf blotch.

**Week 6**  Plant defense mechanisms, host range and non-host resistance. Passive structural and chemical defenses, preformed chemical defenses. Active structural defense, papillae, active chemical defense, hypersensitive response, pathogenesis-related (PR) proteins, phytoalexins and disease resistance.

**Week 7**  Pisatin and pisatin demethylase. Local and systemic acquired resistance, signal molecules.

**Week 8**  Pathogen effects on food quality and safety.

**Week 9**  Epidemiology: historical epidemics, disease pyramid, environmental effects on epidemic development. Plant effects on development of epidemics, including resistance, physiology, density, uniformity.

**Week 10**  Disease assessment: incidence and severity measures, keys, diagrams, scales, measurement errors. Correlations between incidence and severity.

**Week 11**  Molecular detection and diagnosis of pathogens. Host indexing, serology, monoclonal and polyclonal antibodies. ELISA, PCR, rDNA and rep-PCR.

**Week 12**  Strategies for minimizing disease risks: principles of disease control and management.

**Week 13**  Disease control strategies: economic thresholds, physical control methods.

**Week 14**  Cultural control methods: avoidance, tillage practices, crop sanitation, fertilizers, crop rotation.

**Lecture notes**
Detailed lecture notes (~160 pages) will be available for purchase at the cost of reproduction at the start of the semester.

**701-0290-00L**  Seminar in Microbial Evolution and Ecology (HS)  Z  0 credits  2S  S. Bonhoeffer
Seminar of the groups Ackermann, Bonhoeffer, Schmid-Hempel, Velicer. Talks given by members of these groups and external visitors.

In-depth introduction into microbial evolution and ecology, especially the aspects that are the focus of on-going research in this area at D-USYS.

**Major in Human-Environment-Systems**
Students can register for the Major in Human-Environment-Systems in autumn semester 2015 for the last time.

**Natural and Technological Systems**

**Environmental Assessment**

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<tbody>
<tr>
<td>102-0317-00L</td>
<td>Advanced Environmental Assessments</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>S. Hellweg, R. Frischknecht</td>
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</table>

**Abstract**
This course deepens students' knowledge of the environmental assessment methodologies and their various applications. This course has the aim of deepening students' knowledge of the environmental assessment methodologies and their various applications. In particular, students completing the course should have the:
- Ability to judge the scientific quality and reliability of environmental assessment studies, the appropriateness of inventory data and modelling, and the adequacy of life cycle impact assessment models and factors
- Knowledge about the current state of the scientific discussion and new research developments
- Ability to properly plan, conduct and interpret environmental assessment studies
- Knowledge of how to use LCA as a decision support tool for companies, public authorities, and consumers
Technical systems are investigated in projects with numerical modeling. The students learn how to answer given questions with targeted oriented methodologies using various software programs for environmental assessment.

Objectives:

Students should be able to:

- Inventory developments, transparency, data quality, data completeness, and data exchange formats
- Allocation (multisource processes and recycling)
- Hybrid LCA methods.
- Consequential and marginal analysis
- Recent development in impact assessment
- Spatial differentiation in Life Cycle Assessment
- Workplace and indoor exposure in Risk and Life Cycle Assessment
- Uncertainty analysis
- Subjectivity in environmental assessments
- Multicriteria analysis
- Case Studies

Lecture notes:
No script. Lecture slides and literature will be made available.

Literature:
Literature will be made available.

Prerequisites / notice:
Basic knowledge of environmental assessment tools is a prerequisite for this class. Students that have not done coursework in this topic before are required to read an appropriate textbook before or at the beginning of the course (e.g. Baumann&Tillman, The Hitch Hiker's Guide to LCA: An Orientation in Life Cycle Assessment Methodology and Applications, Studentlitteatur, Lund, 2004).

ECTS:
3G
W

Landscape and Ecosystems

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-1453-00L</td>
<td>Ecological Assessment and Evaluation</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>F. Knaus, U. Bollens Hunziker</td>
</tr>
<tr>
<td>701-1631-00L</td>
<td>Foundations of Ecosystem Management</td>
<td>W</td>
<td>5</td>
<td>3G</td>
<td>J. Ghazoul, C. Garcia</td>
</tr>
</tbody>
</table>

Abstract:

The course provides methods and tools for ecological evaluations dealing with nature conservation or landscape planning. It covers census methods, ecological criteria, indicators, indices and critically appraises objectivity and accuracy of the available methods, tools and procedures. Birds and plants are used as main example guiding through different case studies.

Objective:

Students will be able to:

1. critically consider biological data books and local, regional, and national inventories;
2. evaluate the validity of ecological criteria used in decision making processes;
3. critically appraise the handling of ecological data and criteria used in the process of evaluation
4. perform an ecological evaluation project from the field survey up to the decision making and planning.

Lecture notes:
Powerpoint slides are available on the webpage. Additional documents are handed out as copies.

Literature:
Basic literature and references are listed on the webpage.

Prerequisites / notice:

The course structure changes between lecture parts, seminars and discussions. The didactic atmosphere is intended as working group.

Prerequisites for attending this course are skills and knowledge equivalent to those taught in the following ETH courses:

- Pflanzen- und Vegetationsökologie
- Systematische Botanik
- Raum- und Regionalentwicklung
- Naturschutz und Stadtbioökologie

This course introduces the broad variety of conflicts that arise in projects focusing on sustainable management of natural resources. It explores case studies of ecosystem management approaches and considers their practicability, their achievements and possible barriers to their uptake.

Objective:

Students should be able to

a) propose appropriate and realistic solutions to ecosystem management problems that integrate ecological, economic and social dimensions across relevant temporal and spatial scales.
b) identify important stakeholders, their needs and interests, and the main conflicts that exist among them in the context of land and resource management.

Content:

Traditional management systems focus on extraction of natural resources, and their manipulation and governance. However, traditional management has frequently resulted in catastrophic failures such as, for example, the collapse of fish stocks and biodiversity loss. These failures have stimulated the development of alternative ecosystem management approaches that emphasise the functionality of human-dominated systems. Inherent to such approaches are system-wide perspectives and a focus on ecological processes and services, multiple spatial and temporal scales, as well as the need to incorporate diverse stakeholder interests in decision making. Thus, ecosystem management is the science and practice of managing natural resources, biodiversity and ecological processes, to meet multiple demands of society. It can be local, regional or global in scope, and addresses critical issues in developed and developing countries relating to economic and environmental security and sustainability.

This course provides an introduction to ecosystem management, and in particular the importance of integrating ecology into management systems to meet multiple societal demands. The course explores the extent to which human-managed terrestrial systems depend on underlying ecological processes, and the consequences of degradation of these processes for human welfare and environmental well-being. Building upon a theoretical foundation, the course will tackle issues in resource ecology and management, notably forests, agriculture and wild resources within the broader context of sustainability, biodiversity conservation and poverty alleviation or economic development. Case studies from tropical and temperate regions will be used to explore these issues. Dealing with ecological and economic uncertainty, and how this affects decision making, will be discussed. Strategies for conservation and management of terrestrial ecosystems will give consideration to landscape ecology, protected area systems, and community management, paying particular attention to alternative livelihood options and marketing strategies of common pool resources.

Lecture notes:
No Script

Literature:
Social Systems (Micro, Macro)

Psychology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>376-1177-00L</td>
<td>Human Factors I</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>M. Menozzi Jäckli, R. Boutellier, R. Huang, M. Siegrist</td>
</tr>
</tbody>
</table>

Abstract
Every day humans interact with various systems. Strategies of interaction, individual needs, physical & mental abilities, and system properties are important factors in controlling the quality and performance in interaction processes. In the lecture, factors are investigated by basic scientific approaches. Discussed topics are important for optimizing people's satisfaction & overall performance.

Objective
The goal of the lecture is to empower students in better understanding the applied theories, principles, and methods in various applications. Students are expected to learn about how to enable an efficient and qualitatively high standing interaction between human and the environment, considering costs, benefits, health, and safety as well. Thus, an ergonomic design and evaluation process of products, tasks, and environments may be promoted in different disciplines. The goal is achieved in addressing a broad variety of topics and embedding the discussion in macroscopic factors such as the behavior of consumers and objectives of economy.

Content
- Physiological, physical, and cognitive factors in sensation and perception
- Body spaces and functional anthropometry
- Experimental techniques in assessing human performance and well-being
- Human factors and ergonomics in system designs, product development and innovation
- Human information processing and biological cybernetics
- Interaction among consumers, environments, behavior, and tasks

Literature

Political Sciences, Policy and Sociology

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>701-1651-00L</td>
<td>Environmental Governance</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>E. Lieberherr, G. de Buren</td>
</tr>
</tbody>
</table>

Abstract
The course addresses environmental policies, focusing on new approaches, which are generally summarized as environmental governance. The course also provides a broader introduction to social science concepts to provide students with tools to analyze environmental policy processes and assesses the key features of environmental governance by examining various practical environmental policy examples.

Objective
To understand how an environmental problem may (or not) become a policy and explain political processes, using basic concepts and techniques from political science.
To analyze the evolution as well as the key elements of environmental governance.
To be able to identify the main challenges and opportunities for environmental governance and to critically discuss them with reference to various practical policy examples.

Content
Improvements in environmental quality and sustainable management of natural resources cannot be achieved through technical solutions alone. The quality of the environment and the achievement of sustainable development strongly depend on human behavior and specifically the human uses of nature. To influence human behavior, we rely on public policies and other societal rules, which aim to steer the way humans use natural resources and their effects on the environment. Such steering can take place through government intervention alone. However, this often also involves governance, which includes the interplay between governmental and non-governmental actors, the use of diverse tools such as emission standards or financial incentives to steer actors' behavior and can occur at the local, regional, national or international level.

In this course, we will address both the practical aspects of as well as the scientific debate on environmental governance. The course gives future environmental experts a strong basis to position themselves in the governance debate, which does not preclude government but rather involves a spectrum from government to governance.

Key questions that this course seeks to answer: What are the core characteristics of environmental challenges from a policy perspective? What are the key elements of 'environmental governance' and how legitimate and effective are these approaches in addressing persistent environmental challenges?

Lecture notes
Lecture slides and additional course material will be provided throughout the semester.

Literature

Prerequisites / notice
We recommend that students have (a) Three-years BSc education of a (technical) university; (b) Successfully completed Bachelor introductory course to environmental policy (Entwicklungen nationaler Umweltpolitik (or equivalent)) and (c) Familiarity with key issues in environmental policy and some fundamental knowledge of one social science or humanities discipline (political science, economics, sociology, history, psychology, philosophy).

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>851-0594-00L</td>
<td>International Environmental Politics</td>
<td>W</td>
<td>4</td>
<td>2V</td>
<td>T. Bernauer</td>
</tr>
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</table>

Abstract
This course focuses on the conditions under which cooperation in international environmental politics emerges and the conditions under which such cooperation and the respective public policies are effective and/or efficient.

Objective
The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a social sciences viewpoint; (2) learn how to identify interesting/innovative questions concerning this policy area and how to answer them in a methodologically sophisticated way; (3) gain an overview of important global and regional environmental problems.

Data: 06.02.2019 13:00 Autumn Semester 2015 Page 1388 of 1434
The aim of this course is to equip students with a legal and regulatory skill-set that allows them to translate their technical knowledge into practical applications.

Visiting students (e.g., from the University of Zurich) are subject to the same conditions. Registration of visiting students in the web-based system of ETH is compulsory (http://www.rektorat.ethz.ch/students/admission/auditors/specialstudents_uzh/index_EN; see menu on left side of that webpage for students from other universities).

The course is fully booked.

The course is taught as a small interactive seminar and significant participation is expected from the students. Participation will be capped at 15 in order to maintain the interactive nature of the classes. All classes, readings, and assignments, are in English.

Assessment:
(i) Class participation (25%): Students will be expected to contribute to class discussions and prepare short memos on class readings.
(ii) Exam (75%) consisting of three parts:
   a. Policy brief - a maximum of 2 pages (including graphs and tables);
   b. Background document to the policy brief - this document sets out a more detailed and academic overview of the topic (maximum 8 pages including graphs and tables);
   c. Presentation of the policy brief: presentations can use a maximum of 5 slides and can last 7 minutes.

Teaching will take place over two weeks in September and October. The exam date will be in December.

No specific pre-existing legal knowledge is required, however all students must have successfully completed Grundzüge des Rechts (851-0705-00 V) or an equivalent course.

The course is (inter)related to materials discussed in Politikwissenschaft: Grundlagen (851-0577-00 V), Ressourcen- und Umweltökonomie (751-1551-00 V), Umweltrecht: Konzepte und Rechtsgebiete (851-0705-01 V), Rechtlicher Umgang mit natürlichen Ressourcen (701-0743-01 V), Environmental Governance (701-1651-00 G), Policy and Economics of Ecosystem Services (701-1653-00 G), International Environmental Politics: Part I (851-0594-00 V).

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 1389 of 1434
At the end of the course students should:

- Function, purpose and algorithm of a selected number of transdisciplinary methods

Understand:
- Functional application in case studies and other problem oriented projects

Be able to reflect on:
- Potential, limits, and necessity of transdisciplinary methods

Be prepared for:
- Transdisciplinary Case Study 2016

The course deals with the concepts and methodologies for the analysis and assessment of sustainable development. A special focus is given to the social dimension and to social justice as a guiding principle of sustainability as well as to trade-offs between the three dimensions of sustainability.

The course is seminar-like, interactive.

The lecture is structured as follows:

- Overview of concepts and methods of inter/transdisciplinary integration of knowledge, values and interests (approx. 20%)
- Analysis of a selected number of transdisciplinary methods focusing project framing, problem analysis, and impact (approx. 50%)
- Practical application of the methods in a broader project setting (approx. 30%)

This course is recommended for students participating in the Transdisciplinary Case Study 2016.

The course introduces students to the principles of quantitative policy analysis, namely the methods to predict and evaluate the social, economic, and environmental effects of alternative strategies to achieve public objectives. A series of graded assignments will give students an opportunity for students to apply those methods to a set of case studies.

The objectives of this course are to develop the following key skills necessary for policy analysts:

- Identifying the critical quantitative factors that are of importance to policy makers in a range of decision-making situations.
- Developing conceptual models of the types of processes and relationships governing these quantitative factors, including stock-flow dynamics, feedback loops, optimization, sources and effects of uncertainty, and agent coordination problems.

- Develop and program numerical models to simulate the processes and relationships, in order to identify policy problems and the effects of policy interventions.

- Communicate the findings from these simulations and associated analysis in a manner that makes transparent their theoretical foundation, the level and sources of uncertainty, and ultimately their applicability to the policy problem.

Understand:
- Function, purpose and algorithm of a selected number of transdisciplinary methods

Know:
- core concepts of sustainable development, and;
- the concept of social justice - normatively and empirically - as a core element of social sustainability;
- important empirical methods for the analysis and assessment of local / regional sustainability issues.

Understand and reflect on:
- the challenges of trade-offs between the different goals of sustainable development;
- and the respective impacts on individual and societal decision-making.

The course begins with an introduction to multivariate methods such as analysis of variance and multiple linear regression, where a metric dependent variable is "explained" by two or more independent variables. Then two methods for structuring complex data, cluster analysis and factor analysis will be covered. In the last part, procedures for the analysis of relationships involving dichotomous or polytomous dependent variables (e.g., the choice of a mode of transportation) will be discussed.

The course will proceed through a series of policy analysis and modeling exercises, involving real-world or hypothetical problems. The specific examples around which work will be done will concern the environment, energy, health, and natural hazards management.

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The course deals with the concepts and methodologies for the analysis and assessment of sustainable development. A special focus is given to the social dimension and to social justice as a guiding principle of sustainability as well as to trade-offs between the three dimensions of sustainability.

The course is seminar-like, interactive.

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This course is recommended for students participating in the Transdisciplinary Case Study 2016.

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The course is seminar-like, interactive.

The lecture is structured as follows:

- Overview of concepts and methods of inter/transdisciplinary integration of knowledge, values and interests (approx. 20%)
- Analysis of a selected number of transdisciplinary methods focusing project framing, problem analysis, and impact (approx. 50%)
- Practical application of the methods in a broader project setting (approx. 30%)

This course is recommended for students participating in the Transdisciplinary Case Study 2016.
We will mostly work with readings from the following books:

- Reader with issue-specific articles. E-version is partly available under

The course addresses environmental policies, focusing on new approaches, which are generally summarized as environmental governance. The course also provides a broader introduction to social science concepts to provide students with tools to analyze environmental policy processes and assesses the key features of environmental governance by examining various practical environmental policy examples.

Objective

The objective of this lecture is to demonstrate the cultural foundations of ecological phenomena and the use and management of nature and natural resources as responses of man and society towards their environment. An introspection into the rationale of cultural processes of nature appropriation shall enable students to understand human and social development processes throughout the history of culture and mind.

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### Major in Environmental Systems Policy

#### Theoretical Foundations for Environmental Policy

<table>
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<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<th>Lecturers</th>
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<tr>
<td>701-1561-00L</td>
<td>Environmental Governance</td>
<td>O</td>
<td>3</td>
<td>2G</td>
<td>E. Lieberherr, G. de Buren</td>
</tr>
</tbody>
</table>

**Abstract**

The course addresses environmental policies, focusing on new approaches, which are generally summarized as environmental governance. The course also provides a broader introduction to social science concepts to provide students with tools to analyze environmental policy processes and assesses the key features of environmental governance by examining various practical environmental policy examples.

**Objective**

To understand how an environmental problem may (or not) become a policy and explain political processes, using basic concepts and techniques from political science.

To analyze the evolution as well as the key elements of environmental governance.

To be able to identify the main challenges and opportunities for environmental governance and to critically discuss them with reference to various practical policy examples.

**Content**

Improvements in environmental quality and sustainable management of natural resources cannot be achieved through technical solutions alone. The quality of the environment and the achievement of sustainable development strongly depend on human behavior and specifically the human uses of nature. To influence human behavior, we rely on public policies and other societal rules, which aim to steer the way humans use natural resources and their effects on the environment. Such social restrictions are put in place through government intervention alone. However, this often also involves governance, which includes the interplay between governmental and non-governmental actors, the use of diverse tools such as emission standards or financial incentives to steer actors' behavior and can occur at the local, regional, national or international level.

In this course, we will address both the practical aspects of as well as the scientific debate on environmental governance. The course gives future environmental experts a strong basis to position themselves in the governance debate, which does not preclude government but rather involves a spectrum from government to governance.

Key questions that this course seeks to answer: What are the core characteristics of environmental challenges from a policy perspective? What are key elements of ‘environmental governance’ and how legitimate and effective are these approaches in addressing persistent environmental challenges?

**Lecture notes / Literature**

Lecture slides and additional course material will be provided throughout the semester.

We will mostly work with readings from the following books:


**Prerequisites / notice**

A detailed course schedule will be made available at the beginning of the semester.

We recommend that students have (a) Three-years BSc education of a (technical) university; (b) Successfully completed Bachelor introductory course to environmental policy (Entwicklungen nationaler Umweltpolitik (or equivalent)) and (c) Familiarity with key issues in environmental policy and some fundamental knowledge of one social science or humanities discipline (political science, economics, sociology, history, psychology, philosophy).

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### Literature

Will be announced at the beginning of the course.

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### 701-1553-00L

**Introduction to Cultural Ecology**

This lecture introduces to the basic principles of cultural ecology in a historical and cross-cultural perspective. It presents the most important scientific theories and methods in cultural studies and relates them to selected case studies relevant to environment and ecology. Human and social environment interactions are analysed in various European and Non-European settings.

**Objective**

The objective of this lecture is to demonstrate the cultural foundations of ecological phenomena and the use and management of nature and natural resources as responses of man and society towards their environment. An introspection into the rationale of cultural processes of nature appropriation shall enable students to understand human and social development processes throughout the history of culture and mind.

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### 851-0589-00L

**Technology and Innovation for Development**

Technological change plays a crucial role in efforts to create a more sustainable future. In this context, policy decision makers must design rules that minimize its risks and maximize its benefits for society at large. The course discusses this challenge from an interdisciplinary perspective taking into account legal, economic, historical, development and environmental aspects..

**Objective**

- to recognize the challenges and opportunities of technological change in terms of sustainable development
- to become familiar with policy instruments to promote innovation
- to improve understanding of political decision-making processes in the regulation of science & technology
- improved understanding of the role of science and technology in the context of human and societal development

**Content**

Science and Technology Policy is normally associated with the improvement of national competitiveness; yet, it is also an integral part of effective environmental and development policies.

The course will discuss the challenges and opportunities of technological change in terms of sustainable development and show how public policy on the national and the international level is responding to this change.

In this context, students are to become familiar with the basic principles of political economy and New Growth Theory and how such theories help explain political decisions as well as political outcomes in the area of Science, Technology and Innovation. State interventions are either designed to regulate (e.g. environmental regulations, anti-trust law) or facilitate (e.g. intellectual property rights protection, public investment in R&D and technical education, technology transfer) technological change. This will be illustrated by looking at different industries and different national systems of innovation. Subsequently the positive and negative consequences for society and the natural environment will be discussed from a short-term and a long-term perspective.

**Lecture notes**

Reader with issue-specific articles. E-version is partly available under [http://www.ib.ethz.ch/teaching/material/stpp](http://www.ib.ethz.ch/teaching/material/stpp)
Students have a theoretically and empirically sound understanding of the prospects and limitations of international development aid.

The course gives economic and empirical foundations for a sound understanding of the instruments, prospects and limitations of international development aid. The course teaches multivariate statistical methods such as linear regression, analysis of variance, cluster analysis, factor analysis and logistic regression.


Prerequisites / notice

The 2-hour course (5-7 p.m.) will be held as a series of lectures. The course materials will be available in form of an electronic Reader at the beginning of the semester.

The class will be taught in English. Students will be asked to give a (a) presentation (15 Minutes) or write a review paper based on a article selected from the electronic script, and (b) they will have to pass a written test at the end of the course in order to obtain 3 credit points in the ECTS System. In the final mark (a) will have a weight of 40% and (b) 60%.

851-0626-01L International Aid and Development W 2 credits 2V I. Günter

Does not take place this semester.

Abstract

The course gives economic and empirical foundations for a sound understanding of the instruments, prospects and limitations of international development aid.

Objective

Students have a theoretically and empirically sound understanding of the prospects and limitations of international development aid. Students are able to critically discuss the various aid instruments of bi-and multilateral donors and NGOs.

Content

Introduction to the Determinants of Underdevelopment; History of Aid; Aid and Development: Theories and Empirics; Political Economy of Aid; Experience and Impact of Aid; New Instruments of Aid: e.g. Micro-Finance, Budget-Support; Fair-Trade.

Literature

Articles and book abstracts will be uploaded to a course website.

Modeling and Statistical Analysis

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<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tr>
<td>701-1551-00L</td>
<td>Modeling Environmental Policy Problems</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>A. Patt, T. Schmidt, E. Trutnevyte, O. van Vliet</td>
</tr>
</tbody>
</table>

Abstract

The lectures will introduce students to the principles of quantitative policy analysis, namely the methods to predict and evaluate the social, economic, and environmental effects of alternative strategies to achieve public objectives. A series of graded assignments will give students an opportunity for students to apply these methods to a set of case studies.

Objective

The objectives of this course are to develop the following key skills necessary for policy analysts:
- Identifying the critical quantitative factors that are of importance to policy makers in a range of decision-making situations.
- Developing conceptual models of the types of processes and relationships governing these quantitative factors, including stock-flow dynamics, feedback loops, optimization, sources and effects of uncertainty, and agent coordination problems.
- Develop and program numerical models to simulate the processes and relationships, in order to identify policy problems and the effects of policy interventions.

- Communicate the findings from these simulations and associated analysis in a manner that makes transparent their theoretical foundation, the level and sources of uncertainty, and ultimately their applicability to the policy problem.

The course will proceed through a series of policy analysis and modeling exercises, involving real-world or hypothetical problems. The specific examples around which work will be done will concern the environment, energy, health, and natural hazards management.

<table>
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<tr>
<th>Number</th>
<th>Multivariate Methods</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-1541-00L</td>
<td>One of the lectures 701-1551-00 (autumn semester) OR 752-2110-00 (spring semester) are highly recommended for students in Environmental Sciences with the Major Environmental systems and Policy.</td>
<td>W</td>
<td>3 credits</td>
<td>2V+1U</td>
<td>R. Hansmann</td>
</tr>
</tbody>
</table>

Abstract

The course teaches multivariate statistical methods such as linear regression, analysis of variance, cluster analysis, factor analysis and logistic regression.

Objective

Upon completion of this course, the student should have acquired:
(1) Knowledge on the foundations of several methods of multivariate data analysis, along with the conditions under which their use is appropriate
(2) Skill in the estimation, specification and diagnostics of the various models
(3) Hands-on experience with those methods through the use of appropriate software and actual data sets in the PC lab

Content

The course will begin with an introduction to multivariate methods such as analysis of variance and multiple linear regression, where a metric dependent variable is “explained” by two or more independent variables. Then two methods for structuring complex data, cluster analysis and factor analysis will be covered. In the last part, procedures for the analysis of relationships involving dichotomous or polytomous dependent variables (e.g., the choice of a mode of transportation) will be discussed.
**701-0951-00L GIS - Introduction into Geoinformation Science and Technology**

*Number of participants limited to 80.*

**Abstract**
Theoretical basics and fundamental concepts of Geographic Information Science (GIS) are imparted and subsequently further elaborated with the software ArcGIS. At the end, the students will be able to independently solve basic realistic GIS problems.

**Objective**
Students are able to:
- elucidate the theoretical and conceptional foundations of geographic information systems (GIS)
- independently perform normal GIS work using commercial software and practical examples

**Content**
The course covers the following topics:
- What is GIS? What are spatial data?
- The representation of reality by means of spatial data models: vector, raster, TIN
- The four phases of data modelling: Spatial, conceptual, logical and physical model
- Basic concepts of database management systems and spatial databases
- Possibilities of data collection
- Transition of reference frame
- Spatial Analysis I: query and manipulation of vector data
- Spatial Analysis II: operators and functions with raster data
- Digital elevation models and derived products
- Process modelling with vector and raster data
- Presentation possibilities of spatial data

**Literature**


**Prerequisites / notice**
Aufgrund der Grösse des verfügbaren EDV-Schulungsraumes ist die Teilnehmerzahl auf 80 Studierende beschränkt! Für die Übungen werden die Studierenden auf verschiedene Zeitfenster aufgeteilt. Pro Zeitfenster können maximal 20 Studierende betreut werden.

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**701-1453-00L Ecological Assessment and Evaluation**

**Abstract**
The course provides methods and tools for ecological evaluations dealing with nature conservation or landscape planning. It covers census methods, ecological criteria, indicators, indices and critically appraises objectivity and accuracy of the available methods, tools and procedures. Birds and plants are used as main example guiding through different case studies.

**Objective**
Students will be able to:
1) critically consider biological data books and local, regional, and national inventories;
2) evaluate the validity of ecological criteria used in decision making processes;
3) critically appraise the handling of ecological data and criteria used in the process of evaluation
4) perform an ecological evaluation project from the field survey up to the decision making and planning.

**Lecture notes**
Powerpoint slides are available on the webpage. Additional documents are handed out as copies.

**Literature**
Basic literature and references are listed on the webpage. The course structure changes between lecture parts, seminars and discussions. The didactic atmosphere is intended as working group.

**Prerequisites / notice**
Prerequisites for attending this course are skills and knowledge equivalent to those taught in the following ETH courses:
- Pflanzen- und Vegetationsökologie
- Systematische Botanik
- Raum- und Regionalentwicklung
- Naturschutz und Stadtbioökologie

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**363-0541-00L Systems Dynamics and Complexity**

**Abstract**
Finding solutions: what is complexity, problem solving cycle.
Implementing solutions: project management, critical path method, quality control feedback loop.
Controlling solutions: Vensim software, feedback cycles, control parameters, instabilities, chaos, oscillations and cycles, supply and demand, production functions, investment and consumption
A successful participant of the course is able to:
- understand why most real problems are not simple, but require solution methods that go beyond algorithmic and mathematical approaches
- apply the problem solving cycle as a systematic approach to identify problems and their solutions
- calculate project schedules according to the critical path method
- setup and run systems dynamics models by means of the Vensim software
- identify feedback cycles and reasons for unintended systems behavior
- analyse the stability of nonlinear dynamical systems and apply this to macroeconomic dynamics
The objectives of this course are to develop the following key skills necessary for policy analysts:

1. Finding solutions
2. Implementing solutions
3. Controlling solutions

PART 1 introduces complexity as a system immanent property that cannot be simplified. It introduces the problem solving cycle, used in systems oriented management, as an approach to structure problems and to find solutions.

PART 2 discusses selected problems of project management when implementing solutions. Methods for identifying the critical path of subtasks in a project and for calculating the allocation of resources are provided. The role of quality control as an additional feedback loop and the consequences of small changes are discussed.

PART 3, by far the largest part of the course, provides more insight into the dynamics of existing systems. Examples come from biology (population dynamics), management (inventory modeling, technology adoption, production systems) and economics (supply and demand, investment and consumption). For systems dynamics models, the software program VENSIM is used to evaluate the dynamics. For economic models analytical approaches, also used in nonlinear dynamics and control theory, are applied. These together provide a systematic understanding of the role of feedback loops and instabilities in the dynamics of systems. Emphasis is on oscillating phenomena, such as business cycles and other life cycles.

Weekly self-study tasks are used to apply the concepts introduced in the lectures and to come to grips with the software program VENSIM. The lecture slides are provided as handouts - including notes and literature sources - to registered students only. All material is to be found on the Moodle platform. More details during the first lecture.

Self-study tasks (discussion exercises, Vensim exercises), are provided as home work. Weekly exercise sessions (45 min) are used to discuss selected solutions. Regular participation in the exercises is an efficient way to understand the concepts relevant for the final exam.

### Policy Engagement

#### 701-0967-00L

**Project Development in Renewable Energies**

- **Number**: 701-0967-00L
- **Title**: Project Development in Renewable Energies
- **Type**: W
- **ECTS**: 6 credits
- **Hours**: 2G
- **Lecturers**: R. Rechsteiner, A. Appenzeller, A. Wanner

**Abstract**: Realization of projects in the field of renewable energies, analysis of frame conditions and risks. The students learn basics of renewable energy project realization from acknowledged experts active in the field. They identify the different tasks of various investor types. They develop sample projects in practice within groups.

**Objective**: You become acquainted with the regulative, juridical and economic requirements of project development in renewable energies. You learn to launch and judge projects by exercises in groups. You recognize chances and risks of renewable energy projects.

**Content**: Business models for renewable energy projects. Introduction of market trends, market structure, technical trends and regulation in Switzerland and in the EU internal energy market. Necessary frame conditions for profitable projects. Project development samples and exercises in wind power, hydro power, photovoltaics, due diligence and country assessment. Exact Program in German below.

**Lecture notes**: PPT presentation will be distributed (in German) special frames:

http://www.rechsteiner-basel.ch/index.php?id=27

**Literature**: Longlist: http://www.rechsteiner-basel.ch/uploads/media/edoc_literaturliste_1404.pdf

REN21 Renewables GLOBAL STATUS REPORT http://www.ren21.net

Mit einer grünen Anlage schwarze Zahlen schreiben http://www.rechsteiner-basel.ch/uploads/media/Mit_einer_gruenen_Anlage_schwarze_Zahlen_schreiben.pdf


Bundesamt für Energie: Perspektiven für die Grosswasserkraft in der Schweiz http://www.bfe.admin.ch/lehrmittel.27.0.html

**Prerequisites / notice**: For group exercise and presentation reasons the number of participants is limited at 30 students. For exercises students build learning and presentational groups.

### 701-1543-00L

**Transdisciplinary Methods and Applications**

- **Number**: 701-1543-00L
- **Title**: Transdisciplinary Methods and Applications
- **Type**: W
- **ECTS**: 3 credits
- **Hours**: 2G
- **Lecturers**: P. Krüttli, M. Stauffacher

Data: 06.02.2019 13:00
Abstract

The course deals with transdisciplinary (td) methods, concepts and their applications in the context of case studies and other problem oriented research projects. Td methods are used in research at the science-society interface and when collaborating across scientific disciplines.

Students learn to apply methods within a functional framework. The format of the course is seminar-like, interactive.

Objective

At the end of the course students should:

Know:
- Function, purpose and algorithm of a selected number of transdisciplinary methods

Understand:
- Functional application in case studies and other problem oriented projects

Be able to reflect on:
- Potential, limits, and necessity of transdisciplinary methods

Be prepared for:
- Transdisciplinary Case Study 2016

Content

The lecture is structured as follows:

- Overview of concepts and methods of inter-/transdisciplinary integration of knowledge, values and interests (approx. 20%)
- Analysis of a selected number of transdisciplinary methods focusing problem framing, problem analysis, and impact (approx. 50%)
- Practical application of the methods in a broader project setting (approx. 30%)

Lecture notes

Handouts are provided by the lecturers

Literature

Selected scientific articles and book-chapters

Prerequisites / notice

This course is recommended for students participating in the Transdisciplinary Case Study 2016.

701-1551-00L Sustainability Assessment

The course deals with the concepts and methodologies for the analysis and assessment of sustainable development. A special focus is given to the social dimension and to social justice as a guiding principle of sustainability as well as to trade-offs between the three dimensions of sustainability.

The course is seminar-like, interactive.

Objective

At the end of the course students should

Know:
- core concepts of sustainable development, and;
- the concept of social justice - normatively and empirically - as a core element of social sustainability;
- important empirical methods for the analysis and assessment of local / regional sustainability issues.

Understand and reflect on:
- the challenges of trade-offs between the different goals of sustainable development;
- and the respective impacts on individual and societal decision-making.

Content

The course is structured as follows:

- Overview of rationale, objectives, concepts and origins of sustainable development;
- Importance and application of sustainability in science, politics, society, and economy;
- Sustainable (local / regional) development in different national / international contexts;
- Analysis and evaluation methods of sustainable development with a focus on social justice;
- Tradeoffs in selected examples.

Lecture notes

Handouts.

Literature

Selected scientific articles & book chapters

851-0735-11L Environmental Regulation: Law and Policy

The aim of this course is to make students with a technical scientific background aware of the legal and political context of environmental policy in order to place technical solutions in their regulatory context.

Objective

The aim of this course is to equip students with a legal and regulatory skill-set that allows them to translate their technical knowledge into a policy brief directed at legally trained regulators. More generally, it aims to inform students with a technical scientific background of the legal and political context of environmental policy. The focus of the course will be on international and European issues and regulatory frameworks - where relevant, the position of Switzerland within these international networks will also be discussed.

Content

Topics covered in lectures:

(1) Environmental Regulation
   a. Perspectives
   b. Regulatory Challenges of Environment Problems
   c. Regulatory Tools
   (2) Law: International, European and national laws
   a. International law
   b. European law
   c. National law
   (3) Policy: Case studies

Assessment:

(i) Class participation (25%): Students will be expected to contribute to class discussions and prepare short memos on class readings.
(ii) Exam (75%) consisting of three parts:
   a. Policy brief - a maximum of 2 pages (including graphs and tables);
   b. Background document to the policy brief - this document sets out a more detailed and academic overview of the topic (maximum 8 pages including graphs and tables);
   c. Presentation of the policy brief: presentations can use a maximum of 5 slides and can last 7 minutes.
The course is (inter)related to materials discussed in Politikwissenschaft: Grundlagen (851-0577-00 V), Ressourcen- und Umweltökonomie (751-1551-00 V), Umweltrecht: Konzepte und Rechtsgebiete (851-0705-01 V), Rechtlicher Umgang mit natürlichen Ressourcen (701-0743-01 V), Environmental Governance (701-1651-00 G), Policy and Economics of Ecosystem Services (701-1653-00 G), International Environmental Politics: Part I (851-0594-00 V).

Major in Forest and Landscape Management

Natural Science Foundations

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>701-1613-01L</td>
<td>Advanced Landscape Research</td>
<td>W</td>
<td>5</td>
<td>3G</td>
<td>M. Bürgi, J. Bolliger, U. Gimmi, M. Hunziker</td>
</tr>
</tbody>
</table>

Abstract

This course introduces landscapes as socially perceived, spatially and temporally dynamic entities that are shaped by natural and societal factors. Concepts and qualitative and quantitative methods to study landscapes from an ecological, societal and historical perspective are presented. In a term paper students work on a landscape-related topic of their choice.

Objective

Students will:
- learn about concepts and methods to quantify structural and functional connectivity in landscapes, particularly
- be introduced to the topic of landscape genetics and its benefits and (current) limitations for applied conservation
- learn about concepts and methods in scenario-based land-use change modelling
- approach an understanding of landscape as perceived environment
- learn about concepts of landscape preference and related measurement methods
- understand the role of landscape for human well-being
- be introduced into approaches of actively influencing attitudes and behavior as well as related scientific evaluation
- make use of various historical sources to study landscapes and their dynamics
- interpret landscapes as a result of ecological constraints and anthropogenic activities.

Content

1. Encompassing concepts and approaches
   - European Landscape Convention (ELC)
   - Ecosystem Services (ES): introduction and critical evaluation

   Thematic topics
   2. Ecological approach:
      - green infrastructure (e.g., ecological conservation areas)
      - landscape connectivity
      - landscape genetics and management applications
      - concepts of specific quantitative methods: least cost paths, resistance surfaces, Circuitscape, networks (Conefor), land-use change models, various statistical methods

   3. Social-science approach:
      - principle of landscape as perceived and connoted environment
      - theories on landscape preference and place identity
      - role of landscapes for recreation, health and well-being
      - intervention approaches for influencing attitudes and related behavior
      - methods of investigating the human-landscape relationship and evaluating interventions

   4. Historical approach:
      - land use history of Switzerland (agricultural history, forest and woodland history)
      - historical legacies of land use in landscapes and ecosystems
      - historic-ecological approaches and applications

   5. Land change science:
      - modelling future land-use (CLUE, other scenario-based models)
      - landscape functions and services

Lecture notes

Handouts will be available in the course and for download

Basic Landscape Ecology courses at Bachelor level

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<tr>
<td>701-1615-00L</td>
<td>Advanced Forest Pathology</td>
<td>W</td>
<td>3</td>
<td>2G</td>
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</tbody>
</table>

Abstract

In-depth understanding of concepts, insight into current research and experience with methods of Forest Pathology based on selected pathosystems.

Objective

To know current biological and ecological research on selected diseases, to be able to comment on it and to understand the methods.
To understand the dynamics of selected pathosystems and disturbance processes.
To be able to diagnose tree diseases and injuries.
To know forest protection strategies and to be able to comment on them.

Content

- Stress and disease, virulence and resistance, disease diagnosis and damage assessment, tree disease epidemiology, disease management, ecosystem pathology.
- Systems (examples): Air pollution and trees, endophytic fungi, mycorrhiza, wood decay, conifer-root rot, Phytophthora diseases, chestnut canker and its hypoviruses, urban trees, complex diseases, emerging diseases

Lecture notes

no script, the ppt-presentations and specific articles will be made available among others:


Data: 06.02.2019 13:00 Autumn Semester 2015 Page 1396 of 1434
The course is composed of introductory lectures, practical work, discussions and reading. The participants should have basic knowledge in forest pathology (corresponding to the course 701-0563-00 "Wald- und Baumkrankheiten, see teaching book of H. Butin: Tree diseases and disorders, Oxford University Press 1995. 252 pp.").

**701-1644-00L Mountain Forest Hydrology**

**W 5 credits 3G J. W. Kirchner**

**Abstract**
This course presents a process-based view of the hydrology, biogeochemistry, and geomorphology of mountain streams. Students learn how to integrate process knowledge, data, and models to understand how landscapes regulate the fluxes of water, sediment, nutrients, and pollutants in streams, and to anticipate how streams will respond to changes in land use, atmospheric deposition, and climate.

**Objective**
Students will have a broad understanding of the hydrological, biogeochemical and geomorphological functioning of mountain catchments. They will practice using data models and frame test hypotheses about connections between streams and landscapes.

**Content**
Streams are integrated monitors of the health and functioning of their surrounding landscapes. Streams integrate the fluxes of water, solutes, and sediment from their contributing catchment area; thus they reflect the spatially integrated hydrological, ecophysiological, biogeochemical, and geomorphological processes in the surrounding landscape. At a practical level, there is a significant public interest in managing forested upland landscapes to provide a reliable supply of high-quality surface water and to minimize the risk of catastrophic flooding and debris flows, but the scientific background for such management advice is still evolving.

Using a combination of lectures, field exercises, and data analysis, we explore the processes controlling the delivery of water, solutes, and sediment to streams, and how those processes are affected by changes in land cover, land use, and climate. We review the connections between process understanding and predictive modeling in these complex environmental systems. How well can we understand the processes controlling watershed-scale phenomena, and what uncertainties are unavoidable? What are the relative advantages of top-down versus bottom-up approaches? How much can "black box" analyses reveal about what is happening inside the black box? Conversely, can small-scale, micro-mechanistic approaches be successfully "scaled up" to predict whole-watershed behavior? Practical problems to be considered include the effects of land use, atmospheric deposition, and climate on streamflow, water quality, and sediment dynamics. Illustrated with data from experimental watersheds in North America, Scandinavia, and Europe.

**Lecture notes**
No Script

**Literature**
Handouts will be available as they are developed.

**Foundations of Ecosystem Management**

**701-1631-00L**

**W 5 credits 3G J. Ghazoul, C. Garcia**

**Abstract**
This course introduces the broad variety of conflicts that arise in projects focusing on sustainable management of natural resources. It explores case studies of ecosystem management approaches and considers their practicability, their achievements and possible barriers to their uptake.

**Objective**
Students should be able to

- a) propose appropriate and realistic solutions to ecosystem management problems that integrate ecological, economic and social dimensions across relevant temporal and spatial scales.
- b) identify important stakeholders, their needs and interests, and the main conflicts that exist among them in the context of land and resource management.

**Content**
Traditional management systems focus on extraction of natural resources, and their manipulation and governance. However, traditional management systems have frequently resulted in catastrophic failures such as, for example, the collapse of fish stocks and biodiversity loss. These failures have stimulated the development of alternative ecosystem management approaches that emphasise the functionality of human-dominated systems. Inherent to such approaches are system-wide perspectives and a focus on ecological processes and services, multiple spatial and temporal scales, as well as the need to incorporate diverse stakeholder interests in decision making. Thus, ecosystem management is the science and practice of managing natural resources, biodiversity and ecological processes, to meet multiple demands of society. It can be local, regional or global in scope, and addresses critical issues in developed and developing countries relating to economic and environmental security and sustainability.

This course provides an introduction to ecosystem management, and in particular the importance of integrating ecology into management systems to meet multiple societal demands. The course explores the extent to which human-managed terrestrial systems depend on underlying ecological processes, and the consequences of degradation of these processes for human welfare and environmental well-being. Building upon a theoretical foundation, the course will tackle issues in resource ecology and management, notably forests, agriculture and wild resources within the broader context of sustainability, biodiversity conservation and poverty alleviation or economic development. Case studies from tropical and temperate regions will be used to explore these issues. Dealing with ecological and economic uncertainty, and how this affects decision making, will be discussed. Strategies for conservation and management of terrestrial ecosystems will give consideration to landscape ecology, protected area systems, and community management, paying particular attention to alternative livelihood options and marketing strategies of common pool resources.

**Lecture notes**
No Script

**Literature**

**Multifunctional Forest Management**

**701-1635-00L**

**W 5 credits 2G P. Rotach**

**Abstract**
Multifunctional forest management needs to control natural processes such that they efficiently provide the diverse services and goods for society in a sustainable and close to nature way. This course provides the basic knowledge, the principles and the management tools for successful multifunctional forest management.

**Objective**
Forests in heavily populated areas need to provide diverse ecosystem services and goods for the benefits of society. Multifunctional forest management thus needs to control natural processes such that they efficiently provide these services and goods in a sustainable and close to nature way. This course provides the knowledge, the principles and the management tools for multifunctional forest management.

**Content**
Identification of social needs for the multi-dimensional ecosystem goods and services and their transformation into detailed objectives (profiles) regarding ecosystem functions, structures and processes. Understanding of the important natural processes and their spatial and temporal dynamics in the most important forest ecosystems of Europe. Identification of critical, relevant processes and ecosystem conditions for the different objectives (profiles). Development of management options and assessment of their effects on ecosystem goods and services. Requirements for modern, multifunctional forest management from a Swiss and European perspective - strategies and possible solutions.

**Lecture notes**
No class notes or text books
Lecture presentations are available for download

**Literature**
A bibliography of cited literature will be available
## Decision Making, Policy and Planning

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<td>701-0743-01L</td>
<td>Law and Natural Resources</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>N. Dajcar</td>
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<td>Abstract</td>
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<td>This course teaches the possibilities and limits of the law in order to protect natural resources and landscapes against harm and nuisance. The learning concept is based on the co-ordinated implementation of the relevant legislations. The complexity of the legal situation will be discussed by analysing virtual and real law cases focused on spatial projects and planning. The students know the opportunities and restrictions which are given by the law when using natural resources. They have insights into the complex environmental legal system and their application in concrete cases. The students are able to formulate typical legal questions, to understand the argumentation of courts and to solve simple legal problems with respect to environmental problems.</td>
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<td>Griffel, A.; Raumplanungs- und Baurecht in a nutshell, Dike Verlag, Zürich/St. Gallen 2012</td>
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<td>Keil, Zimmermann: Bundesgerichtliche Rechtssprechung zur Waldgesetzgebung. In URP 2009/3</td>
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<td>Umweltrecht in der Praxis URP (Juristische Fachzeitschrift für Umweltrecht, herausgegeben von der Vereinigung für Umweltrecht (VUR)) Weitere Literaturangaben erfolgen in der ersten Veranstaltung.</td>
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The course addresses environmental policies, focusing on new approaches, which are generally summarized as environmental governance. The course also provides a broader introduction to social science concepts to provide students with tools to analyze environmental policy processes and assesses the key features of environmental governance by examining various practical environmental policy examples.

**Objective**
- To understand how an environmental problem may (or not) become a policy and explain political processes, using basic concepts and techniques from political science.
- To analyze the evolution as well as the key elements of environmental governance.
- To be able to identify the main challenges and opportunities for environmental governance and to critically discuss them with reference to various practical policy examples.

**Content**
- Improvements in environmental quality and sustainable management of natural resources cannot be achieved through technical solutions alone. The quality of the environment and the achievement of sustainable development strongly depend on human behavior and specifically the human uses of nature. To influence human behavior, we rely on public policies and other societal rules, which aim to steer the way humans use natural resources and their effects on the environment. Such steering can take place through government intervention alone. However, this is often also involves governance, which includes the interplay between governmental and non-governmental actors, the use of diverse tools such as emission standards or financial incentives to steer actors' behavior and can occur at the local, regional, national or international level.

In this course, we will address both the practical aspects of as well as the scientific debate on environmental governance. The course gives future environmental experts a strong basis to position themselves in the governance debate, which does not preclude government but rather involves a spectrum from government to governance.

**Key questions that this course seeks to answer:** What are the core characteristics of environmental challenges from a policy perspective? What are key elements of 'environmental governance' and how legitimate and effective are these approaches in addressing persistent environmental challenges?

**Lecture notes / Literature**
- Lecture slides and additional course material will be provided throughout the semester.
- A detailed course schedule will be made available at the beginning of the semester.

We recommend that students have (a) three-years BSc education of a (technical) university; (b) successfully completed Bachelor introductory course to environmental policy (Entwicklungen nationaler Umweltpolitik (or equivalent)) and (c) Familiarity with key issues in environmental policy and some fundamental knowledge of one social science or humanities discipline (political science, economics, sociology, history, psychology, philosophy)
Methods and Tools

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<th>Number</th>
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<tr>
<td>701-1673-00L</td>
<td>Environmental Measurement Laboratory</td>
<td>W</td>
<td>5</td>
<td>4G</td>
<td>P. U. Lehmann Grunder, D. Or</td>
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**Abstract**
Measurements are the sole judge of scientific truth and provide access to unpredictable information, enabling the characterization and monitoring of complex terrestrial systems. Based on lectures and field- and laboratory training the students learn to apply modern methods to determine forest inventory parameters and to measure subsurface properties and processes.

**Objective**
- explain functioning of sensors that are used for characterization of landscapes and terrestrial systems
- select appropriate measurement methods and sampling design to quantify key variables and processes in the subsurface
- deploy sensors in the field and maintain sensor network
- interpret collected laboratory and field data and report main conclusions deduced from measurements

**Content**
1) Measurement Science: Measurement precision and accuracy; sensing footprint, sampling design and sampling errors, uncertainty reduction, spatial and temporal variability, sampling network design and information costs
2) Electronics: Basic introduction to electronic components, voltage and current measurements, A/D converters, power requirements, power consumption calculations, batteries, storage capacity, solar panels
3) Datalogging (Lecture): Data Logging, data transfer, storage, and sensing technologies; basic data logger programming; overview of soil sensor types and sensor calibration; including programming in the laboratory
4) Geophysical methods on Subsurface Characterization: Basic principles of ERT, GPR, and EM;
5) Soil and Groundwater Direct Sampling (Lab): Soil physical sampling; profile characterization, disturbed and undisturbed soil sampling, direct-push geoprobe sampling; soil water content profiles and transects;
6) Electronics Laboratory: Setup and measurement of simple circuits, selection and use of voltage dividers, batteries and solar panels; pressure and temperature measurements;
7) Deployment of monitoring network: Field installation of TDR, temperature probes, tensiometers, data loggers and power supply
8) Geophysics lab: Demonstration and application of geophysical methods in the field;
9 & 10) Forest characterization/ inventory: Principles of LIDAR; structures and features of the tree crowns, size/volume of the leaf area tree positions and diameters at breast height
11 & 12) Ecological Assessment and Soil Monitoring Networks- Data management for long term monitoring networks Tereno, and other critical zone observatories

**Lecture notes**
Lecture material on page:
http://www.step.ethz.ch/education/active-courses/environmental-measurements-laboratory

**Literature**
Lecture material on page:
http://www.step.ethz.ch/education/active-courses/environmental-measurements-laboratory

**Prerequisites / notice**
The details of the schedule will be optimized based on the number of students; some blocks of the course will be offered as well to students of Environmental Engineering

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**Individual Project Work in Analysis of Environmental Data**

**Number** 701-1675-01L

**Type** W

**ECTS** 1 credit

**Hours** 2A

**Lecturers** J. W. Kirchner

**Abstract**
Individual project work as part of the Analysis of Environmental Data module, for students who have previously received credit for 401-6215-00L Using R for Data Analysis and Graphics or 401-0649-00L Applied Statistical Regression.

**Objective**
This individual project course is only available to students enrolled in 701-1675-00G, Analysis of Environmental Data, who have previously received credit for 401-6215-00L Using R for Data Analysis and Graphics or 401-0649-00L Applied Statistical Regression (which are otherwise required as part of the Analysis of Environmental Data module).

This course allows students to do individual projects for up to three credits within the module, because they cannot repeat 401-6215-00L or 401-0649-00L.

**Prerequisites / notice**
Concepts for statistical inference 401-0624-00L Mathematik IV Statistik, or equivalent.

Concurrent enrollment in 701-1675-00G, Analysis of Environmental Data, is required.

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Ecosystem Management

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**Electives**

**Ecosystem Management**

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<tr>
<td>701-1453-00L</td>
<td>Ecological Assessment and Evaluation</td>
<td>W</td>
<td>3</td>
<td>3G</td>
<td>F. Knaus, U. Bollens Hunziker</td>
</tr>
</tbody>
</table>

**Abstract**
The course provides methods and tools for ecological evaluations dealing with nature conservation or landscape planning. It covers census methods, ecological criteria, indicators, indices and critically appraises objectivity and accuracy of the available methods, tools and procedures. Birds and plants are used as main example guiding through different case studies.

**Objective**
Students will be able to:
1) critically consider biological data books and local, regional, and national inventories;
2) evaluate the validity of ecological criteria used in decision making processes;
3) critically appraise the handling of ecological data and criteria used in the process of evaluation
4) perform an ecological evaluation project from the field survey up to the decision making and planning.

**Lecture notes**
Powerpoint slides are available on the webpage. Additional documents are handed out as copies.

**Literature**
Basic literature and references are listed on the webpage.

**Prerequisites / notice**
The course structure changes between lecture parts, seminars and discussions. The didactic atmosphere is intended as working group.

Prerequisites for attending this course are skills and knowledge equivalent to those taught in the following ETH courses:
- Pflanzen- und Vegetationsökologie
- Systematische Botanik
- Raum- und Regionalentwicklung
- Naturschutz und Stadtbiodiversität
The field course in Belize will develop an understanding of, and solutions to, issues of landscape management relevant to conservation and natural resources. Students will be expected to integrate skills in quantitative natural science with social science approaches in real world, and hence highly complex, settings.

**Objective**

To address complex multi-dimensional environmental problems through the application of interdisciplinary and transdisciplinary skills.

**Content**

Day 1: Ecology of the forest habitats

A first impression of the biology of the region will be gained through an exploration of the different forest formations, ranging from mesic forests to dry evergreen, dry deciduous, and mangrove forests. The learning objective will be to understand the underlying environmental conditions that determine forest formations within the relatively small area of Shipstern Reserve. This includes linking climate, soil, and geology with community processes to understand the mosaic of habitat types, their distribution, form, and function.

Day 2: The ecology of natural resources

Students will begin to explore how people use forest resources, ranging from timber, to a variety of non-timber forest products, and animals for hunting. This will lead to an evaluation of threats to species and habitats, and hence set the scene for subsequent work.

Day 3: Familiarisation with landscape scale dynamics

We will explore the land uses in the landscape in the vicinity of Shipstern and Freshwater creeks. This will encompass a range of land uses, including small scale to large scale agriculture, extractive forest reserves, and protected forests. In the process the students will gain a better understanding of the pressures on land and forests, and a chance to meet some of the local stakeholders involved in land use transformations.

Days 4 & 5: Problem conceptualisation

Working with reserve managers and local stakeholders the students will develop a conceptual understanding of the key problems in the region, including the underlying drivers of change.

Day 6-9: Integrative analysis

Students, working in small groups, will analyse selected natural resource problems in greater depth. Options include biodiversity responses to habitat fragmentation, conservation management of mangrove and coral reef systems, restoration ecology, community forest management, and tourism development, among others. Students will have opportunities to collect original data across natural and social sciences, and will use different modelling approaches to explore future development trajectories.

Day 10-11: Synthesis and presentation of results

Research will be synthesised and presented to the local management community of Shipstern and Freshwater Creek reserves. The course will conclude with an afternoon allocated to discussion and debriefing, including an appraisal of the challenges of addressing natural resource management issues in complex socioecological systems, and the lessons learned.

### Decision Making, Policy and Planning

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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>851-0735-11L</td>
<td>Environmental Regulation: Law and Policy</td>
<td>W</td>
<td>3</td>
<td>1S</td>
<td>J. van Zeben</td>
</tr>
</tbody>
</table>

**Abstract**

The aim of this course is to equip students with a legal and political skill-set that allows them to translate their technical knowledge into a policy brief directed at legally trained regulators. More generally, it aims to inform students with a technical scientific background of the legal and political context of environmental policy. The focus of the course will be on international and European issues and regulatory frameworks - where relevant, the position of Switzerland within these international networks will also be discussed.

**Objective**

The aim of this course is to make students with a technical scientific background aware of the legal and political context of environmental policy in order to place technical solutions in their regulatory context.

**Content**

Topics covered in lectures:

1. Environmental Regulation
   a. Perspectives
   b. Regulatory Challenges of Environment Problems
   c. Regulatory Tools
2. Law: International, European and national laws
   a. International law
   b. European law
   c. National law
3. Policy: Case studies

**Assessment:**

1. Class participation (25%): Students will be expected to contribute to class discussions and prepare short memos on class readings.
2. Exam (75%) consisting of three parts:
   a. Policy brief - a maximum of 2 pages (including graphs and tables);
   b. Background document to the policy brief - this document sets out a more detailed and academic overview of the topic (maximum 8 pages including graphs and tables);
   c. Presentation of the policy brief: presentations can use a maximum of 5 slides and can last 7 minutes.

**Teaching notes**

The course is taught as a small interactive seminar and significant participation is expected from the students. Participation will be capped at 15 in order to maintain the interactive nature of the classes. All classes, readings, and assignments, are in English.

During the second week of the teaching period, students will have individual 30-minute meetings with the lecturer to discuss their project.

An electronic copy of relevant readings will be provided to the students at no cost before the start of the lectures.

No specific pre-existing legal knowledge is required, however all students must have successfully completed Grundzüge des Rechts (851-0708-00 V) or an equivalent course.

The course is (inter)related to materials discussed in Politikwissenschaft: Grundlagen (851-0577-00 V), Ressourcen- und Umweltökonomie (751-1551-00 V), Umweltrecht: Konzepte und Rechtsgebiete (851-0705-01 V), Rechtlicher Umgang mit natürlichen Ressourcen (701-0743-01 V), Environmental Governance (701-1651-00 G), Policy and Economics of Ecosystem Services (701-1653-00 G), International Environmental Politics: Part I (851-0594-00 V).

### Methods and Tools

<table>
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<tr>
<th>Number</th>
<th>Title</th>
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</table>

Data: 06.02.2019 13:00  Autumn Semester 2015  Page 1400 of 1434
Students should have a good understanding of the concepts of general sampling theory in a modern framework. They should also master
- Overview and history of dendrochronology
- Age and size structures, forest dynamics (regeneration, growth, competition, mortality)
- Disturbance ecology (fire, insects, blowdown)
- Application of tree-ring research in practice and in interdisciplinary research projects
- Field and lab day (date for one entire day or two half days will be searched together with the students in the beginning of the semester): discussion of different dendroecological questions in the forest; sampling of trees; insight into different tree-ring projects in the lab (Swiss National Forest Inventory).

A simulation software will be used throughout the lectures to illustrate the theoretical developments. Upon request a half day field demonstration can be organized at the WSL outside the lecture time. A repetitorium for the exam is also offered.

The course gives a general introduction into the geoprocessing framework of ArcGIS and shows how to use python scripts to access and
- get hands-on experience based on the demonstration of wood (increment cores, stem discs, wedges), sampling in the field, and measuring and dating of tree rings in the tree-ring lab.
- solve R-based exercises (R tutorial will be provided) and answer questions in Moodle.
- work out an independent research question related to a dendroecological topic and write a short literature review based on scientific papers.

The lecture notes and further documents (papers, software) can also be downloaded from Moodle (https://moodle-app2.let.ethz.ch) following registration for the course.

The class language is German and English, on request English only.

The lecture notes, exercises and worked out solutions to them will be provided.

Lecture notes
Lecture notes (in English) will be handed out in the class.

Literature


Sampling techniques for forest inventories. Daniel Mandallaz, Chapman and Hall. A free electronic copy of the book is also available. A PDF file containing parts of the book will be mailed to the participants


Sampling methods, remote sensing and GIS multisource forest inventory


Sampling techniques for forest inventories. Daniel Mandallaz, Chapman and Hall. A free electronic copy of the book is also available. A PDF file containing parts of the book will be mailed to the participants


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Sampling methods, remote sensing and GIS multisource forest inventory


The module “public health concepts” offers an introduction to key principles of public health. Students get acquainted with the concepts and methods of epidemiology. Students also learn to use epidemiological data for prevention and health promotion purposes. Public health concepts and intervention strategies are presented, using examples from infectious and chronic diseases.

At the end of this module students are able:

- to interpret the results of epidemiological studies
- to critically assess scientific literature
- to know the definition, dimensions and determinants of health
- to plan public health interventions and health promotion projects

Content

Concepts of descriptive and analytical epidemiology, study designs, measures of effect, confounding and bias, screening, surveillance, definition of health and health promotion, health dimensions and health determinants, prevention strategies, public health interventions, public health action cycle, epidemiology and prevention of infectious and chronic diseases (HIV, Tuberculosis, Obesity, Public health nutrition).

Lecture notes

Handouts are provided to students in the classroom.

References:
- Nonparametric Simple Regression, by J. Fox, Sage Publications.
- Kernel Smoothing, by M.P. Wand and M.C. Jones, Chapman and Hall.
- Density Estimation, by B.W. Silverman, Chapman and Hall.
- Statistical Inference, by S.D. Silvey, Chapman & Hall.
- Density Estimation, by B.W. Silverman, Chapman and Hall.
- Kernel Smoothing, by M.P. Wand and M.C. Jones, Chapman and Hall.
- Smoothing and Nonparametric Regression with Examples, by S. Beran-Ghosh.
Prerequisites / notice

401-0629-00L Applied Biostatistics W 4 credits 3G M. Müller

Abstract
Principles and main methods in biostatistics with emphasis on practical aspects. Experimental and observational studies. Regression and analysis of variance. Introduction into survival analysis.

Objective
Getting an overview of the problems and statistical methods used in health sciences. Practise in using the software R to analyze data and interpreting the sufts.

Content

Lecture notes
see teaching document repository

Literature


Prerequisites / notice
The statistical package R will be used in the exercises.

If you are unfamiliar with R, I highly recommend the online R course etutoR.

Infectious Diseases

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-0283-01L</td>
<td>Seminar in Evolutionary Ecology of Infectious Diseases</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>D. Croll, S. Bonhoeffer, R. R. Regös</td>
</tr>
</tbody>
</table>

Abstract
Students of this course will discuss current topics from the field of infectious disease biology. From a list of publications, each student chooses some themes that he/she is going to explain and discuss with all other participants and under supervision. The actual topics will change from year to year corresponding to the progress and new results occurring in the field.

Objective
This is an advanced course that will require significant student participation. Students will learn how to evaluate and present scientific literature and trace the development of ideas related to understanding the ecology and the etiologic biology of infectious diseases.

Content
A core set of ~10 classic publications encompassing unifying themes in infectious disease ecology and evolution, such as virulence, resistance, metapopulations, networks, and competition will be presented and discussed. Pathogens will include bacteria, viruses and fungi. Hosts will include animals, plants and humans.

Lecture notes
Publications and class notes can be downloaded from a web page announced during the lecture.

Literature
Papers will be assigned and downloaded from a web page announced during the lecture.

551-0223-00L Immunology III W 4 credits 2V M. Kopf, M. Bachmann, J. Kisielow, A. Lanzavecchia, S. R. Leibundgut, A. Oxenius, R. Spörri

Abstract
This course provides a detailed understanding of
- development of T and B cells
- the dynamics of a immune response during acute and chronic infection
- mechanisms of immunopathology
- modern vaccination strategies

Key experimental results will be shown to help understanding how immunological text book knowledge has evolved.

Objective
Obtain a detailed understanding of
- the development, activation, and differentiation of different types of T cells and their effector mechanisms during immune responses,
- Recognition of pathogenic microorganisms by the host cells and molecular events thereafter,
- events and signals for maturation of naive B cells to antibody producing plasma cells and memory B cells.
- Optimization of B cell responses by intelligent design of new vaccines

Content
- Development and selection of CD4 and CD8 T cells, natural killer T cells (NKT), and regulatory T cells (Treg)
- NK T cells and responses to lipid antigens
- Differentiation, characterization, and function of CD4 T cell subsets such as Th1, Th2, and Th17
- Overview of cytokines and their effector function
- Co-stimulation (signals 1-3)
- Dendritic cells
- Evolution of the "Danger" concept
- Cells expressing Pattern Recognition Receptors and their downstream signals
- T cell function and dysfunction in acute and chronic viral infections

Literature
Documents of the lectures are available for download at: https://moodle-app2.let.ethz.ch/course/view.php?id=998

Prerequisites / notice
Immunology I and II

551-1171-00L Immunology: from Milestones to Current Topics W 4 credits 2S B. Ludewig, M. Kopf, A. Oxenius, University lecturers

Abstract
Milestones in Immunology: on old concepts and modern experiments

Objective
The course will cover six grand topics in immunology (B cells, innate immunity, antigen presentation, tumor immunity, thymus and T cells, cytotoxic T cells and NK cells) and for each grand topic four hours will be allocated. During the first double hour, historical milestone papers will be presented by the supervisor providing an overview on the development of the conceptual framework and critical technological advances. The students will also prepare themselves for this double lecture by reading the historical milestone papers and contributing to the discussion. In the following lecture up to four students will present each a recent high impact research paper which emerged from the landmark achievements of the previously discussed milestone concepts.

Content
Milestones and current topics of innate immunity, antigen presentatin, B cells, thymus and T cells, cytotoxic T cells and NK cells, and tumor immunity.

Literature
Original and review articles will be distributed by the lecturer.

752-4009-00L Molecular Biology of Foodborne Pathogens W 3 credits 2V M. Loessner, M. Schuppler

Abstract
The course offers detailed information on selected foodborne pathogens and toxin producing organisms; the focus lies on relevant molecular biological aspects of pathogenicity and virulence, as well as on the occurrence and survival of these organisms in foods.

Objective
Detailed and current status of research and insights into the molecular basis of foodborne diseases, with focus on interactions of the microorganism or the toxins they produce with the human system. Understanding the relationship between specific types of food and the associated pathogens and microbial risks.
Content
Molecular biology of infectious foodborne pathogens (Listeria, Vibrio, E. coli, Campylobacter, etc.) and toxin-producing organisms (Bacillus, Clostridium, Staphylococcus). How and under which conditions will toxins and virulence factors be produced, and how do they work? How is the interaction between the human host and the microbial pathogen? What are the roles of food and the environment? What can be done to interfere with the potential risks?

Lecture notes
Electronic copies of the presentation slides (PDF) will be made available for download to registered students.

Literature
Recommendations will be given in the first lecture.

Prerequisites / notice
Lectures (2 hours) will be held as a single session of approximately 60+ minutes (10:15 until 11:15 h), with no break.

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#### Nutrition and Health

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<tr>
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<tbody>
<tr>
<td>752-2122-00L</td>
<td>Food and Consumer Behaviour</td>
<td>W</td>
<td>2</td>
<td>2V</td>
<td>M. Siegrist, C. Hartmann, V. Visschers</td>
</tr>
<tr>
<td>752-5103-00L</td>
<td>Functional Microorganisms in Foods</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>C. Lacroix, T. de Wouters, L. Meile, C. Schwab</td>
</tr>
<tr>
<td>752-6101-00L</td>
<td>Nutrition and Chronic Disease (HS)</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>M. B. Zimmermann</td>
</tr>
<tr>
<td>752-6402-00L</td>
<td>Nutrigenomics</td>
<td>W</td>
<td>3</td>
<td>2V</td>
<td>G. Vergères</td>
</tr>
</tbody>
</table>

Abstract
- To understand the principles, roles and mechanisms of microorganisms with metabolic activities of high potential for application in traditional and functional foods utilization with high quality, safety and potential health benefits for the consumers. Selected topics will be used to illustrate the rapid development but also limits of basic knowledge for applications of functional microorganisms to produce food with high quality, safety, and potential health benefits for consumers.

Objective
- To examine and understand the protective effect of foods and food ingredients in the maintenance of health and the prevention of chronic disease, as well as the progression of complications of the chronic diseases.

Literature
Copy of the power point slides from lectures will be provided.

Prerequisites / notice
- No compulsory prerequisites, but prior completion of Human Nutrition I + II (Humanernährung I+II) is strongly advised.

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The script is composed of circa 450 slides (ca 18 slides/lecture) organized in 9 modules

Module A
From biochemical nutrition research to nutrigenomics

Module B
Nutritional genomics

Module C
Nutrigenetics

Module D
Nutri-epigenomics

Module E
Transcriptomics in nutrition research

Module F
Proteomics in nutrition research

Module G
Metabolomics in nutrition research

Module H
Nutritional systems biology

Module I
Individualized nutrition - opportunities and challenges

No extra reading requested. Most slides in the lecture are referenced with web addresses.

Basic training in biochemistry, molecular biology, physiology, and human nutrition. Interest in interdisciplinary sciences linking molecular biology to human health. Interest in the application of analytical laboratory methods to the understanding of human biology, in particular nutrition.

### Environment and Health

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<tr>
<td>701-1341-00L</td>
<td>Water Resources and Drinking Water</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>S. Hug, M. Berg, F. Hammes, U. von Gunten</td>
</tr>
</tbody>
</table>

The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Natural processes, anthropogenic pollution, legislation of groundwater and surface water and of drinking water as well as water treatment will be discussed for industrialized and developing countries.

The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality.

Various water resources, particularly groundwater and surface water, are discussed as part of the natural water cycle influenced by anthropogenic activities such as agriculture, industry, urban water systems. Furthermore legislation related to water resources and drinking water will be discussed. The lecture is focused on industrialized countries, but also addresses global water issues and problems in the developing world. Finally unit processes for drinking water treatment (filtration, adsorption, oxidation, disinfection etc.) will be presented and discussed.

Handouts will be distributed

### Term Paper

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Writing of a review paper of scientific quality on a topic in the domain of Human Health, Nutrition and Environment based on critical evaluation of scientific literature.

Topics are offered in the domains of the major ‘Human Health, Nutrition and Environment’ covering ‘Public Health’, ‘Infectious Diseases’, ‘Nutrition and Health’ and ‘Environment and Health’.

Guidelines will be handed out in the beginning.

### Minors

#### Minor in Sustainable Energy Use

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<tr>
<td>701-0967-00L</td>
<td>Project Development in Renewable Energies</td>
<td>W</td>
<td>2 credits</td>
<td>2G</td>
<td>R. Reochsteiner, A. Appenzeller, A. Wanner</td>
</tr>
</tbody>
</table>

Realization of projects in the field of renewable energies, analysis of frame conditions and risks. The students learn basics of renewable energy project realization from acknowledged experts active in the field. They identify the different tasks of various investor types. They develop sample projects in practice within groups.

You become acquainted with the regulative, juridical and economic requirements of project development in renewable energies.

You learn to launch and judge projects by exercises in groups.

You recognize chances and risks of renewable energy projects.

Guidelines will be handed out in the beginning.

Literature will be identified based on the topic chosen.
The reduction of CO2 emissions is the only option for keeping future climate change within reasonable bounds. In this course, we will discuss a portfolio of options involving the alteration of natural carbon sinks and carbon sequestration. The course includes introductory lectures, presentations from guest speakers from industry and the public sector, and final presentations by the students.

The lecture's target is the knowledge of the physical basics and technical components of relevant systems for an efficient and sustainable energy supply and due diligence and country assessment. Exact Program in German below

http://www.rechsteiner-basel.ch/index.php?id=27

PPT presentation will be distributed (in German)

http://www.rechsteiner-basel.ch/Lehrmittel.27.0.html

Carbon Mitigation 2 credits 4G A. Gruber

Energy- and Climate Systems I 2 credits 4G A. Schüeter

Power Market I - Portfolio and Risk Management 6 credits 4G D. Reichelt, G. A. Koeppel

Bundesamt für Energie: Perspektiven für die Grosswasserkraft in der Schweiz

http://www.admin.ch/bae/2013/1202/01600013_de.html

Energy- and Climate Systems I

The lecture contains concepts, physics and components of building technologies for the efficient and sustainable energy supply and climatisation of buildings and their interaction with architecture and urban design. Using calculations, students learn to acquire relevant numbers and assess the performance of solutions.

Objective

The lecture’s target is the knowledge of the physical basics and technical components of relevant systems for an efficient and sustainable climatisation and maintenance of buildings and their interdependency with the architectonic design and construction. By learning rough calculation methods, determination of relevant dimensions and identification of important parameters become possible. Hence, adequate approaches for the own design can be chosen, reviewed quantitatively and qualitatively and set in with a synergistic effect.

Content

1. Introduction
2. Thermal systems
3. Ventilation
4. Daylight and artificial lighting

EK I lectures focus on technical components in use as well as their rough calculation methods and their integration into design and construction.

Lecture notes

The Slides from the lecture serve as lecture notes and are available as download.

Power Market I - Portfolio and Risk Management

Portfolio and risk management in the electrical power business, Pan-European power market and trading, futures and forward contracts, hedging, options and derivatives, performance indicators for the risk management, modelling of physical assets, cross-border trading, ancillary services, balancing market, Swiss market model, strategy development and positioning.

Objective

The seminar is designed for students and researchers (MA, PhD, PostDoc) who use inter- and transdisciplinary elements in their projects. It addresses the challenges of this research: How to integrate disciplines? How (and in what role) to include societal actors? How to bring results to fruition? We discuss these questions based on case studies and theories and on the participant's projects. The participants understand the specific challenges of inter- and transdisciplinary research in general and in the context of sustainable development in particular. They know methods and concepts to address these challenges and apply them to their research projects.

The seminar is specifically suitable for PhD or PostDoc researchers. It is open to master students (minor "global change and sustainability") and further interested people, who preferably are preparing, or working on, a project/thesis.
The objectives of this course are to (1) gain an overview of relevant questions in the area of international environmental politics from a methodologically sophisticated way; (2) gain an overview of important global and regional environmental problems; (3) gain an overview of sustainable development in global and regional contexts.

Content

Particularly suitable for students of D-ITET, D-USYS

Objective

At the end of the course students should:

Know:
- core concepts of sustainable development, and;
- the concept of social justice - normatively and empirically - as a core element of social sustainability;
- important empirical methods for the analysis and assessment of local / regional sustainability issues.

Understand and reflect on:
- the challenges of trade-offs between the different goals of sustainable development;
- and the respective impacts on individual and societal decision-making.

The course is structured as follows:

- Overview of rationale, objectives, concepts and origins of sustainable development;
- Importance and application of sustainability in science, politics, society, and economy;
- Sustainable (local / regional) development in different national / international contexts;
- Analysis and evaluation methods of sustainable development with a focus on social justice;
- Tradeoffs in selected examples.

Sustainability Assessment

The course deals with the concepts and methodologies for the analysis and assessment of sustainable development. A special focus is given to the social dimension and to social justice as a guiding principle of sustainability as well as to trade-offs between the three dimensions of sustainability.

At the end of the course students should:

Know:
- core concepts of sustainable development, and;
- the concept of social justice - normatively and empirically - as a core element of social sustainability;
- important empirical methods for the analysis and assessment of local / regional sustainability issues.

Understand and reflect on:
- the challenges of trade-offs between the different goals of sustainable development;
- and the respective impacts on individual and societal decision-making.

The course is structured as follows:

- Overview of rationale, objectives, concepts and origins of sustainable development;
- Importance and application of sustainability in science, politics, society, and economy;
- Sustainable (local / regional) development in different national / international contexts;
- Analysis and evaluation methods of sustainable development with a focus on social justice;
- Tradeoffs in selected examples.

Lecture notes
Handouts.

Literature
Selected scientific articles & book chapters

International Environmental Politics

This course focuses on the conditions under which cooperation in international environmental politics emerges and the conditions under which such cooperation and the respective public policies are effective and/or efficient.

At the end of the course students should:

Know:
- core concepts of sustainable development, and;
- the concept of social justice - normatively and empirically - as a core element of social sustainability;
- important empirical methods for the analysis and assessment of local / regional sustainability issues.

Understand and reflect on:
- the challenges of trade-offs between the different goals of sustainable development;
- and the respective impacts on individual and societal decision-making.

Content

This course deals with the concepts and methodologies for the analysis and assessment of sustainable development. A special focus is given to the social dimension and to social justice as a guiding principle of sustainability as well as to trade-offs between the three dimensions of sustainability.

At the end of the course students should:

Know:
- core concepts of sustainable development, and;
- the concept of social justice - normatively and empirically - as a core element of social sustainability;
- important empirical methods for the analysis and assessment of local / regional sustainability issues.

Understand and reflect on:
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- Analysis and evaluation methods of sustainable development with a focus on social justice;
- Tradeoffs in selected examples.

Lecture notes
Handouts.

Literature
Selected scientific articles & book chapters

Minor in Transdisciplinarity for Sustainable Development

Transdisciplinary Methods and Applications

The course deals with transdisciplinary (td) methods, concepts and their applications in the context of case studies and other problem oriented research projects. Td methods are used in research at the science-society interface and when collaborating across scientific disciplines.

At the end of the course students should:

Know:
- Function, purpose and algorithm of a selected number of transdisciplinary methods

Understand:
- Functional application in case studies and other problem oriented projects

Be able to reflect on:
- Potential, limits, and necessity of transdisciplinary methods

Be prepared for:
- Transdisciplinary Case Study 2016
The lecture is structured as follows:

- Overview of concepts and methods of inter/transdisciplinary integration of knowledge, values and interests (approx. 20%)
- Analysis of a selected number of transdisciplinary methods focusing problem framing, problem analysis, and impact (approx. 50%)
- Practical application of the methods in a broader project setting (approx. 30%)

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<tr>
<td>101-0577-00L</td>
<td>An Introduction to Sustainable Development in the Built Environment</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>G. Habert</td>
</tr>
<tr>
<td>701-1551-00L</td>
<td>Sustainability Assessment</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>P. Krüttli, C. E. Pohl</td>
</tr>
</tbody>
</table>

Objective
At the end of the course students should

Know:
- core concepts of sustainable development, and;
- the concept of social justice - normatively and empirically - as a core element of social sustainability;
- important empirical methods for the analysis and assessment of local / regional sustainability issues.

Understand and reflect on:
- the challenges of trade-offs between the different goals of sustainable development;
- and the respective impacts on individual and societal decision-making.

Content
The course is structured as follows:
- Overview of rational, objectives, concepts and origins of sustainable development;
- Importance and application of sustainability in science, politics, society, and economy;
- Sustainable (local / regional) development in different national / international contexts;
- Analysis and evaluation methods of sustainable development with a focus on social justice;
- Tradeoffs in selected examples.

Lecture notes
Handouts.

Literature
Selected scientific articles & book-chapters

Minor in Life Cycle Assessment

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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</thead>
<tbody>
<tr>
<td>102-0317-00L</td>
<td>Advanced Environmental Assessments</td>
<td>W</td>
<td>3</td>
<td>2G</td>
<td>S. Hellweg, R. Frischknecht</td>
</tr>
</tbody>
</table>

Abstract
This course deepens students' knowledge of the environmental assessment methodologies and their various applications.

Objective
This course has the aim of deepening students' knowledge of the environmental assessment methodologies and their various applications.

- Ability to judge the scientific quality and reliability of environmental assessment studies, the appropriateness of inventory data and modelling, and the adequacy of life cycle impact assessment models and factors
- Knowledge about the current state of the scientific discussion and new research developments
- Ability to properly plan, conduct and interpret environmental assessment studies
- Knowledge of how to use LCA as a decision support tool for companies, public authorities, and consumers
- Inventory developments, transparency, data quality, data completeness, and data exchange formats
- Allocation (multiooutput processes and recycling)
- Hybrid LCA methods.
- Consequential and marginal analysis
- Recent development in impact assessment
- Spatial differentiation in Life Cycle Assessment
- Workplace and indoor exposure in Risk and Life Cycle Assessment
- Uncertainty analysis
- Subjectivity in environmental assessments
- Multicriteria analysis
- Case Studies

Lecture notes
No script. Lecture slides and literature will be made available.

Literature
Literature will be made available.

Prerequisites / notice
Basic knowledge of environmental assessment tools is a prerequisite for this class. Students that have not done classwork in this topic before are required to read an appropriate textbook before or at the beginning of this course (e.g. Baumann&Tillman, The Hitch Hiker's Guide to LCA: An Orientation in Life Cycle Assessment Methodology and Applications, Studentlitteratur, Lund, 2004).

- Tradeoffs in selected examples.
- Knowledge of how to use LCA as a decision support tool for companies, public authorities, and consumers

102-0317-01L Advanced Environmental Assessment (Computer Lab and Exercises) | W    | 3    | 2U+2P| S. Pfister               |

- Allocation (multiooutput processes and recycling)
- Hybrid LCA methods.
- Consequential and marginal analysis
- Recent development in impact assessment
- Spatial differentiation in Life Cycle Assessment
- Workplace and indoor exposure in Risk and Life Cycle Assessment
- Uncertainty analysis
- Subjectivity in environmental assessments
- Multicriteria analysis
- Case Studies

Abstract
Technical systems are investigated in projects with numerical modeling. The students learn how to answer given questions with target oriented methodologies using various software programs for environmental assessment.

Objective
Become acquainted with various software programs for environmental assessment including Life Cycle Assessment, Environmental Risk Assessment, Probabilistic Modeling, Material Flow Analysis.

102-0577-00L An Introduction to Sustainable Development in the Built Environment

This course was offered as "Sustainable Construction" until HS14.
This year the UN Conference in Paris will shape future world objectives to tackle climate change. This course provides an introduction to the notion of sustainable development when applied to our built environment.

In order to address current challenges of climate change mitigation and resource depletion, students will learn a holistic approach of sustainable development. Ecological, economical and social constraints will be presented and students will learn about methods for argumentation and tools for assessment (i.e. life cycle assessment).

For this purpose an overview of sustainable development is presented with an introduction to the history of sustainability and its today definition as well as the role of cities, urbanisation and material resources (i.e. energy, construction material) in social economic and environmentally aspects.

The course aims to promote an integral view and understanding of sustainability and describing different spheres (social/cultural, ecological, economical, and institutional) that influence our built environment.

Students will acquire critical knowledge and understand the role of involved stakeholders, their motivations and constraints, learn how to evaluate challenges, identify deficits and define strategies to promote a more sustainable construction.

After the course students should be able to define the relevance of specific local, regional or territorial aspects to achieve coherent and applicable solutions toward sustainable development.

The course offers an environmental, socio-economic and socio-technical perspective focussing on buildings, cities and their transition to resilience with sustainable development. Students will learn on theory and application of current scientific pathways towards sustainable development.

529-0041-00L Analytical Chemistry I (3. Semester)

- Overview on the history and emergence of sustainable development
- Overview on the current understanding and definition of sustainable development
- Case Study 1: Sustainable construction, the role of construction industry (national/international)
- Case Study 2: Cities, forms of settlements
- Case Study 3: Material resources, scenarios, energy, construction materials, urban metabolism
- Case Study 4: Buildings, heating/cooling, consumers, producers and other stakeholder, cooperations
- Method 1: Life cycle assessment (planning, construction, operation/use, deconstruction)
- Method 2: Economics for sustainable construction
- Method 3: Construction, flexibility, modularity
- Synthesis 1: Climate Change mitigation and adaptation in cities
- Synthesis 2: Transition to sustainable development

Exercises are an integral part of the lecture.

Information about relevant literature will be available in the lecture & in the lecture notes.

Prerequisites / notice
- Course registration is necessary
- Advanced knowledge in chemical analysis and methods
- Participation in seminars and study groups

Number Title Type ECTS Hours Lecturers
529-0041-00L Analytical Chemistry I (3. Semester) W 7 credits 3G R. Zenobi, M. Badertscher, B. Hattendorf, P. Martinez-Lozano, Sinues
529-0051-00L Analytical Chemistry II (4. Semester) W 6 credits 3G R. Zenobi, M. Badertscher, B. Hattendorf, P. Martinez-Lozano, Sinues
529-0058-00L Analytical Chemistry II (4. Semester) W 6 credits 3G R. Zenobi, M. Badertscher, B. Hattendorf, P. Martinez-Lozano, Sinues

529-0043-00L Isotopic and Organic Tracers in Biogeochemistry W 3 credits 2G

- Overview on the current understanding and definition of sustainable development
- Method 1: Life cycle assessment (planning, construction, operation/use, deconstruction)
- Method 2: Economics for sustainable construction
- Method 3: Construction, flexibility, modularity
- Synthesis 1: Climate Change mitigation and adaptation in cities
- Synthesis 2: Transition to sustainable development

Exercises are an integral part of the lecture.

Information about relevant literature will be available in the lecture & in the lecture notes.

Prerequisites / notice
- Course registration is necessary
- Advanced knowledge in chemical analysis and methods
- Participation in seminars and study groups

Number Title Type ECTS Hours Lecturers
701-1313-00L Isotopic and Organic Tracers in Biogeochemistry W 3 credits 2G R. Kipfer, C. Schubert
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. The course aims at understanding the fractionation of stable isotopes in biogeochemical processes. Students learn to know the origin and decay modes of relevant radiogenic isotopes. They discover the spectrum of possible geochemical tracers and biomarkers, their potential and limitations and get familiar with important applications.

**Content**
- Geogenic and cosmogenic radionuclides (sources, decay chains); stable isotopes in biogeochemistry (natural abundance, fractionation);
- geochemical tracers for processes such as erosion, productivity, redox fronts; biomarkers for specific microbial processes.

**Lecture notes / Literature**
Handouts will be provided for every chapter.

**Prerequisites / notice**
A list of relevant books and papers will be provided.

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**Abstract**
The course addresses major biogeochemical processes that drive the cycling of different groups of trace elements (heavy metals, redox-sensitive trace elements, chalcophile elements) in the environment, and the chemical methods that are used to study the behavior of these elements in the geosphere.

**Objective**
The students gain a detailed understanding of the sources and the cycling of trace elements in the terrestrial and aquatic environment. The interaction of environmentally important trace elements with abiotic and biotic geosphere components as well as their abiotically and biotically driven transformations will be discussed. Relevant methods/techniques to study these processes will be presented.

**Content**
The course deals in-depth with the major biogeochemical processes controlling the cycling of different groups of trace elements (heavy metals, redox-sensitive and chalcophile elements) in the environment. Sources and cycling of trace elements as related to interactions with abiotic and biotic geosphere components, and abiotically and biotically driven transformations will be discussed. The techniques most commonly used to study these processes will be presented as well.

**Lecture notes / Literature**
Selected handouts (lecture notes, literature, exercises) will be distributed during the course.

**Prerequisites / notice**
Students are expected to be familiar with the concepts of aquatic or soil chemistry covered in the respective classes at the bachelor level.

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**Abstract**
The course introduces the scientific concepts and typical applications of tracers in biogeochemistry. The course covers stable and radioactive isotopes, geochemical tracers and biomarkers and their application in biogeochemical processes as well as regional and global cycles. The course provides essential theoretical background for the lab course "Isotopic and Organic Tracers Laboratory".

**Objective**
The course aims at understanding the fractionation of stable isotopes in biogeochemical processes. Students learn to know the origin and decay modes of relevant radiogenic isotopes. They discover the spectrum of possible geochemical tracers and biomarkers, their potential and limitations and get familiar with important applications.

**Content**
- stable isotopes in biogeochemistry (natural abundance, fractionation);
- geochemical tracers for processes such as erosion, productivity, redox fronts; biomarkers for specific microbial processes.

**Lecture notes / Literature**
Handouts will be distributed during the course.

**Prerequisites / notice**
This lecture is a prerequisite for attending the laboratory course "Trace elements laboratory".

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**Abstract**
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. Natural processes, anthropogenic pollution, legislation of groundwater and surface water and of drinking water as well as water treatment will be discussed for industrialized and developing countries.

**Objective**
The goal of this lecture is to give an overview over the whole path of drinking water from the source to the tap and understand the involved physical, chemical and biological processes which determine the drinking water quality.

**Content**
The course covers qualitative (chemistry and microbiology) and quantitative aspects of drinking water from the resource to the tap. The various water resources, particularly groundwater and surface water, are discussed as part of the natural water cycle influenced by anthropogenic activities such as agriculture, industry, urban water systems. Furthermore legislation related to water resources and drinking water will be discussed. The lecture is focused on industrialized countries, but also addresses global water issues and problems in the developing world. Finally unit processes for drinking water treatment (filtration, adsorption, oxidation, disinfection etc.) will be presented and discussed.

**Lecture notes / Literature**
Handouts will be distributed during the course.

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**Abstract**
The reduction of CO2 emissions is the only option for keeping future climate change within reasonable bounds. In this course, we will discuss a portfolio of options involving the alteration of natural carbon sinks and carbon sequestration. The course includes introductory lectures, presentations from guest speakers from industry and the public sector, and final presentations by the students.

**Objective**
The goal of this course is to investigate, as a group, a particular set of carbon mitigation/sequestration options and to evaluate their potential, their cost, and their consequences.

**Content**
From the large number of carbon sequestration/mitigation options, a few options will be selected and then investigated in detail by the students. The results of this research will then be presented to the other students, the involved faculty, and discussed in detail by the whole group.

**Lecture notes / Literature**
Will be identified based on the chosen topic.

**Prerequisites / notice**
Exam: No final exam. Pass/No-Pass is assigned based on the quality of the presentation and ensuing discussion.

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**Abstract**
Practices of landfiling and remediation of contaminated sites and disposal of radioactive waste are based on the same concepts that aim to protect the environment. The assessment of contaminants that may leach into the environment as a function of time and how to reduce the rate of their release is key to the design of chemical, technical and geological barriers.

**Objective**
Upon successful completion of this course students are able to:
- assess the risk posed to the environment of landfills, contaminated sites and radioactive waste repositories in terms of fate and transport of contaminants
- describe technologies available to minimize environmental contamination
- describe the principles in handling of contaminated sites and to dispose and evaluate suitable remediation techniques
- explain the concepts that underlie radioactive waste disposal practices

**Content**
This lecture course comprises of lectures with exercises and guided case studies.
- A short overview of the principles of environmental protection in waste management and how this is applied in legislation.
- A overview of the chemistry underlying the release and transport of contaminants from the landfilled/contaminated material/radioactive waste repository focusing on processes that control redox state and pH buffer capacity; mobility of heavy metals and organic compounds
- Technical barrier design and function. Clay as a barrier.
- Contaminated site remediation: Site evaluation, remediation technologies
- Concepts and safety in radioactive waste management
- Role of the geological and engineered barriers and radionuclide transport in geological media.

**Lecture notes / Literature**
Short script plus copies of overheads

**Prerequisites / notice**
This is an interdisciplinary course aimed at environmental scientists and environmental engineers.
Applications of basic physical concepts to glaciers and ice caps. Understanding glaciers and ice sheets with simple physical concepts.

Relevant literature will be given during the lecture.

We will explain the fundamentals of physics of glaciers which are necessary for treating applied problems. We will go into climate-glacier relationships, flow of glaciers, lake and hydrology of glaciers.

The dynamics of glaciers and polar ice sheets is the key requisite to understand their history and their future evolution. We will take a closer look at ice deformation, basal motion, heat flow and glacier hydraulics. The specific dynamics of tide water and calving glaciers is investigated, as is the reaction of glaciers to changes in their environment. Polar ice caps, ice streams and mountain glaciers and their recent rapid changes are discussed.

Basics in physical glaciology

Dynamics of glaciers: deformation of glacier ice, role of water in glacier motion, reaction of glaciers to climate changes, glacier calving, surges, ice falls, ice avalanches, glacier floods, Lake ice and bearing capacity.

Lecture notes

Handouts are available

Relevant literature will be provided during the lecture.

For actual examples, risk-based measures at glaciological natural hazards will be discussed.

Voraussetzungen: Grundkenntnisse in Mechanik und Physik vorausgesetzt.

Seminar in Glaciology

Studium aktueller und klassischer Arbeiten der glaziologischen Forschung


Studium aktueller und klassischer Arbeiten der glaziologischen Forschung

Handouts are available

Relevant literature will be given during the lecture.

Für aktuelle Fallbeispiele werden risikobasierte Massnahmen bei glaziologischen Naturgefahren diskutiert.

Voraussetzungen: Grundkenntnisse in Mechanik und Physik vorausgesetzt.

Quantification and Modeling of the Cryosphere: Dynamic Processes (University of Zurich)

No enrolment to this course at ETH Zurich. Book the corresponding module directly at UZH.

UZH Module Code: GEO815

Mind the enrolment deadlines at UZH:
http://www.uzh.ch/studies/application/mobilitaet_en.html

Overview of the most important earth surface processes and landforms in cold regions (regions with glaciers and intense frost) with emphasis on high-mountain aspects. Discussion of present research challenges.

Knowledge of the most prominent climate-related geomorphological processes and phenomena in high-mountain regions, understanding of primary research challenges.

Erosion and sedimentation by glaciers as a function of topography, englacial temperature, sediment balance, melting and meltwater runoff, processes and landforms in regions of seasonal and perennial frost (frost weathering, rock falls, debris cones/talus, solifluction, permafrost creep/rock glaciers, debris flows).

Glacial and periglacial geomorphodynamics in high-mountain regions. Ca. 100 pages.

Basic knowledge about geomorphology and glaciers/permafrost from corresponding courses at ETH/UZH or from the related lecture notes.

Physics of Glaciers

Application of basic physical concepts to glaciers and ice caps. Understanding glaciers and ice sheets with simple physical concepts. Topics include the reaction of glaciers to the climate, ice rheology, temperature in glaciers and ice sheets, glacier hydrology, basal motion and calving glaciers. A special focus is the current development of Greenland and Antarctica.

The course outlines the physical principles governing the gravity-driven motion of glacier ice. This is applied to understand the response of glaciers and ice sheets to changes in their environment. Polar ice caps, ice streams and mountain glaciers and their recent rapid changes are discussed.

The dynamics of glaciers and polar ice sheets is the key requisite to understand their history and their future evolution. We will take a closer look at ice deformation, basal motion, heat flow and glacier hydraulics. The specific dynamics of tide water and calving glaciers is investigated, as is the reaction of glaciers to changes in mass balance (and therefore climate).

Good high school mathematics and physics knowledge required.

http://people.ee.ethz.ch/~luethim/teaching.html

Minor in Catchment Management and Natural Hazards

Additionally, the module GEO977 Physische Geographie III für die Erdwissenschaften (3KP) can be taken at the UZH for this Minor. No enrolment to this course at ETH Zurich. Book the module directly at UZH (see link: http://www.vorlesungen.uzh.ch/HS15/suche/sm-50352125.modveranst.html).

Hydrology

The course introduces the students to engineering hydrology. It covers first physical hydrology, that is the description and the measurement of hydrological processes (precipitation, interception, evapotranspiration, runoff, erosion, snow), and it introduces then the basic mathematical models of the single processes and of the rainfall-runoff transformation, thereby including flood analysis.

Know the main features of engineering hydrology. Apply methods to estimate hydrological variables for dimensioning hydraulic structures and managing water resources.
Interzeption: Messung und Schätzung.

Evaporation and Evapotranspiration: Prozesse, Messung und Schätzung, potentielle und effektive Evapotranspiration, Energiebilanzmethode, empirische Methode.

Infiltration: Messung, Horton-Gleichung, empirische und konzeptionelle Methoden, F-index und Prozentuale Methode, SCS-CN Methode.


Schnee und Eis: Schneeeigenschaften und -messungen Schätzung des Schneeschmelzprozesses durch die Energiebilanzmethode, Abfluss aus Schneeschmelze, Temperatur-Index- und Grad-Tag-Verfahren.


Lecture notes
Einem Internen Skript ist zur Verfügung (kostenpflichtig, nur Herstellungskosten)

Literature

Prerequisites / notice

651-3525-00L Introduction to Engineering Geology W 3 credits 3G S. Löw

This introductory course starts from a descriptions of the behavior and phenomena of soils and rocks under near surface loading conditions and their key geotechnical properties. Lab and field methods for the characterization of soils, rocks and rock masses are introduced. Finally practical aspects of ground engineering, including tunneling and landslide hazards are presented.

Objective
Understanding the basic geotechnical and geomechanical properties and processes of rocks and soils. Understanding the interaction of rock and soil masses with technical systems. Understanding the fundamentals of geological hazards.

Content

Lecture notes
Written course documentation available under "Kursunterlagen".

Literature

701-0565-00L Fundamentals of Natural Hazards Management W 3 credits 3G H. R. Heinemann, B. Krummenacher, S. Löw

Abstract
Risks to life and human assets result when settlement areas and infrastructure overlap regions where natural hazard processes occur. This course utilizes case studies to teach how a future natural hazards-specialist should analyze, assess and manage risks.

Objective
Concepts will be explained step-by-step through a set of case studies, and applied in lab by the students. The following principal steps are used when coping with natural hazard-risks. At each step, students will learn and apply the following skills:
Risk analysis - What can happen?
- Characterize the processes and environmental measures that lead to a natural hazard and integrate modeling results of these processes.
- Identify threats to human life and assets exposed to natural hazards and estimate possible drawbacks or damages.
Risk assessment - What are the acceptable levels of risk?
- Apply principles to determine acceptable risks to human life and assets in order to identify locations which should receive added protection.
- Explain causes for conflicts between risk perception and risk analysis.
Risk management - What steps should be taken to manage risks?
- Explain how various hazard mitigation approaches reduce risk.
- Describe hazard scenarios as a base for adequate dimensioning of control measures.
- Identify the best alternative from a set of thinkable measures based on an evaluation scheme.
- Explain the principles of risk-governance.
In an introduction to wood anatomy, the general structural features of softwoods and hardwoods will be explained and factors of diversity considered. The learning unit aims at developing analytical and problem solving skills that are essential in engineering sciences. Case studies are characteristic examples for timber harvesting and manufacturing.

**Objective**

Production processes are changing the properties of substances, energy and information in terms of time, location, quantity, quality, and their interactions. The learning unit is designed to develop analytical and problem solving skills that are essential in engineering sciences. Case studies are characteristic examples for timber harvesting and manufacturing.

**Content**

1. Methodische Grundlagen
2. Ubersicht über die weltweiten Holzflüsse
3. Bearbeitungs-, Umformungs-, Transport- und Speicherprozesse der Rohholzbereitstellung
4. Logistikprozesse für divergierende Material- und Informationsflüsse
5. Systematische Analyse und Gestaltung einer Supply Chain der Forst- und Holzwirtschaft anhand eines Falles
6. Engineering Tools (Input-Output Modelle, Prozess-Analysen); inklusive Entwickeln eigener Tools in Visual Basic for Applications (EXCEL)

**Number**

101-0637-10L

**Title**

Structures of Wood and Function

**Abstract**

The lecture Wood structure and function conveys basic knowledge on the microstructure of softwoods and hardwoods as well as general and species-specific relationships between growth processes, wood properties and wood function in the living tree. The students will learn to identify the relationships between tree growth and wood properties with a specific focus on the wood function in the living tree.

**Objective**

Learning target is a basic understanding of the anatomy of wood and the resulting impact of endogenous and exogenous factors. The students will learn to identify the relationships between tree growth and wood properties with a specific focus on the wood function in the living tree.

**Content**

In an introduction to wood anatomy, the general structural features of softwoods and hardwoods will be explained and factors of diversity and variability will be discussed. A specific focus is laid on common central European tree species with relevance in the wood sector, which will be studied in macro- and microstructural investigations. For softwoods, exercises for wood identification and wood protection as well as potentials and limitations in the application of wood and wood-based products.

**Number**

101-0637-20L

**Title**

Fundamentals of Wood Elaboration and Woodmachining

**Abstract**

The lecture Wood processing conveys knowledge on technological properties of wood and wood-based materials as well as on industrial processes for the fabrication of a variety of wood products.

**Objective**

Learning target is a basic understanding of the anatomy of wood and the resulting impact of endogenous and exogenous factors. The students will learn to identify the relationships between tree growth and wood properties with a specific focus on the wood function in the living tree.

**Content**

In an introduction to wood anatomy, the general structural features of softwoods and hardwoods will be explained and factors of diversity and variability will be discussed. A specific focus is laid on common central European tree species with relevance in the wood sector, which will be studied in macro- and microstructural investigations. For softwoods, exercises for wood identification and wood protection as well as potentials and limitations in the application of wood and wood-based products.

**Number**

363-0445-00L

**Title**

Logistics, Operations and Supply Chain Management I

**Abstract**

Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.

**Objective**

An effective and efficient flow of goods, data, and control in and between companies contributes significantly to the value added for the customer. Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.

**Content**

Strategic and tactical concepts in logistics, operations, and supply chain management: Conflicts of objectives and strategies and in the entrepreneurial context; business process analysis and fundamental logistics concepts; the MRP II / ERP concept: business processes and methods; the lean / just-in-time and repetitive manufacturing; concepts for product families and one-of-a-kind production; concepts for the process industry.
This book also serves as textbook for LOS II (spring term) as well as ERP and SCM software systems (autumn term). In addition powerpoint-handouts and documents for case studies.

Sales at 17.9.15, from 12:45, before and during brakes of the first lecture.

see "script"

As for the lecture of the 3rd week (BEMAD, a much-liked Business Engineering and Management Ability Development game), this lecture (of Oct. 1) will follow a specific schedule in specific rooms. The schedule will be presented at Sept. 17 during the 1st lecture.

Due to the big number of students, about half of the students will play this game, instead of Oct. 1, at Friday afternoon, Oct. 2. Please be available. Thank you for your help in this matter.

363-0445-02L Logistics, Operations, and Supply Chain Management I (Additional Cases) 1 credit 2A P. Schönsleben

Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.

An effective and efficient flow of goods, data, and control in and between companies contributes significantly to the value added for the customer. Students will acquire know-how, from a strategic and tactic viewpoint, to organize and realize operational business processes as well as to plan and control value-added systems, both in an industry and a service industry environment.

Environmental Management

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<td>2G</td>
<td>S. Hellweg, R. Frischknecht</td>
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<td></td>
<td>Advanced Environmental, Social and Economic Assessments (6KP) and 102-0317-00 Advanced Environmental Assessments (3KP) cannot be chosen both. 102-0317-00 is already included in 102-0307-00.</td>
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<tr>
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<td>- Inventory developments, transparency, data quality, data completeness, and data exchange formats - Allocation (multioutput processes and recycling) - Hybrid LCA methods. - Consequential and marginal analysis - Recent development in impact assessment - Spatial differentiation in Life Cycle Assessment - Workplace and indoor exposure in Risk and Life Cycle Assessment - Uncertainty analysis - Subjectivity in environmental assessments - Multicriteria analysis - Case Studies</td>
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Lecture notes No script. Lecture slides and literature will be made available.

Literature Literature will be made available.

Prerequisites / notice Basic knowledge of environmental assessment tools is a prerequisite for this class. Students that have not done classwork in this topic before are required to read an appropriate textbook before or at the beginning of this course (e.g. Baumann&Tillman, The Hitch Hiker's Guide to LCA: An Orientation in Life Cycle assessment Methodology and Applications, Studentlitteratur, Lund, 2004).

102-0317-01L Advanced Environmental Assessment (Computer Lab and Exercises) 3 credits 2U+2P S. Pfister

102-0307-00 Advanced Environmental, Social and Economic Assessments (6KP) and 102-0317-00 Advanced Environmental Assessment (Lab) (2KP) cannot be chosen if 102-0307-00 Advanced Environmental, Social and Economic Assessments (6KP) is selected. 102-0317-01 and 102-0317-02 are already included in 102-0307-00.

Abstract Technical systems are investigated in projects with numerical modeling. The students learn how to answer given questions with target oriented methodologies using various software programs for environmental assessment.

Objective Become acquainted with various software programs for environmental assessment including Life Cycle Assessment, Environmental Risk Assessment, Probabilistic Modelling, Material Flow Analysis.

Minor in Soil-Plant Relations and Land Use

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<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-1681-00L</td>
<td>Element Balancing and Soil Functions in Managed Ecosystems</td>
<td>W</td>
<td>3 credits</td>
<td>2G</td>
<td>A. Keller</td>
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<td>Abstract</td>
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<td>Applying element balances of agricultural soils and the assessment of soil functions for real applications in computer exercises to design preventive strategies against soil pollution and to support sustainable management of regional agroecosystems also in the context of spatial planning procedures. The students learn to critical assess changes in land use management on element cycles in agro-ecosystems and to assess soil services (soil functions). You design solutions for chemical problems in soil protection at the regional scale and learn to assess soil functions using different methods.</td>
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<td>Objective</td>
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<td>The students learn to critical assess changes in land use management on element cycles in agro-ecosystems and to assess soil services (soil functions). You design solutions for chemical problems in soil protection at the regional scale and learn to assess soil functions using different methods.</td>
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<td>Content</td>
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<td>The students apply a regional balance model for Swiss regions in computer exercises and assess major soil functions of agricultural soils. You assess the sustainability of current land use and analyse management options improving nutrient and metal cycling in agro-ecosystems. The students will have the opportunity to calculate specific scenarios regarding land use management and environmental changes. Special focus we be paid on the soil services such as regulation-, production function and soil as habitat, and the assessment of these functions based on soil mapping data.</td>
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</table>

Lecture notes Literature and Exercises for a case study
At the end of this course the students are familiar with the principles on which radioisotope works are based and they have learned from case studies how radioisotopes can be used to obtain meaningful data. They are aware of the advantages of using radioisotopes in ecosystem cycling studies, but also of the risks and open questions related to isotope work.

Radio-isotopes are extensively used at the soil/plant or ecosystem level to quantify the fluxes of elements (phosphorus (P), heavy metals, radionuclides) within a given system and to assess the importance of processes controlling these fluxes (e.g., exchange reactions between the soil solution and the soil solid phase, element turnover through the microbial biomass, organic matter mineralization etc.).

The course will first present the assumptions and the theoretical framework that underlay the work with radioisotopes. It will present how the introduction of an isotope into a system can be done so as to get information on the structure of the system (e.g., number and size of compartments). Secondly, case studies on isotopic dilution and tracer work will be presented for instance on the isotopic exchange kinetics method to determine nutrients or pollutants availability. The case studies will be adapted to the ongoing research of the group of plant nutrition and will thus give an insight into our current research. In addition, published studies will be analyzed and presented by the students. Finally, the advantages and disadvantages of work with radioisotopes will be analyzed and discussed critically.

**Prerequisites / notice**

The course consists of lectures and computer exercises. The course take place every 2 weeks à 4 hours. Recommended prerequisites for attending this course:

- Bodenschutz und Landnutzung
- Biochemistry of Trace Elements
- Angewandte Bodenökologie

**Lecture notes**

Documents will be distributed during the lecture.

**Literature**

The lecture will take place at the ETH experimental station in Eschikon Lindau. See the location of the station at: http://www.pe.ipw.agrli.ethz.ch/about/reach

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**Radio-Isotopes in Plant Nutrition**

**H. A. Gamper**

**Abstract**

The course will present the principles underlying the use of radioisotopes in soil/plant systems. It will present how the introduction of an isotope into a system can be done to get some information on the structure of the system. Case studies will be presented to determine element availability. Finally, published studies from other groups will be analyzed and presented by the students.

**Objective**

At the end of this course the students are familiar with the principles on which radioisotope works are based and they have learned from case studies how radioisotopes can be used to obtain meaningful data. They are aware of the advantages of using radioisotopes in ecosystem cycling studies, but also of the risks and open questions related to isotope work.

**Content**

Radio-isotopes are extensively used at the soil/plant or ecosystem level to quantify the fluxes of elements (phosphorus (P), heavy metals, radionuclides) within a given system and to assess the importance of processes controlling these fluxes (e.g., exchange reactions between the soil solution and the soil solid phase, element turnover through the microbial biomass, organic matter mineralization etc.).

The course will first present the assumptions and the theoretical framework that underlay the work with radioisotopes. It will present how the introduction of an isotope into a system can be done so as to get information on the structure of the system (e.g., number and size of compartments). Secondly, case studies on isotopic dilution and tracer work will be presented for instance on the isotopic exchange kinetics method to determine nutrients or pollutants availability. The case studies will be adapted to the ongoing research of the group of plant nutrition and will thus give an insight into our current research. In addition, published studies will be analyzed and presented by the students. Finally, the advantages and disadvantages of work with radioisotopes will be analyzed and discussed critically.

**Lecture notes**

Documents will be distributed during the lecture.

**Literature**

The lecture will take place at the ETH experimental station in Eschikon Lindau. See the location of the station at: http://www.pe.ipw.agrli.ethz.ch/about/reach

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**Biogeochemistry and Sustainable Management**

**L. Merbold**

**Abstract**

This course focuses on the interactions between ecology, biogeochemistry and management of agro- and forest ecosystems, thus, coupled human-environmental systems. Students learn how human impacts on ecosystems and their feedback mechanisms to ecosystems' state or global change are mainly driven by effects on biogeochemical cycles and ecosystem functioning, but also about feedback mechanisms of terrestrial ecosystems.

**Objective**

Students will know and understand the complex and interacting processes of ecology, biogeochemistry and management of agro- and forest ecosystems, be able to analyze and evaluate the various impacts of different management practices under different environmental conditions, search literature, write and evaluate scientific reports, and be able to coordinate and work successfully in small (interdisciplinary) teams.

**Content**

Agroecosystems and forest ecosystems play a major role in all landscapes, either for production purposes, ecological areas or for recreation. The human impact of any management on the environment is mainly driven by effects on biogeochemical cycles. Effects of global change impacts will also act via biogeochemistry at the soil-biosphere-atmosphere-interface. Thus, ecosystem functioning, i.e., the interactions between ecology, biogeochemistry and management of terrestrial systems, is the science topic for this course.

Students will gain profound knowledge about nutrient cycles and population dynamics in managed and unmanaged grassland, cropland and forest ecosystems in the field and in the lab. Responses of agro- and forest ecosystems to the environment, e.g., to climate, anthropogenic deposition, major disturbances, soil nutrients or competition of plants (including invasives) and microorganisms, but also feedback mechanisms of ecosystems on (micro)climate, soils or vegetation patterns will be studied. Different management practices will be investigated and assessed in terms of production and quality of yield (ecosystem goods and services), but also in regard to environmental regulations (including subsidies) and their effect on the environment, e.g., greenhouse gas budgets. Thus, students will learn about the complex interactions of a coupled human-environmental system.

**Lecture notes**

Handouts will be available on the webpage of the course.

**Literature**

Will be discussed in class.

**Prerequisites / notice**

Prerequisites: Attendance of introductory courses in plant ecophysiology, ecology, and grassland or forest sciences. Course will be taught in English.

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**Rhizosphere Ecology**

**H. A. Gamper**

**Abstract**

This course emphasizes interactions among physicochemical and biological processes and highlights implications for plant nutrition, growth, and health. Nutrient mobilization and acquisition by plants in response to fertilization, other plants, and microbes, are explored in model systems. Newly gained knowledge is applied to understand results of a pot experiment and thereby critically reflected.

**Objective**

To gain a holistic understanding of resource-driven and regulatory processes in natural and agronomic plant-microbe-soil systems.

To practice abilities to read scientific literature, understand it, present it and, discuss it with peers.

To combine available and newly acquired knowledge from soil physics, chemistry and (micro-)biology, plant physiology, pathology, and ecology and reflect on their relative importance for plant production, bioremediation, and nature conservation when considered together.

To practice manual skills in handling seedlings, soil, plant, and DNA samples, laboratory equipment, and working with different computer software.

To make observations, analyse, display, interpret and present own data.

To get familiar with (bio-)chemical, molecular genetic, and simple bioinformatics analyses.

To prepare as a group of course participants a poster on one selected aspect of a bigger pot experiment, present it, and discuss findings and posters of other course participants.

To combine findings with available knowledge, generate explanatory hypotheses, and identify potentially informative further analyses and experiments.

**Content**

This course comprised lectures, the set-up, harvest and data analysis of an experiment, soil (bio-)chemical, microbiological and molecular genetic analyses in the laboratory and practical computational data analyses. The focus is set on a better understanding of the role played by spatial and temporal physicochemical and microbiological gradients and various soil organisms in plant mineral nutrition. Mutualistic associations between plant roots and microbes, such as the root symbiosis with mycorrhizal fungi and root nodule-inducing bacteria are discussed. Rhizobia are isolated from field-collected root nodules and characterized, using molecular genetic tools. A short introduction into DNA-based bioinformatics and phylogenetic analyses is given to demonstrate how bacterial species are identified and potential host ranges of isolated rhizobia can be inferred, using so-called functional genes. A pot experiment in the glasshouse on cereal-legume mixed intercropping, including effects of pot size, intra- and interspecific plant competition, and root traits, allows to relate scientifically interesting research topics to practical application, while simultaneously stimulating critical reflections.

**Lecture notes**

Lecture slides and laboratory protocols are being made available in the directory "751-5100-00L Rhizosphere Ecology" of the electronic document exchange platform ILIAS, LDA-ELBA: https://ilias-app2.let.ethz.ch/ilias.php?ref_id=88984&cmdClass=ilrepositorygui&cmdNode=el&baseClass=ilRepositoryGUI

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Literature

Arbuscular mycorrhizas in soil nutrient management, e-learning module of Sustainable Plant Systems by Gamper, HA, van der Heijden, MGA, Hofmann, A.: https://www.olat.uzh.ch/olat/auth/1%3A1%3A0%3A0%3A0/

http://www.els.net/WileyCDA/ElsArticle/refId-a0000403.html


http://www.nature.com/scitable/knowledge/library/plant-soil-interactions-nutrient-uptake-105289112


http://www.plantphysiol.org/content/156/3/1078

http://dx.doi.org/10.1111/nph.12235

http://link.springer.com/article/10.1007%2Fs11104-008-9885-9

http://dx.doi.org/10.1111/nph.12235


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http://dx.doi.org/10.1111/nph.12235

http://www.plantphysiol.org/content/156/3/1078

http://onlineibrary.wiley.com


How microbes can feed the world (American Academy of Microbiology)
http://academy.asm.org/index.php/browse-all-reports/800-how-microbes-can-help-feed-the-world

Can microbes feed the world? (Society for general microbiology)

Popular science entries to the topic:
http://www.the-scientist.com/?articles.view/articleNo/30950/title/The-Root-of-the-Problem/

Ecological Understanding (Second Edition)
The Nature of Theory and the Theory of Nature:

Prerequisites / notice

For students of the Agricultural Sciences of D-USYS: Lectures in Plant Nutrition I and II (Nutrient cycling in agroecosystems by Prof. E. Frossard).
We ask all other course participants to read and understand the e-learning module Plant Nutrition I by Prof. E. Frossard:
https://moodle-app2.let.ethz.ch/course/view.php?id=279

This course on Rhizosphere Ecology is complementary to those on Radioisotopes in Plant Nutrition, and Nutrient Fluxes in Soil-Plant Systems. However, a limited number of thematic overlaps cannot be avoided. Particular emphasis is given to the ecophysiology of interacting organisms and detection, enumeration, culturing, and molecular genetic identification of root-associated microbes.
A written closed book exam will take place on Friday January 8, 2016, from 10.15-12.15am in Eschikon.
Maximum number of participants: 18.
Students of the agricultural sciences of D-USYS will be reimbursed for travel expenses upon handover of collected tickets of the public transport systems, excluding the tax zone of the town of Zurich.
Spatial development deals with the development and the design of our living space. To meet the expectations, the interests and the plans of the different actors, it is needed a planning approach considering the overview of both the actual and future situation. The concept of sustainable development in spatial planning leads necessarily to an efficient management of the resources, especially regarding the resource land. The basics of this important discipline will be the subject of this lecture, which is therefore organised in three parts:
- Inner development
- Integrated spatial and infrastructure development
- Cross-border issues in spatial development

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<tr>
<td>701-1695-00L</td>
<td>Soil Science Seminar</td>
<td>Z</td>
<td>0</td>
<td>1S</td>
<td>R. Schulin</td>
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<tr>
<td>Objective</td>
<td>Invited external speakers present their research on current issues in the field of soil science and discuss their results with the participants. The program will be announced through various channels and also be made available through the teaching materials.</td>
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<tr>
<td>Literature</td>
<td>References in the lecture notes</td>
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<td>Download: <a href="http://www.irl.ethz.ch/plus/education">http://www.irl.ethz.ch/plus/education</a></td>
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Minor in Agricultural Plant Production and Environment

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<tr>
<td>751-4001-00L</td>
<td>Forage Cropping</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>N. Buchmann, A. Lüschner</td>
</tr>
<tr>
<td>Objective</td>
<td>Die Studierenden werden wichtige Mischungen und Pflanzengemeinschaften mitteuropäischer Graslandökosysteme kennenlernen, klassische und aktuelle Arbeiten der Bestandesökophysiologie kennen, in der Lage sein, den Einfluss von Umweltfaktoren und Bewirtschaftung nicht nur auf Einzelpflanzen, sondern auf Pflanzenbestände und ihre Erträge abzuschätzen, und üben, ein wissenschaftliches Thema schriftlich prägnant zusammenzufassen.</td>
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<tr>
<td>Content</td>
<td>In diesem Kurs werden die verschiedenen Typen des Futterbaus und die wichtigsten Mischungen, aber auch natürliche Pflanzengemeinschaften in Mitteleuropa vorgestellt (Bestandesbeurteilung). Basierend auf der Ökophysiologie von Einzelpflanzen wird die Ökophysiologie von Pflanzenbeständen erarbeitet. Es werden verschiedene Arten der Bewirtschaftung vorgestellt (z. B. Bestandeslenkung durch Düngung, Beweidung, Schnitttermine, etc.) und ihre Auswirkungen auf die Bestandeszusammensetzung und auf die Erträge diskutiert. Feedback-Mechanismen zwischen Umwelt und Futterbausystemen werden angesprochen.</td>
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<tr>
<td>Lecture notes</td>
<td>Handouts werden auf dem Netz zur Verfügung gestellt.</td>
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<tr>
<td>Literature</td>
<td>Wird in der Veranstaltung angesprochen.</td>
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<tr>
<td>Prerequisites / notice</td>
<td>Course will be given in German. Course builds on the Ertrags- und Ökophysiologie lecture and provides the basics for the Graslandsysteme.</td>
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<tr>
<td>751-4101-00L</td>
<td>Crops</td>
<td>W</td>
<td>2</td>
<td>2G</td>
<td>A. Walter, F. Liebsch, W. Richner</td>
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<tr>
<td>Objective</td>
<td>During this course, students acquire essential knowledge on agriculturally relevant aspects of crop biology. Via lectures and 'hands-on' teaching elements, differences between species as well as common aspects of different species will be experienced. Thereby, the foundation will be laid for a more intense examination of alternative crops, cropping systems and of procedures to characterize geno- and phenotype.</td>
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<tr>
<td>Lecture notes</td>
<td>W</td>
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<td>B. Streit, N. Delabays, U. J. Haas</td>
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Data: 06.02.2019 13:00  Autumn Semester 2015  Page 1418 of 1434
Abstract
The focus will be on the basic principles of biology and ecology of weeds, crop-weed interactions and basic knowledge of chemical, physical and biological weed control with their respective (dis-) advantages. Furthermore students will get an introduction on the mechanisms of weed management in different farming systems and crops.

751-4003-01L Current Topics in Grassland Sciences (HS) W 2 credits 2S N. Buchmann
Abstract
Research results in agro- and forest ecosystem sciences will be presented by experienced researchers as well as Ph.D. and graduate students. Citation classics as well as recent research results will be discussed. Topics will range from plant ecophysiology, biodiversity and biogeochemistry to management aspects in agro- and forest ecosystems.
Objective
Students will be able to understand and evaluate experimental design and data interpretation of on-going studies, be able to critically analyze published research results, practice to present and discuss results in the public, and gain a broad knowledge of recent research and current topics in agro- and forest ecosystem sciences.
Content
Research results in agro- and forest ecosystem sciences will be presented by experienced researchers as well as Ph.D. and graduate students. Citation classics as well as recent research results will be discussed. Topics will range from plant ecophysiology, biodiversity and biogeochemistry to management aspects in agro- and forest ecosystems.
Lecture notes none
Prerequisites / notice
Prerequisites: Basic knowledge of plant ecophysiology, terrestrial ecology and management of agro- and forest ecosystems. Course will be taught in English.

751-4104-00L Alternative Crops W 2 credits 2V A. Walter, B. Büter
Abstract
Few crops dominate the crop rotations worldwide. Following the goal of an increased agricultural biodiversity, species such as buckwheat but also medicinal plants might become more important in future. The biology, physiology, stress tolerance and central aspects of the value-added chain of the above-mentioned and of other alternative crops will be depicted.
Objective
During this course, students learn to assess the potential of different minor or alternative crops compared to the dominant major crops based on their biological and agronomical features. Each student will assess and present a specific alternative crop of his or her choice based on information from scientific articles and Wikipedia. Wikipedia-entries will be generated.

751-5001-00L Agroecologists without Borders W 2 credits 2S C. Decock, A. Hofmann, J. Six
Abstract
In this seminar students apply their knowledge on sustainable agriculture, tropical soils and land use to a case study related to a current research project from the Sustainable Agroecosystems group. The seminar offers interactions with researchers and extension specialists working in the context of agricultural development.
Objective
(1) Students analyze concrete examples of agricultural development projects in tropical agroecosystems.
(2) Students broaden their understanding of environmental and socio-economic challenges of smallholder farmers.
(3) Students articulate complexity and challenges in agricultural development interventions.
(4) Students develop their science communication skills by producing science communication materials in the context of the given case study.
Prerequisites / notice
Students signing up for this class should have a strong interest in tropical agriculture and science communication.

751-5003-00L Sustainable Agroecosystems II W 2 credits 2V J. Six, A. Hofmann
Abstract
This class is intended to convey methods of agroecological research through selected case studies from current research projects and hands-on exercises. Students will gain an overview on actors in the field of sustainable agricultural development.
Objective
(1) Get to know methods for field and laboratory investigations in agroecology, (2) Analyze case studies from current agroecological research, (3) Place institutions and related projects into the context of sustainable agricultural development
Literature
Prerequisites / notice
Prior participation in the lecture Nachhaltige Agrarökosysteme I (Sustainable Agroecosystems I) 751-5000-00G (in spring semester) recommended; classes taught mostly in English

Minor in Environmental, Resource and Food Economics

Number Title Type ECTS Hours Lecturers
363-0537-00L Resource and Environmental Economics W 3 credits 2G L. Bretschger, A. Brausmann
Abstract
Relationship between economy and environment, market failure, external effects and public goods, contingent valuation, internalisation of externalities; economics of non-renewable resources, economics of renewable resources, cost-benefit analysis, sustainability, and international aspects of resource and environmental economics.
Understanding of the basic issues and methods in resource and environmental economics; ability to solve typical problems in the field using the appropriate tools, which are concise verbal explanations, diagrams or mathematical expressions.

Topics are:
- Introduction to resource and environmental economics
- Importance of resource and environmental economics
- Main issues of resource and environmental economics
- Normative basis
- Utilitarianism
- Fairness according to Rawls
- Economic growth and environment
- Externalities in the environmental sphere
- Governmental internalisation of externalities
- Private internalisation of externalities: the Coase theorem
- Free rider problem and public goods
- Types of public policy
- Efficient level of pollution
- Tax vs. permits
- Command and Control Instruments
- Empirical data on non-renewable natural resources
- Optimal price development: the Hotelling-rule
- Effects of exploration and Backstop-technology
- Effects of different types of markets.
- Biological growth function
- Optimal depletion of renewable resources
- Social inefficiency as result of over-use of open-access resources
- Cost-benefit analysis and the environment
- Measuring environmental benefit
- Measuring costs
- Concept of sustainability
- Technological feasibility
- Conflicts sustainability / optimality
- Indicators of sustainability
- Problem of climate change
- Cost and benefit of climate change
- Climate change as international ecological externality
- International climate policy: Kyoto protocol
- Implementation of the Kyoto protocol in Switzerland

Content
- Economy and natural environment, welfare concepts and market failure, external effects and public goods, measuring externalities and contingent valuation, internalising external effects and environmental policy, economics of non-renewable resources, renewable resources, cost-benefit-analysis, sustainability issues, international aspects of resource and environmental problems, selected examples and case studies.

Lecture notes
- Learning material and script can be found here: https://moodle-app2.let.ethz.ch/course/view.php?id=328

Literature

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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Type</th>
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<tbody>
<tr>
<td>751-1555-00L</td>
<td>Food Economics</td>
<td>W 2 G 2</td>
<td>A. Champetier de Ribes</td>
</tr>
<tr>
<td>751-2203-00L</td>
<td>Swiss Food Value Chains in a Global Change Context</td>
<td>W 2</td>
<td>S. Peter, S. Mann</td>
</tr>
<tr>
<td>751-2401-00L</td>
<td>Food and Agricultural Trade Policy</td>
<td>W 3</td>
<td>R. Jörin</td>
</tr>
</tbody>
</table>

Abstract
- Food Economics proposes to explore important issues in food production, supply, and consumption using the concepts and tools of microeconomics.
- The two objectives of the class are:
  - to provide an overview of the important issues related to food markets and supply chains.
  - to present the economics concepts and tools that are useful to understand the functioning of food supply chains under various governance regimes or policies (emphasis on welfare analysis)
- The course is balanced between presentation of economics concepts and illustration by case-studies. The lecture titles include:
  - Demand for food.
  - Matching demand with supply.
  - Industrial organization in the food supply chain.
  - Non-quality attributes of food.
  - When information is costly.
  - Food production and the environment.
  - The food sector within human economies.

In addition, the students collectively identify and address an applied research question. We implement an empirical strategy to tackle the question before results are discussed individually by students during the final written examination.

Lecture notes
- Lecture notes are made available after each lecture.

Literature
- Readings in the standard economics literature include:
  - Coase 1937,
  - Mussa Rosen 1978,
  - Lancaster 1966,
  - Akerlof 1970.

Prerequisites / notice
- Students are expected to master basic microeconomics concepts such as demand, supply, or consumer and producer surplus. We will review how to calculate elasticities, tax and quota impacts on prices etc...but the class focuses on applications of these tools rather than on basic understanding. Students are expected to have taken at least one intermediary microeconomics class.

Abstract
- We introduce microeconomic foundations of management decisions in cereal production and deal with supply analyzes, applying normative sector models. Furthermore, the agricultural supply chain is described and analyzed with a microeconomic focus. Issues of financial management are highlighted as well as the political frame in which the supply chain is situated.

Objective
- Students become familiar with solving optimization problems in cereal production and hear about supply analyzes with normative sector models. Students know about theory and the empirical situation of different agribusiness markets. They know the significant peculiarities of e.g. the markets for land, money or genetic material and they know innovative tools to buffer the risk of price fluctuations.

Abstract
- The course focuses on the role of agricultural trade in a rapidly globalizing world. We analyze the impact of trade policy instruments on welfare and distribution. By means of case studies the following specific aspects of agricultural trade are analyzed: trade and food security; trade and environment/natural resources; trade and development.
Objective

1. Knowledge of the mechanisms of agricultural trade
2. Impact of trade policy instruments on welfare and distribution
3. Specific aspects of agricultural trade and links to other courses:
   - Trade and food security
   - Trade and environment
   - Trade and development

Content

The course focuses on the role of agricultural trade in a rapidly globalizing world. We analyze the impact of trade policy instruments on welfare and distribution.

By means of case studies the following specific aspects of agricultural trade are analyzed: trade and food security; trade and environment/natural resources; trade and development.

Lecture notes

Handouts (power point presentations)

Literature


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<tr>
<th>Number</th>
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<tr>
<td>701-0019-00L</td>
<td>Readings in Environmental Thinking</td>
<td>W</td>
<td>3</td>
<td>2S</td>
<td>J. Ghazoul, C. Garcia, G. Hirsch Hadorn</td>
</tr>
</tbody>
</table>

Abstract

This course introduces students to foundational texts that led to the emergence of the environment as a subject of scientific importance, and shaped its relevance to society. Above all, the course seeks to give confidence and raise enthusiasm among students to read more widely around the broad subject of environmental sciences.

Objective

The course will provide opportunities to read, discuss, evaluate and interpret key texts that have shaped the environmental movement and, more specifically, the environmental sciences. Students will gain familiarity with the foundational texts, but also understand the historical context within which their academic and future professional work is based. More directly, the course will encourage debate and discussion of each text that is studied, from both the original context as well as the modern context. In so doing students will be forced to consider and justify the current societal relevance of their work.

Content

The course will be run as a book reading club. The first session will provide a short introduction as to how to explore a particular text (that is not a scientific paper) to identify the key points for discussion.

Thereafter, in each week a text (typically a chapter from a book or a paper) considered to be seminal or foundational will be assigned by a course lecturer. The lecturer will introduce the selected text with a brief background of the historical and cultural context in which it was written, with some additional biographical information about the author. He/she will also briefly explain the justification for selecting the particular text.

The students will read the text, with two to four students (depending on class size) being assigned to present it at the next session. Presentation of the text requires the students to prepare by, for example:

- identifying the key points made within the text
- identifying issues of particular personal interest and resonance
- considering the impact of the text at the time of publication, and its importance now
- evaluating the text from the perspective of our current societal and environmental position

Such preparation would be supported by a mid-week tutorial discussion (about 1 hour) with the assigning lecturer.

These students will then present the text (for about 15 minutes) to the rest of the class during the scheduled class session, with the lecturer facilitating the subsequent class discussion (about 45 minutes). Towards the end of the session the presenting students will summarise the emerging key points (5 minutes) and the lecturer will finish with a brief discussion of how valuable and interesting the text was (10 minutes). In the remaining 15 minutes the next text will be presented by the assigning lecturer for the following week.

Literature

The specific texts selected for discussion will vary, but examples include:

- Leopold (1949) A Sand County Almanach
- Carson (1962) Silent Spring
- Jared Diamond (2005) Collapse

Discussions might also encompass films or other forms of media and communication about nature.

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<th>Number</th>
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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-0337-00L</td>
<td>Environmental Mineralogy</td>
<td>Z</td>
<td>1</td>
<td>1V</td>
<td>A. U. Gehring</td>
</tr>
</tbody>
</table>

Abstract

The lecture Environmental Mineralogy provides an outline of chemical and physical properties of iron oxides, clays, and carbonates. Analytical methods (XRD, spectroscopy and magnetics) are presented in order to identify and characterize minerals in natural samples as a tool for the reconstruction of weathering in soils, of diagenesis in sediment, and of phase transitions in hydrothermal systems.

Objective

Knowledge of the most important minerals (Fe-oxides, carbonates, and sheet silicates) in environmental systems

Knowing about the technical and analytical tools for the identification and characterization of mineral phases.

Development of strategies for the analytical handling of multimineral systems.

The application of mineralogical informations to solve specific environmental problems.

Content

Short introduction to mineral sciences

Inorganic minerals and biominerals

Analytical methods for the identification and characterization of minerals

Weathering & diagenesis and the formation of minerals

Minerals as environmental indicators (tropical soils and lacustrine sediments as case studies)

The use of minerals in the environmental management (e.g. controlled landfills)

Weathering and conservation of building materials

Lecture notes

Hand-outs are delivered

Literature


Prerequisites / notice

Voraussetzungen: Bodenchemie
# Work Experience

<table>
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<tr>
<th>Number</th>
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<th>Lecturers</th>
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<tr>
<td>701-1001-00L</td>
<td>Internship</td>
<td>O</td>
<td>30</td>
<td></td>
<td>A. Funk</td>
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</tbody>
</table>

**Abstract**

In the mandatory internship outside of ETH, the students in Environmental Sciences learn about how environmental issues are handled professionally through their own practical work and by applying the knowledge they acquired. They will analyse complex environmental problems on scientific, technical and social levels and develop solutions in conjunction with social actors.

**Objective**

The students experience political/legal, economic, social and psychological aspects in a professional working environment and acquire key skills such as communication and planning skills, cooperation with non-specialists or recognition of relevant aspects. Further they make useful contacts for starting their careers.

**Content**

This internship takes place outside of ETH. The main locations of an internship are the following: environmental consulting firms, planning and engineering offices, industrial and service companies, public administration, environmental organisations (nature conservation and protection, development cooperation).

The internship is a mandatory part of the two-year Master programme and lasts for at least 18 weeks (30 credit points). The internship agreement is a condition for the performance assessment of the internship.

The students look for a placement themselves.

**Lecture notes**


**Prerequisites / notice**

Listed in the Praxisregister are Swiss companies that offer internship to students in Environmental Sciences, some explicitly offer internships in English: [www.intranet.usys.ethz.ch/UMNW/berufspraxis/Praxisregister](http://www.intranet.usys.ethz.ch/UMNW/berufspraxis/Praxisregister)

Current employment opportunities can be found at [www.intranet.usys.ethz.ch/UMNW/stellen-plattform/](http://www.intranet.usys.ethz.ch/UMNW/stellen-plattform/)

To get an overview, subjects of previous internships can be found at [www.intranet.usys.ethz.ch/UMNW/berufspraxis/Berufspraxisarbeiten](http://www.intranet.usys.ethz.ch/UMNW/berufspraxis/Berufspraxisarbeiten)

If publication is permitted, reports of former internships are available online as PDF-files.


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# Master Thesis

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<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>701-1002-00L</td>
<td>Master's Thesis</td>
<td>O</td>
<td>30</td>
<td>64</td>
<td>Lecturers</td>
</tr>
</tbody>
</table>

Only students who fulfill the following criteria are allowed to begin with their Master thesis:

a) The signed request for the Bachelor's Degree Certificate has been submitted (if the Bachelor's programme has been finished at ETHZ).

b) At least 32 CP of coursework related to the major have been acquired.

c) All additional requirements (as stated in the admissions decision), including any assessment repetitions, are fulfilled.

Please submit the registration form, downloadable at [www.usys.ethz.ch/docs/env/master](http://www.usys.ethz.ch/docs/env/master), at the beginning of your thesis!

**Abstract**

The course is completed by a Master thesis. This component is designed to enable the students to explore how the course content can be applied to an actual scientific problem. The thesis also provides an opportunity for the students to exercise initiative and to demonstrate that they are capable of working independently and in a scientifically structured manner.

**Objective**

This component is designed to enable the students to explore how the course content can be applied to an actual scientific problem. The thesis also provides an opportunity for the students to exercise initiative and to demonstrate that they are capable of working independently and in a scientifically structured manner.

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# Course Units for Additional Admission Requirements

*The courses below are only available for MSc students with additional admission requirements.*

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
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<tr>
<td>406-0062-AAL</td>
<td>Physics I</td>
<td>E-</td>
<td>5</td>
<td>11</td>
<td>A. Vaterlaus</td>
</tr>
</tbody>
</table>

Enrolment only for MSc students who need this course as additional admission requirement.

**Abstract**

Introduction to the concepts and tools in physics: mechanics of point-like and rigid bodies, elasticity theory, elements of hydrostatics and hydrodynamics, periodic motion and mechanical waves.

**Objective**

Introduction to the scientific methodology. The student should develop his/her capability to turn physical observations into mathematical models, and to solve the latter.

The student should acquire an overview over the basic concepts in mechanics.

**Content**


Chapters:

1, 2, 3, 4, 5, 6 (without: 6-5, 6-6, 6-8), 7, 8 (without 8-9), 9, 10 (without 10-10), 11 (without 11-7), 13 (without 13-13, 13-14), 14 (without 14-6), 15 (without 15-3, 15-5)
Mathematics is of ever increasing importance to the Natural Sciences and Engineering. The key is the so-called mathematical modelling.

**406-0063-AAL**

**Mathematics II**

**Enrolment only for MSc students who need this course as additional admission requirement.**

**Abstract**

Introduction to the "way of thinking" and the methodology in Physics. The Chapters treated are Magnetism, Refraction and Diffraction of Waves, Elements of Quantum Mechanics with applications to Spectroscopy, Thermodynamics, Phase Transitions, Transport Phenomena.

**Objective**

Introduction to the scientific methodology. The student should develop his/her capability to turn physical observations into mathematical models, and to solve the latter.

The student should acquire an overview over the basic concepts used in the theory of heat and electricity.

**Content**

**Book:**


Chapters:


**Literature**

see "Content"

**406-0251-AAL**

**Mathematics I**

**Enrolment only for MSc students who need this course as additional admission requirement.**

**Abstract**

This course covers mathematical concepts and techniques necessary to model, solve and discuss scientific problems - notably through ordinary differential equations.

**Objective**

Mathematics is of ever increasing importance to the Natural Sciences and Engineering. The key is the so-called mathematical modelling cycle, i.e. the translation of problems from outside of mathematics into mathematics, the study of the mathematical problems (often with the help of high level mathematical software packages) and the interpretation of the results in the original environment.

The goal of Mathematics I and II is to provide the mathematical foundations relevant for this paradigm. Differential equations are by far the most important tool for modelling and are therefore a main focus of both of these courses.

**Content**

1. Linear Algebra and Complex Numbers:
   - systems of linear equations, Gauss-Jordan elimination, matrices, determinants, eigenvalues and eigenvectors, cartesian and polar forms for complex numbers, complex powers, complex roots, fundamental theorem of algebra.

2. Single-Variable Calculus:
   - review of differentiation, linearisation, Taylor polynomials, maxima and minima, antiderivative, fundamental theorem of calculus, integration methods, improper integrals.

3. Ordinary Differential Equations:
   - separable ordinary differential equations (ODEs), integration by substitution, 1st and 2nd order linear ODEs, homogeneous systems of linear ODEs with constant coefficients, introduction to 2-dimensional dynamical systems.

**Literature**

- Bretschner, O.: Linear Algebra with Applications (Pearson Prentice Hall).

**406-0252-AAL**

**Mathematics II**

**Enrolment only for MSc students who need this course as additional admission requirement.**

**Abstract**

Continuation of the topics of Mathematics I. Main focus: multivariable calculus and partial differential equations.

**Objective**

Mathematics is of ever increasing importance to the Natural Sciences and Engineering. The key is the so-called mathematical modelling cycle, i.e. the translation of problems from outside of mathematics into mathematics, the study of the mathematical problems (often with the help of high level mathematical software packages) and the interpretation of the results in the original environment.

The goal of Mathematics I and II is to provide the mathematical foundations relevant for this paradigm. Differential equations are by far the most important tool for modelling and are therefore a main focus of both of these courses.

**Content**

- Multivariable Differential Calculus:
  - functions of several variables, partial differentiation, curves and surfaces in space, scalar and vector fields, gradient, curl and divergence.
  - Multivariable Integral Calculus:
    - multiple integrals, line and surface integrals, work and flux, Green, Gauss and Stokes theorems, applications.
  - Partial Differential Equations:
    - separation of variables, Fourier series, heat equation, wave equation, Laplace equation, Fourier transform.
  - Thomas, G. B.: Thomas’ Calculus, Parts 2 (Pearson Addison-Wesley).

**Literature**

- Thomas, G. B.: Thomas’ Calculus, Parts 2 (Pearson Addison-Wesley).
1. Linear Algebra and Complex Numbers:
- systems of linear equations, Gauss-Jordan elimination, matrices, determinants, eigenvalues and eigenvectors, cartesian and polar forms for complex numbers, complex powers, complex roots, fundamental theorem of algebra.

2. Single-Variable Calculus:
- review of differentiation, linearsation, Taylor polynomials, maxima and minima, antiderivative, fundamental theorem of calculus, integration methods, improper integrals.

3. Ordinary Differential Equations:
- separable ordinary differential equations (ODEs), integration by substitution, 1st and 2nd order linear ODEs, homogeneous systems of linear ODEs with constant coefficients, introduction to 2-dimensional dynamical systems.

4. Multivariable Differential Calculus:
- functions of several variables, partial differentiation, curves and surfaces in space, scalar and vector fields, gradient, curl and divergence.

5. Multivariable Integral Calculus:
- multiple integrals, line and surface integrals, work and flow, Green, Gauss and Stokes theorems, applications.

6. Partial Differential Equations:
- separation of variables, Fourier series, heat equation, wave equation, Laplace equation, Fourier transform.

Literature
- Bretscher, O.: Linear Algebra with Applications (Pearson Prentice Hall).
- Thomas, G. B.: Thomas’ Calculus, Parts 2 (Pearson Addison-Wesley).

406-0603-AAL | Stochastics (Probability and Statistics) | E- | 4 credits | 9R | M. Kalisch

**Abstract**
Introduction to basic methods and fundamental concepts of statistics and probability theory for non-mathematicians. The concepts are presented on the basis of some descriptive examples. Learning the statistical program R for applying the acquired concepts will be a central theme.

**Objective**
The objective of this course is to build a solid fundament in probability and statistics. The student should understand some fundamental concepts and be able to apply these concepts to applications in the real world. Furthermore, the student should have a basic knowledge of the statistical programming language "R".

**Content**
From "Statistics for research" (online)
- Ch 1: The Role of Statistics
- Ch 2: Populations, Samples, and Probability Distributions
- Ch 3: Binomial Distributions
- Ch 6: Sampling Distribution of Averages
- Ch 7: Normal Distributions
- Ch 8: Student’s t Distribution
- Ch 9: Distributions of Two Variables

From "Introductory Statistics with R (online)"
- Ch 1: Basics
- Ch 2: The R Environment
- Ch 3: Probability and distributions
- Ch 4: Descriptive statistics and tables
- Ch 5: One- and two-sample tests
- Ch 6: Regression and correlation

**Literature**
- "Statistics for research" by S. Dowdy et. al. (3rd edition); Print ISBN: 9780471267355; Online ISBN: 9780471477433; DOI: 10.1002/0471477435
  From within the ETH, this book is freely available online under: http://onlinelibrary.wiley.com/book/10.1002/0471477435
  From within the ETH, this book is freely available online under: http://www.springerlink.com/content/m17578/

529-2001-AAL | Chemistry I and II | E- | 9 credits | 19R | H. Grützmacher, W. Uhlig

**Abstract**
General Chemistry I and II: Chemical bond and molecular structure, chemical thermodynamics, chemical equilibrium, kinetics, acids and bases, electrochemistry

**Objective**
Introduction to general and inorganic chemistry. Basics of the composition and the change of the material world. Introduction to the thermodynamically controlled physico-chemical processes. Macroscopic phenomena and their explanation through atomic and molecular properties. Using the theories to solve qualitatively and quantitatively chemical and ecologically relevant problems.

**Content**
1. Stoichiometry

2. Atoms and Elements (Quantenmechanical Model of the Atom)

3. Chemical Bonding

4. Thermodynamics

5. Chemical Kinetics

6. Chemical Equilibrium (Acids and Bases, Solubility Equilibria)

7. Electrochemistry

**Lecture notes**
Nivaldo J. Tro
Chemistry - A molecular Approach (Pearson), Chapter 1-18

**Literature**
Housecroft and Constable, CHEMISTRY
Octoby, Gillis, Nachtrieb, MODERN CHEMISTRY

551-0001-AAL | General Biology I | E- | 3 credits | 6R | U. Sauer, A. Widmer

**Abstract**
Introduction to basic methods and fundamental concepts of biology. The concepts are presented on the basis of some descriptive examples. Learning the statistical program R for applying the acquired concepts will be a central theme.

**Objective**
The objective of this course is to build a solid fundament in probability and statistics. The student should understand some fundamental concepts and be able to apply these concepts to applications in the real world. Furthermore, the student should have a basic knowledge of the statistical programming language "R".

**Content**
From "Statistics for research" (online)
- Ch 1: The Role of Statistics
- Ch 2: Populations, Samples, and Probability Distributions
- Ch 3: Binomial Distributions
- Ch 6: Sampling Distribution of Averages
- Ch 7: Normal Distributions
- Ch 8: Student’s t Distribution
- Ch 9: Distributions of Two Variables

From "Introductory Statistics with R (online)"
- Ch 1: Basics
- Ch 2: The R Environment
- Ch 3: Probability and distributions
- Ch 4: Descriptive statistics and tables
- Ch 5: One- and two-sample tests
- Ch 6: Regression and correlation

**Literature**
- "Statistics for research" by S. Dowdy et. al. (3rd edition); Print ISBN: 9780471267355; Online ISBN: 9780471477433; DOI: 10.1002/0471477435
  From within the ETH, this book is freely available online under: http://onlinelibrary.wiley.com/book/10.1002/0471477435
  From within the ETH, this book is freely available online under: http://www.springerlink.com/content/m17578/
Enrolment only for MSc students who need this course as additional admission requirement.

Abstract
Basics of structure, formation and function of cells and biomacromolecules, principles of metabolism, as well as basic classical and molecular genetics and evolutionary biology.

This is a virtual self-study lecture for non-german speakers of the "Allgemeine Biology I" lecture. The exam will be written jointly with the participants of this lecture.

Objective
The understanding of some basic principles of biology: the hierarchy of the structural levels of biological organisation, with particular emphasis on the cell and its functions, as well as metabolism, inheritance and evolution.

Content
The structure and function of biomacromolecules; basics of metabolism; cell biology; membrane structure and function; basic energetics of cellular processes; respiration, photosynthesis; cell cycle, meiosis and sexual life cycles; Mendelian and molecular genetics; animal reproduction and behavior; sensory and motor mechanisms; population biology and evolution; principles of phylogeny.

The Campbell Chapters 1-4 (10th edition) under the heading "The role of chemistry in biology" are expected. We will treat the following Campbell chapters:

- Chapter 5: Biochemistry
- Chapter 6: Biological Macromolecules and Lids
- Chapter 7: Cell biology
- Chapter 8: Cell Membranes
- Chapter 10: Cell biology
- Chapter 11: Cell biology
- Chapter 12: Cell Biology
- Chapter 13: The Genetic Basis of Life
- Chapter 14: The Genetic Basis of Life
- Chapter 15: The Genetic Basis of Life
- Chapter 20: The Genetic Basis of Life
- Chapter 21: Evolution
- Chapter 22: Evolution
- Chapter 23: Evolution
- Chapter 24: Evolution
- Chapter 25: Evolution

Lecture notes
No script

Literature

Prerequisites / notice
This is a virtual self-study lecture for non-german speakers of the "Allgemeine Biology I" lecture. The exam will be written jointly with the participants of this lecture.

Example exam questions will be discussed during the lectures, and old exam questions are kept by the various student organisations. If necessary, please contact Prof. Alexander Widmer (alex.widmer@env.ethz.ch) for details regarding the exam.

701-0002-AAL
General Biology II
Enrolment only for MSc students who need this course as additional admission requirement.

Abstract
Basics of structure, formation and function of cells and biomacromolecules, principles of metabolism, basic molecular genetics, form and function of plants.

Objective
The understanding of some basic concepts of biology: the hierarchy of the structural levels of biological organisation, with particular emphasis on the cell and its functions, the fundamentals of metabolism and molecular genetics, as well as form and function of vascular plants.

Content
The structure and function of biomacromolecules; basics of metabolism; tour of the cell; membrane structure and function; basic energetics of cellular processes; respiration, photosynthesis; cell cycle, from gene to protein; bacteria and archaea; structure and growth of vascular plants, resource acquisition and transport, soil and plant nutrition

Lecture notes
No script

Literature

Prerequisites / notice
Basic general and organic chemistry

701-0023-AAL
Atmosphere
Enrolment only for MSc students who need this course as additional admission requirement.

Abstract
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

Objective
Understanding of basic physical and chemical processes in the atmosphere. Understanding of mechanisms of and interactions between: weather - climate - atmosphere - ocean - continents, troposphere - stratosphere. Understanding of environmentally relevant structures and processes on vastly differing scales. Basis for the modelling of complex interrelations in the atmosphere.

Content
Basic principles of the atmosphere, physical structure and chemical composition, trace gases, atmospheric cycles, circulation, stability, radiation, condensation, clouds, oxidation capacity and ozone layer.

Lecture notes
Written information will be supplied.

Literature

701-0243-AAL
Biology III: Essentials of Ecology
Enrolment only for MSc students who need this course as additional admission requirement.

Abstract
This course assigns reading for students needing further background for understanding ecological processes. Central problems in ecology, including population growth and regulation, the dynamics of species interactions, the influence of spatial structure, the controls over species invasions, and community responses to environmental change will be explored from basic and applied perspectives.
Objective

Original language Students will understand how ecological processes operate in natural communities. They will appreciate how mathematical theory, field experimentation, and observational studies combine to generate a predictive science of ecological processes.

Upon completing the course, students will be able to:

1. Understand the factors determining the outcome of species interactions in communities, and how this information informs management.
2. Apply theoretical knowledge on species interactions to predict the potential outcomes of novel species introductions.
3. Understanding the role of spatial structure in mediating population dynamics and persistence, species interactions, and patterns of species diversity.
4. Use population and community models to predict the stability of interactions between predators and prey and between different competitors.
5. Understand the conceptual basis of predictions concerning how ecological communities will respond to climate change.

Content

Readings from a text book will focus on understanding central processes in community ecology. Topics will include demographic and spatial structure, consumer resource interactions, food webs, competition, invasion, and the maintenance of species diversity. Each of these more conceptual topics will be discussed in concert with their applications to the conservation and management of species and communities in a changing world.

701-0401-AAL Hydrosphere E- 3 credits 6R P. Bayer, R. Kipfer

Enrolment only for MSc students who need this course as additional admission requirement.

Abstract

Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.

Objective

Qualitative and quantitative understanding of the physical processes that control the terrestrial water cycle. Energy and mass exchange, mixing and transport processes are described and the coupling of the hydrosphere with the atmosphere and the solid Earth are discussed.

Content

Topics of the course.

- Physical properties of water (i.e. density and equation of state)
- Exchange at boundaries
  - energy (thermal & kinetic), gas exchange
  - vertical stratification, large scale transport
  - turbulence and mixing
  - mixing and exchange processes in rivers
- Groundwater and its dynamics
  - ground water as part of the terrestrial water cycle
  - ground water hydraulics, Darcy’s law
  - aquifers and their properties
  - hydrochemistry and tracer
  - ground water use
- Case studies
  - 1. Water as resource, 2. Water and climate

Lecture notes Literature

In addition to the self-learning literature handouts are distributed.

Textbooks for self-studying.

Surface water:
  - Chapter 4: Imboden, D.M., and Wüest, A. ‘Mixing Mechanisms in Lakes’
  - Chapter 6.4: Air-Water Partitioning
  - Chapter 19.2: Bottleneck Boundaries

Ground water:
  - Chapters 1 - 6, 8, 10, 11.

Optional additional readers.


701-0501-AAL Pedosphere E- 3 credits 6R R. Kretzschmar

Enrolment only for MSc students who need this course as additional admission requirement.

Abstract

Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

Objective

Introduction to the formation and properties of soils as a function of parent rock, landscape position, climate, and soil organisms. Complex relationships between soil forming processes, physical and chemical soil properties, soil biota, and ecological soil properties are explained and illustrated by numerous examples.

Content

Definition of the pedosphere, soil functions, rocks as parent materials, minerals and weathering, soil organic matter, physical soil properties and functions, chemical soil properties and functions, soil formation, principles of soil classification, global soil regions, soil fertility, land use and soil degradation.

Lecture notes Literature

Lecture notes can be purchased during the first lecture (15.- SFr)


Prerequisites / notice

Prerequisites: Basic knowledge in chemistry, biology and geology.

701-0721-AAL Psychology E- 3 credits 6R M. Siegrist

Enrolment only for MSc students who need this course as
Abstract
This is an introductory course in psychology. This course will emphasize cognitive psychology and the psychological experiment.

Objective
Knowledge of key concepts and exemplary theories of psychology and their relation to "daily" psychology. Comprehension of relation between theory and experiment in psychology.

Goals: Learning how psychologists are thinking, a side change from the ETH natural science perspective to psychological thinking.

Domains of psychology:
- Psychology fields
- Concept definitions of psychology
- Theories of psychology
- Methods of psychology
- Results of psychology

Capability:
Be able to define a psychological research question
Basics understanding of role of psychology

Comprehension:
Psychology as a science of experience and behavior of the human

Content
Einführung in die psychologische Forschung und Modellbildung unter besonderer Berücksichtigung der kognitiven Psychologie und des psychologischen Experiments. Themen sind u.a.: Wahrnehmung; Lernen und Entwicklung; Denken und Problemlösen; Kognitive Sozialpsychologie; Risiko und Entscheidung.

Literature
English book of Zimbardo (http://www.amazon.de/Psychology-Life-Discovering-Psych-Lab/dp/0205654770/ref=sr_1_2?s=books-intl-de&ie=UTF8&qid=1317208260&sr=1-2)

Prerequisites / notice
Determine with Prof. Dr. Michael Siegrist the chapters in "Zimbardo" which are compulsory reading

Read the two Psychology chapters (6 + 7) from the book of Prof. Roland W. Scholz

701-0757-AAL Principles of Economics E- 3 credits 6R R. Schubert

Abstract
Students understand basic microeconomics and macroeconomics problems and theories. They are able to argue along economic principles and to judge policy measures.

Objective
Students should be enabled to understand basic microeconomics and macroeconomics problems and theories. They should be able to argue along economic principles and to judge policy measures.

Content
Supply and demand behaviour of firm and households; market equilibrium and taxation; national income and indicators; inflation; unemployment; growth; macroeconomics policies

Lecture notes
available on electronic platform

Literature


For English Speaking students:


701-1901-AAL Systems Analysis E- 3 credits 6R N. Gruber

Abstract
Self study course in Systems Analysis to fulfill requirements for enrollment into the master program. Topics covered include linear box models with one and several variables; non-linear box models with one or several variables; discrete-time models; and continuous models in space and time.

Objective
The aim of this course is to develop an understanding of the dynamical behavior of environmental systems and how this behavior can be captured and understood using mathematical concepts.

Lecture notes
For English Speaking students:


Transdisciplinary Case Studies

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<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
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</table>

Abstract
This summer school will function as an inter-disciplinary think-tank, exploring the requisites for sustainable urban development in Barranquilla through the lens of architecture, engineering, and environmental sciences. You will be challenged to work in an intensive cross-cultural setting and develop solutions in a complex, real-life context with local practitioners and stakeholders.

Objective
You will receive full support on-site from Universidad del Norte and ETH tutors from your discipline. In developing the scenarios you will work side by side with young professionals with a grounded knowledge of the field, and be joined by a wide variety of local stakeholders.

The program will combine site visits, expert lectures and workshops to allow you to develop the following skills:

- The capacity to work to address urban challenges in an inter-disciplinary team
- Apply Scenario Analysis technique to structure and integrate knowledge from various fields
- Cross cultural understanding and skills in an international collaboration
- Mechanisms to collaborate and communicate with practitioners and stakeholders
- Understanding of integrated and sustainable urban development
- Ability to use stakeholder participation to solve real world problems
Mid-sized cities in Latin America are growing at unprecedented rates. The next decade will be decisive in terms of demographic and economic growth, creating a time window to respond to unprecedented demands on resources, such as land, water and energy.

Are these boomtowns doomed to follow the fate of megacities or will they successfully avoid the pitfalls of rapid urban development? This program is part of a three-year ambitious collaboration with the Inter American Development Bank's Emerging and Sustainable Cities Initiative and the Swiss Ministry for Economic Cooperation (SECO). It will influence decision makers and engage with real issues.

ETH is teaming up with the leading Universidad del Norte in Colombia to focus on Barranquilla, a rapidly growing city of 1.2 million inhabitants on the Atlantic coast of Colombia. Following a period of decline, vast sums of foreign investment are now flowing into this port city, with the potential to reverse current inequalities and spark more sustainable development.

In a team, you will produce alternative urban scenarios for the redevelopment of Barranquillas Central Market. You will contribute your expertise and unpack the realities of sustainable development in a tropical climate. How can knowledge from the ETH be combined with leading Colombian research and translated to a Latin American context? Through debate, controversy and collaboration it is expected you produce scenarios that integrate your different disciplines and question the preconceptions of sustainable urban development.

This immersive summer school will be structured in three interlocking modules:

In the first module you will investigate the central market and gain a strong understanding of the social, environmental and built context in Barranquilla. You will employ and combine your varied disciplinary methodologies to gain insight into the sustainability challenges facing the city and the redevelopment of the avenue.

In the second module, you will develop a series of scenarios for the central market in Barranquilla, proposing alternatives for its sustainable future. You will build on research from the first module, and explore the potential of your ideas with local stakeholders and professionals from your field. You will document these scenarios using creative and varied representational methods.

In the final module you will pitch your scenarios to decision makers. During this high-level event you will measure their preferences, debate the associated trade-offs, and provide a series of orientations for those planning the future of Barranquilla.

More information on our blog: www.marketsinthetropics.com

Who should apply?

Enthusiastic students currently enrolled in a masters program in ETH Zurich and Universidad del Norte, Barranquilla Colombia. A balanced group of 12 ETH master students from the D-ARCH, D-USYS and D-BAUG departments will be selected. They will be joined by 12 Colombian students from our partner university in Barranquilla, Universidad del Norte.

Applicants should have a strong interest in sustainable urban development and trans disciplinary collaborative research. They should be able to demonstrate their academic strength, motivation, interest and expertise. Knowledge of Spanish is welcomed but not obligatory.

ETH participants will be charged a fee of 300 CHF to cover local activities, travel and accommodation.

Students will be responsible for organising visa, health insurance, and transportation to and from Barranquilla. Flights to Barranquilla from Zurich cost approximately 1700 CHF. Additional travel grants are available for ETH students.

Applications can be submitted including curriculum vitae, portfolio where relevant and letter of motivation as portable document format (pdf) by May 30th, 17:00 CET to hertzog@usys.ethz.ch

Notification for admission June 1st.

Environmental Sciences Master - Key for Type

| W+ | Eligible for credits and recommended |
| W  | Eligible for credits                |
| E- | Recommended, not eligible for credits |

Z | Courses outside the curriculum |
Dr | Suitable for doctorate |
O  | Compulsory |

Key for Hours

| V  | lecture               |
| G  | lecture with exercise |
| U  | exercise              |
| S  | seminar               |
| K  | colloquium            |

P | practical/laboratory course |
A | independent project       |
D | diploma thesis            |
R | revision course / private study |

ECTS | European Credit Transfer and Accumulation System

Special students and auditors need special permission from the lecturers.
### Core Courses

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
</table>

**Abstract**
This course gives an introduction into algorithms and numerical methods for parallel computing for multi and many-core architectures and for applications from problems in science and engineering.

**Objective**
Introduction to HPC for scientists and engineers

Fundamental of:
1. Parallel Computing Architectures
2. MultiCores
3. ManyCores

**Content**
Programming models and languages:
1. C++ threading (2 weeks)
2. OpenMP (4 weeks)
3. MPI (5 weeks)

Computers and methods:
1. Hardware and architectures
2. Libraries
3. Particles: N-body solvers
4. Fields: PDEs
5. Stochastics: Monte Carlo

**Lecture notes**
http://www.cse-lab.ethz.ch/index.php/teaching/42-teaching/classes/615-hpcse1

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<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0213-00L</td>
<td>Fluid Dynamics with the Lattice Boltzmann Method</td>
<td>W</td>
<td>4 credits</td>
<td>3G</td>
<td>I. Karlin</td>
</tr>
</tbody>
</table>

**Abstract**
The course provides an introduction to theoretical foundations and practical usage of the Lattice Boltzmann Method for fluid dynamics simulations.

**Objective**
Methods like molecular dynamics, DSMC, lattice Boltzmann etc are being increasingly used by engineers all over and these methods require knowledge of kinetic theory and statistical mechanics which are traditionally not taught at engineering departments. The goal of this course is to give an introduction to ideas of kinetic theory and non-equilibrium thermodynamics with a focus on developing simulation algorithms and their realizations.

During the course, students will be able to develop a lattice Boltzmann code on their own. Practical issues about implementation and performance on parallel machines will be demonstrated hands on.

Central element of the course is the completion of a lattice Boltzmann code (using the framework specifically designed for this course).

The course will also include a review of topics of current interest in various fields of fluid dynamics, such as multiphase flows, reactive flows, microflows among others.

Optionally, we offer an opportunity to complete a project of student's choice as an alternative to the oral exam. Samples of projects completed by previous students will be made available.

**Content**
The course builds upon three parts:
1. Elementary kinetic theory and lattice Boltzmann simulations introduced on simple examples.
2. Theoretical basis of statistical mechanics and kinetic equations.

The content of the course includes:

1. Background: Elements of statistical mechanics and kinetic theory:
   - Particle's distribution function, Liouville equation, entropy, ensembles; Kinetic theory: Boltzmann equation for rarefied gas, H-theorem, hydrodynamic limit and derivation of Navier-Stokes equations, Chapman-Enskog method, Grad method, boundary conditions; mean-field interactions, Vlasov equation; Kinetic models: BGK model, generalized BGK model for mixtures, chemical reactions and other fluids.

2. Basics of the Lattice Boltzmann Method and Simulations:
   - Minimal kinetic models: lattice Boltzmann method for single-component fluid, discretization of velocity space, time-space discretization, boundary conditions, forcing, thermal models, mixtures.

3. Hands on:
   - Development of the basic lattice Boltzmann code and its validation on standard benchmarks (Taylor-Green vortex, lid-driven cavity flow etc).

4. Practical issues of LBM for fluid dynamics simulations:
   - Lattice Boltzmann simulations of turbulent flows; numerical stability and accuracy.

5. Microflow:
   - Rarefaction effects in moderately dilute gases; Boundary conditions, exact solutions to Couette and Poiseuille flows; micro-channel simulations.

6. Advanced lattice Boltzmann methods:
   - Entropic lattice Boltzmann scheme, subgrid simulations at high Reynolds numbers; Boundary conditions for complex geometries.

7. Introduction to LB models beyond hydrodynamics:
   - Relativistic fluid dynamics; flows with phase transitions.

**Lecture notes**
Lecture notes on the theoretical parts of the course will be made available. Selected original and review papers are provided for some of the lectures on advanced topics. Lecture notes and basic code framework for implementation of the lattice Boltzmann models will be provided.

**Prerequisites / notice**
The course addresses mainly graduate students (MSc/Ph D) but BSc students can also attend.

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<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-0293-00L</td>
<td>Combustion and Reactive Processes in Energy and Atmosphere</td>
<td>W</td>
<td>4 credits</td>
<td>2V+1U+2A</td>
<td>K. Boulouchos, F. Ernst</td>
</tr>
</tbody>
</table>
### Materials Technology

**Abstract**
The students should become familiar with the fundamentals and with application examples of chemically reactive processes in energy conversion (combustion engines in particular) as well as the synthesis of new materials.

**Objective**
The students should become familiar with the fundamentals and with application examples of chemically reactive processes in energy conversion (combustion engines in particular) as well as the synthesis of new materials. The lecture is part of the focus "Energy, Flows & Processes" on the Bachelor level and is recommended as a basis for a future Master in the area of energy. It is also a facultative lecture on Master level in Energy Science and Technology and Process Engineering.

**Content**

**Lecture notes**
HANDOUTS are EXCLUSIVELY IN GERMAN ONLY, however recommendations for English text books will be provided.

**Literature**

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### Introduction to Plasmonics

**151-0911-00L**

**Introduction to Plasmonics**

**W** 4 credits 2V+1U

**D. J. Norris**

**Abstract**
This course provides fundamental knowledge of surface plasmon polaritons and discusses their applications in plasmonics.

**Objective**
Electromagnetic oscillations known as surface plasmon polaritons have many unique properties that are useful across a broad set of applications in biology, chemistry, physics, and optics. The field of plasmonics has arisen to understand the behavior of surface plasmon polaritons and to develop applications in areas such as catalysis, imaging, photovoltaics, and sensing. In particular, metallic nanoparticles and patterned metallic interfaces have been developed to utilize plasmonic resonances. The aim of this course is to provide the basic knowledge to understand and apply the principles of plasmonics. The course will strive to be approachable to students from a diverse set of science and engineering backgrounds.

**Content**
Fundamentals of Plasmonics:
- Basic electromagnetic theory
- Optical properties of metals
- Surface plasmon polaritons on surfaces
- Surface plasmon polariton propagation
- Localized surface plasmons

Applications of Plasmonics:
- Waveguides
- Extraordinary optical transmission
- Enhanced spectroscopy
- Sensing
- Metamaterials

**Lecture notes**
Class notes and handouts

**Literature**

**Prerequisites / notice**
Handouts during the class.

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### Mass Transfer

**151-0917-00L**

**Mass Transfer**

**W** 4 credits 2V+2U

**R. Büchel, S. E. Pratsinis**

**Abstract**
This course presents the fundamentals of transport phenomena with emphasis on mass transfer. The physical significance of basic principles is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

**Objective**
This course is elucidated and quantitatively described. Furthermore the application of these principles to important engineering problems is demonstrated.

**Content**
Fick's laws; application and significance of mass transfer; comparison of Fick's laws with Newton's and Fourier's laws; derivation of Fick's 2nd law; diffusion in dilute and concentrated solutions; rotating disk; dispersion; diffusion coefficients, viscosity and heat conduction (Pr and Sc numbers); Brownian motion; Stokes-Einstein equation; mass transfer coefficients (Nu and Sh numbers); mass transfer across interfaces; Reynolds- and Chilton-Colburn analogies for mass-, heat-, and momentum transfer in turbulent flows; film-, penetration-, and surface renewal theories; simultaneous mass, heat and momentum transfer (boundary layers); homogenous and heterogenous reversible and irreversible reactions; diffusion-controlled reactions; mass transfer and first order heterogenous reaction. Applications.

**Literature**

**Prerequisites / notice**
Three tests are offered for practicing the course material. Participation is voluntary.

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### Rate-Controlled Separations in Fine Chemistry

**151-0927-00L**

**Rate-Controlled Separations in Fine Chemistry**

**W** 4 credits 3G

**M. Mazzotti**

**Abstract**
The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

**Objective**
The students are supposed to obtain detailed insight into the fundamentals of separation processes that are frequently applied in modern life science processes in particular, fine chemistry and biotechnology.

**Content**
The class covers separation techniques that are central in the purification and downstream processing of chemicals and biopharmaceuticals. Examples from both areas illustrate the utility of the methods: 1) Liquid-liquid extraction; 2) Adsorption and chromatography; 3) Membrane processes; 4) Crystallization and precipitation.

**Lecture notes**
Handouts during the class

**Literature**
Recommendations for text books will be covered in the class

**Prerequisites / notice**
Requirements: Thermal separation Processes I (151-0926-00) and Modelling and mathematical methods in process and chemical engineering (151-0940-00)

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### Process Design and Safety

**151-0951-00L**

**Process Design and Safety**

**W** 4 credits 2V+1U

**P. Rudolf von Rohr**

**Abstract**
Process design and safety deals with the fundamentals of process apparatus, plant design and safety.

**Objective**
The goal of the lecture is to expound design characteristics of systems for process engineering applications.
### Content
Fundamentals of plant and apparatus design; materials in the process industries, mechanical design and design rules of main components; pumps and fans; piping and armatures, safety in process industry

### Lecture notes
Script is available, English slides will be distributed

### Literature

### 151-0957-00L
**Practicum in Process Engineering I**

**Prerequisites:** "Einführung in Verfahrenstechnik" (151-0973-00L) and further process engineering courses.

**Abstract**
Practical training at pilot facilities for fundamental processing steps, typical laboratory and pilot facility experiments.

**Objective**
Getting acquainted with unit operations, measuring tools and data processing

**Content**
6 practica in total (2 from Prof. Norris, 4 from Prof. Rudolf von Rohr), details on dates are available at the beginning of the semester in ML H 14 and on our website

- Mixing in Batch reactors
  - Rudolf von Rohr
- Heat transfer
  - Rudolf von Rohr
- Thin-film evaporator
  - Rudolf von Rohr
- Residence time distribution
  - Rudolf von Rohr

**Lecture notes**
Descriptions of the practica available

**Literature**
Information in the description

### 529-0613-00L
**Process Simulation and Flowsheeting**

**Prerequisites:**
- 2 credits
- 2P
- D. J. Norris, P. Rudolf von Rohr

**Abstract**
This course encompasses the theoretical principles of chemical process simulation, as well as its practical application in process analysis and optimization. The techniques for simulating stationary and dynamic processes are presented, and illustrated with case studies. Commercial software packages are presented as a key engineering tool for solving process flowsheeting and simulation problems.

**Objective**
This course aims to develop the competency of chemical engineers in process flowsheeting and simulation. Specifically, students will develop the following skills:

- Deep understanding of chemical engineering fundamentals: the acquisition of new concepts and the application of previous knowledge in the area of chemical process systems and their mechanisms are crucial to intelligently simulate and evaluate processes.
- Modeling of general chemical processes and systems: students have to be able to identify the boundaries of the system to be studied and develop the set of relevant mathematical relations, which describe the process behavior.
- Mathematical reasoning and computational skills: the familiarization with mathematical algorithms and computational tools is essential to be capable of achieving rapid and reliable solutions to simulation and optimization problems. Hence, students will learn the mathematical principles necessary for process simulation and optimization, as well as the structure and application of process simulation software. Thus, they will be able develop criteria to correctly use commercial software packages and critically evaluate their results.

**Content**
Overview of process simulation and flowsheeting
- Definition and fundamentals
- Classification: stationary (steady-state) versus dynamic (transient state) systems
- Fields of application
- Case studies

Process modeling
- Modeling strategies of process systems
- Mass conservation
- Species balance
- Energy conservation
- Momentum balance
- Multiphase-systems: equilibrium & non-equilibrium models
- Process system model

Process simulation
- Process specification
- Introduction to process specification
- Classification of mathematical models: AMS, DOE, DAE, PDE
- Model validation
- Software tools
- Solution methods for process flowsheeting
- Simultaneous methods
- Sequential methods
- Dynamic simulation
- Numerical solution: explicit and implicit methods
- Continuous-discrete simulation: handling of discontinuities

Process optimization and analysis
- Classification of optimization problems
- Linear programming
- Non-linear programming
- Dynamic programming
- Optimization methods in process flowsheeting
- Sequential methods
- Simultaneous methods

Commercial software for simulation: Aspen Plus
- Thermodynamic property methods
- Reaction and reactors
- Separation / columns
- Convergence & debugging
Introduction into the field of microbial biotechnology, covering possible products, fermentation and downstream technology.

Students should be able to identify opportunities for microbial bioprocesses and to go through basic and advanced design procedures for microbial bioprocesses.

Students will obtain a thorough overview over microbial biotech products and the elements of bioprocess design: cellular growth and its modelling; mass transfer in fermentation; bioreaction engineering; bioreactors; downstream processing.

The class will be largely based on the book: Data Analysis: A Bayesian Tutorial by Devinderjit Sivia as well as on class notes and related literature that will be distributed in class.

Prerequisites:
- Fundamentals in Chemistry and Biology (eg Bio-Engineering 151-0600-00)
- Prerequisites: Fundamentals in Chemistry and Biology (eg Bio-Engineering 151-0600-00)
- Probability Theory: The Logic of Science by E. T. Jaynes
Multidisciplinary Courses
The students are free to choose individually from the entire course offer of ETH Zurich, ETH Lausanne and the Universities of Zurich and St. Gallen.

Semester Project

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1008-00L</td>
<td>Semester Project Process Engineering</td>
<td>O</td>
<td>8</td>
<td>17A</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract
The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program. Tutors propose the subject of the project, elaborate the project plan, and define the roadmap together with their students, as well as monitor the overall execution.

Objective
The semester project is designed to train the students in the solution of specific engineering problems. This makes use of the technical and social skills acquired during the master's program.

Industrial Internship

<table>
<thead>
<tr>
<th>Number</th>
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<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1012-00L</td>
<td>Industrial Internship Process Engineering</td>
<td>O</td>
<td>8</td>
<td></td>
<td>external organisers</td>
</tr>
</tbody>
</table>

Abstract
The main objective of the 12-week internship is to expose master's students to the industrial work environment. During this period, students have the opportunity to be involved in on-going projects at the host institution.

Objective
The main objective of the 12-week internship is to expose master's students to the industrial work environment.

Compulsory Electives in Humanities, Social and Political Sciences

Recommended GESS compulsory elective courses (Type B) for D-MAVT.

see GESS Compulsory Electives: Type A: Enhancement of Reflection Capability

see GESS Compulsory Electives: Language Courses ETH/UZH

Master Thesis

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>151-1005-00L</td>
<td>Master's Thesis Process Engineering</td>
<td>O</td>
<td>30</td>
<td>64D</td>
<td>Professors</td>
</tr>
</tbody>
</table>

Abstract
Master's programs are concluded by the master's thesis. The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem. The subject of the master's thesis, as well as the project plan and roadmap, are proposed by the tutor and further elaborated with the student.

Objective
The thesis is aimed at enhancing the student's capability to work independently toward the solution of a theoretical or applied problem.

Seminars, Colloquia, and Additional Courses

<table>
<thead>
<tr>
<th>Number</th>
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<th>Type</th>
<th>ECTS</th>
<th>Hours</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>227-0950-00L</td>
<td>Acoustics</td>
<td>E-</td>
<td>0</td>
<td>0.5K</td>
<td>K. Heutschi</td>
</tr>
</tbody>
</table>

Abstract
Current topics in Acoustics presented mostly by external speakers from academia and industry.

Objective
see above

151-0933-00L | Seminar on Advanced Separation Processes   | E-   | 0     | 1S    | M. Mazzotti   |

Abstract
Research seminar for master's students and doctoral students

Objective
Research seminar for master's students and doctoral students

227-0920-00L | Seminar in Systems and Control             | E-   | 0     | 1S    | F. Dörfler, R. D'Andrea, J. Lygeros, R. Smith |

Abstract
Current topics in Systems and Control presented mostly by external speakers from academia and industry

Objective
see above

227-0970-00L | Research Topics in Biomedical Engineering  | E-   | 0     | 2K    | M. Rudin, S. Kozerke, K. P. Prassmann, M. Stampanoni, K. Stephan, J. Vórdis |

Abstract
Current topics in Biomedical Engineering presented by speakers from academia and industry.

Objective
Getting insight into actual areas and problems of Biomedical Engineering an Health Care.

151-0931-00L | Seminar on Particle Technology             | E-   | 0     | 3S    | S. E. Pratsinis |

Abstract

Objective
Abstract
The goal of the lecture is to convey a basic knowledge in the area of FV materials as well as their construction and production processes and to empower the students to apply the knowledge gained to address current problems in research and practice.

Objective
Students attend and give research presentations for the research they plan to do and at the end of the semester they defend their results and answer questions from research scientists. Familiarize the students with the latest in this field.

401-5650-00L
Zurich Colloquium in Applied and Computational Mathematics
Abstract
Research colloquium

401-5640-00L
ZüKoSt: Seminar on Applied Statistics
Abstract
About 5 talks on applied statistics.
Objective
See how statistical methods are applied in practice.
Content
There will be about 5 talks on how statistical methods are applied in practice.
Prerequisites / notice
This is no lecture. There is no exam and no credit points will be awarded. The current program can be found on the web:
http://stat.ethz.ch/events/zukost
Course language is English or German and may depend on the speaker.

Process Engineering Master - Key for Type
<table>
<thead>
<tr>
<th>O</th>
<th>Compulsory</th>
<th>E-</th>
<th>Recommended, not eligible for credits</th>
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</thead>
<tbody>
<tr>
<td>W+</td>
<td>Eligible for credits and recommended</td>
<td>Z</td>
<td>Courses outside the curriculum</td>
</tr>
<tr>
<td>W</td>
<td>Eligible for credits</td>
<td>Dr</td>
<td>Suitable for doctorate</td>
</tr>
</tbody>
</table>

Key for Hours
<table>
<thead>
<tr>
<th>V</th>
<th>lecture</th>
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<tbody>
<tr>
<td>G</td>
<td>lecture with exercise</td>
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<tr>
<td>U</td>
<td>exercise</td>
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<tr>
<td>S</td>
<td>seminar</td>
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<td>K</td>
<td>colloquium</td>
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<tr>
<td>P</td>
<td>practical/laboratory course</td>
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<tr>
<td>A</td>
<td>independent project</td>
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<tr>
<td>D</td>
<td>diploma thesis</td>
</tr>
<tr>
<td>R</td>
<td>revision course / private study</td>
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</tbody>
</table>

ECTS
European Credit Transfer and Accumulation System
Special students and auditors need special permission from the lecturers.