Kontaktpersonen:
## Inhaltsverzeichnis

### 221 Pflichtmodule

<table>
<thead>
<tr>
<th>Modulnummer</th>
<th>Modulname</th>
<th>Seite</th>
</tr>
</thead>
<tbody>
<tr>
<td>19100</td>
<td>Chemistry and Biology for Environmental Engineers</td>
<td>5</td>
</tr>
<tr>
<td>19120</td>
<td>Sanitary Engineering</td>
<td>9</td>
</tr>
<tr>
<td>19150</td>
<td>German as a Foreign Language</td>
<td>11</td>
</tr>
<tr>
<td>19310</td>
<td>Urban Drainage and Design of Wastewater Treatment Plants</td>
<td>12</td>
</tr>
<tr>
<td>50090</td>
<td>Environmental Fluid Mechanics I</td>
<td>13</td>
</tr>
<tr>
<td>72750</td>
<td>Requirements of Professional Life and Engineering in Practise</td>
<td>15</td>
</tr>
<tr>
<td>900</td>
<td>Schlüsselqualifikationen</td>
<td>17</td>
</tr>
</tbody>
</table>

### 222 Wahlmodule

<table>
<thead>
<tr>
<th>Modulnummer</th>
<th>Modulname</th>
<th>Seite</th>
</tr>
</thead>
<tbody>
<tr>
<td>15010</td>
<td>Integrated River Management and Engineering</td>
<td>19</td>
</tr>
<tr>
<td>15160</td>
<td>Water and Power Supply</td>
<td>21</td>
</tr>
<tr>
<td>34420</td>
<td>Regional and Urban Planning II</td>
<td>23</td>
</tr>
<tr>
<td>50130</td>
<td>Integrated Watershed Modeling</td>
<td>24</td>
</tr>
<tr>
<td>50140</td>
<td>Modeling of Hydrosystems</td>
<td>26</td>
</tr>
<tr>
<td>50210</td>
<td>Geohydrology and Geoengineering</td>
<td>28</td>
</tr>
<tr>
<td>50230</td>
<td>Hydrogeological Investigations</td>
<td>30</td>
</tr>
<tr>
<td>50260</td>
<td>Measurements in the Watercycle</td>
<td>32</td>
</tr>
<tr>
<td>50330</td>
<td>Regional and Urban Planning I</td>
<td>34</td>
</tr>
<tr>
<td>50620</td>
<td>Hydraulic Structures</td>
<td>36</td>
</tr>
<tr>
<td>50650</td>
<td>Planning and Design of Water Supply Facilities</td>
<td>38</td>
</tr>
<tr>
<td>58100</td>
<td>Constructed wetlands for wastewater treatment</td>
<td>40</td>
</tr>
<tr>
<td>75550</td>
<td>Data, Statistics and Optimization</td>
<td>42</td>
</tr>
</tbody>
</table>

### 72050 Module Chalmers University of Technology

<table>
<thead>
<tr>
<th>Modulnummer</th>
<th>Modulname</th>
<th>Seite</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>44</td>
</tr>
</tbody>
</table>
221 Pflichtmodule

Zugeordnete Module:
- 19100 Chemistry and Biology for Environmental Engineers
- 19120 Sanitary Engineering
- 19150 German as a Foreign Language
- 19310 Urban Drainage and Design of Wastewater Treatment Plants
- 50090 Environmental Fluid Mechanics I
- 72750 Requirements of Professional Life and Engineering in Practise
- 900 Schlüsselqualifikationen
Modul: 19100 Chemistry and Biology for Environmental Engineers

2. Modulkürzel: 021230502
3. Leistungspunkte: 6 LP
4. SWS: 6
5. Moduldaauer: Einsemestrig
6. Turnus: Wintersemester
7. Sprache: Weitere Sprachen
8. Modulverantwortlicher: Univ.-Prof. Dr. Jörg Metzger
9. Dozenten: Karl Heinrich Engesser
Brigitte Schwederski
Jörg Metzger
Bertram Kuch
Daniel Dobslaw

10. Zuordnung zum Curriculum in diesem Studiengang:
11. Empfohlene Voraussetzungen:
12. Lernziele:

Lecture: Inorganic chemistry

The students

- know the fundamental concepts of chemistry (atomic structure, periodic system, chemical formulae, stoichiometry, molecular structures) and are able to use them,
- know the principle types of chemical substances and chemical reactions and can apply their knowledge to synthetic problems,
- know about the most important industrial compounds, their preparation and environmental aspects in their application.

Lecture: Organic chemistry

The students

- can identify important functional groups in organic molecules
- know the main compound classes in organic chemistry and the common rules for their nomenclature
- know the most important representatives thereof and are able to draw their structural formulae
- know the structure and properties of important bio-molecules such as fats, carbohydrates, proteins, nucleic acids, ATP, lignin and humic acids
- know the most important reactions involved in chemical and microbial degradation of organic matter
- know summary parameters used to characterize water quality

- know the properties of bio-molecules and can explain their general function with respect to cell structures, enzymatic and immune reactions

- knows selected environmental organic contaminants (PAH, dioxins, pesticides etc.) and their properties

**Lecture: Biology and ecology of water, soil and air systems**

The students

- know about the relation between water, soil and air compartments and many diseases, happening especially in developing countries

- know about the reasons for break out of diseases, the structure and function of prokaryotic and eucaryotic cells as well as the methods for identification and determination of growth conditions and possible growth limitations

- comprehend microbial metabolism, energy production, release and conservation, enzyme syntheses and their regulation.

- know important events and scientists in the history of biology

- know basics in ecology of natural and artificial ('technical') ecosystems as well as selected methods to detect distorted equilibria in technical ecosystems influenced by mankind

**Lecture: Technical and medical microbiology for engineers**

The students

- know the most important microorganisms being active in plants treating waste water, air and contaminated soil

- know the kind of participation in purification and thus the procedures used to make them feel happy as well as the problems associated with excess biomass

- are aware of a detailed overview of the kind of medically important microorganisms and of the most relevant agents of illness met in these plants, this holds also for the compartments 'drinking water' and 'sewage sludge'.

13. Inhalt:

**Lecture: Inorganic chemistry**

- atomic structure: stable nuclear particles, atomic nuclei, isotopes and radioactivity, atomic spectra and the hydrogen atom, heavier atoms
• the periodic system of the elements: the sequence of elements, the electronic configuration of some elements, the periodicity of some properties
• chemical bonding: the ionic bond, the metallic bond, the covalent bond, hydrogen bonding, van der Waals forces
• quantitative Relationships and Stoichiometric Equations
• characterizing chemical reactions: the chemical equilibrium, water: the solvent, acid/base reactions, redox reactions
• descriptive part: selected chemical compounds and their preparation and properties

**Lecture: Organic chemistry**
• functional groups and compound classes
• classification of chemical reactions in organic chemistry
• organic bio-molecules (e.g. proteins, carbohydrates, nucleic acids, fats, humic acids, lignin): structure and function
• chemical and microbial degradation of organic matter in the environment
• summary parameters
• organic environmental contaminants

**Lecture: Biology and ecology of water, soil and air systems**
The following topics are presented within the lecture:
• Introduction in history of microbiology
• Important waterbased/water related diseases
• Function of microscopy of staining techniques
• Structure and function of prokaryotic cells
• Structure and function of eucaryotic cells
• Necessity and effects of microbial nutrition
• Microbial growth relations and possible limitations
• Microbial metabolism: Energy production, conservation and release
• Microbial metabolism: Enzymes syntheses and regulation.

**Lecture: Technical and medical microbiology for engineers**
• Important (sewage) water based /water related diseases/ detection and possible countermeasures
• Important soil and air connected diseases
• (micro)biological principles in application of engineering techniques
• Implication of engineer work on ecosystems /environment protection problems

Some test systems for estimation of (bio)degradability of chemicals will be evaluated

14. Literatur: Lecture notes
pdf download of powerpoint slides for lectures
Exercises as hand-out or download (pdf)

15. Lehrveranstaltungen und -formen:
• 191001 Lecture Inorganic chemistry
• 191002 Lecture Organic chemistry
• 191003 Lecture Biology and ecology of water, soil and air systems
• 191004 Lecture Technical and medical microbiology for engineers

16. Abschätzung Arbeitsaufwand: Time of attendance:
Inorganic chemistry (Schwederski): Lecture, 1 SWS = 14 hours
Organic chemistry (Metzger/Kuch): Lecture, 1 SWS = 14 hours
Biology and ecology of water, soil and air systems (Engesser): Lecture,
  1 SWS = 14 hours
Technical and medical microbiology for engineers (Engesser): Lecture,
  1 SWS = 14 hours
Exercises for Chemistry and Biology for environmental engineers,
  2 SWS = 28 hours
Exam: 2 hours
Sum of attendance: 86 hours
Exercises (group work with presentations): 28 hours
Self-study: 94 hours:

17. Prüfungsnummer/n und -name: 19101 Chemistry and Biology for Environmental Engineers (PL),
  Schriftlich oder Mündlich, 120 Min., Gewichtung: 1

18. Grundlage für ... :

19. Medienform: Video projector (powerpoint) presentation
explations on blackboard, group work with presentations

20. Angeboten von: Hydrochemie und Hydrobiologie in der Siedlungswasserwirtschaft
Modul: 19120 Sanitary Engineering

2. Modulkürzel: 021220012
5. Modulddauer: Einsemestrig

3. Leistungspunkte: 6 LP
6. Turnus: Wintersemester

4. SWS: 4
7. Sprache: Englisch

8. Modulverantwortlicher: Dr.-Ing. Klaus Fischer

9. Dozenten: Klaus Fischer
Harald Schönberger

10. Zuordnung zum Curriculum in diesem Studiengang:

11. Empfohlene Voraussetzungen:

12. Lernziele:
The students have detailed knowledge about waste avoidance procedures in household and industry. Waste avoidance includes the ecology-oriented daily shopping, the substitution of contaminated materials in the industrial production as well as the Zero Emission Society. In the case of unavoidable waste fractions, the students acquire the competence to establish collection and transportation systems for these wastes, within the logistic, economic and legal frame. Main emphasis is given to the collection of recyclables. The students know the relevant factors which influence the waste amount and waste composition in general and in particular within the separate collection of recyclables. The students are acquainted with the state of the art of recycling technologies for separate collected paper, glass, metal and plastic including the pretreatment process. They have knowledge of the aerobic and anaerobic treatment and utilization of separate collected biowaste. Not avoided and recycled waste has to be treated before disposing off e.g. in a landfill site. The students possess a general knowledge of the mechanical and biological treatment technology as well as of the thermal waste treatment. They are able to evaluate the different treatment and recycling processes from an ecological and economic point of view. The students have knowledge about the most important components of the urban drainage and the basic treatment processes of wastewater. Thus they are able to compare different systems in dependence of changing boundary conditions and assess the effectiveness and pros and cons of the systems, e.g. concerning impacts on the environment, economical and operational aspects. They obtain an understanding for system connections between the urban drainage system and the wastewater treatment system as well as between the urban water system and the environment.

13. Inhalt:
Solid Waste Management:
Waste generation and waste composition
National and international regulations for waste
Waste avoidance
Collection and transport of waste
Separate collection of recyclables
Sorting of recyclables
Recycling technologies for paper, glass, metal, plastic
Biological treatment of waste
Waste Disposal
Ecological indicator systems
Waste Water Technology:
Basics of urban drainage and municipal wastewater treatment
Quantity and Composition of Wastewater
Urban drainage systems
stormwater treatment
mechanical wastewater treatment
biological wastewater treatment
sludge treatment
natural close and ECOSAN systems

14. Literatur:
Lecture Manuscripts Solid Waste Management
G. Tchobanoglous et. Al.: Handbook of solid waste management,
3-540-59210-5
Butler, D., Davies, J.W.: Urban drainage, Spon press London,
Henze, M., Harremoes, J., la Coour Jansen, J., Arvin, E:
Wastewater treatment. Springer Verlag Berlin

15. Lehrveranstaltungen und -formen:
• 191201 Vorlesung Solid Waste Management
• 191202 Vorlesung Waste Water
• 191203 Exkursion Sanitary Engineering

16. Abschätzung Arbeitsaufwand:
Time of attendance:
I Solid Waste Management, lecture: 2.0 SWS = 28 hours
II Waste Water: 2 SWS = 28 hours
excursion: 12 hours
exam: 2 hours
sum of attendance: 70 hours
self-study: 110 hours
total: 180 hours

17. Prüfungsnummer/n und -name:
• 19121 Solid Waste Management and Waste Water Technology (PL),
  Schriftlich, 120 Min., Gewichtung: 1
• V Vorleistung (USL-V), Schriftlich oder Mündlich

18. Grundlage für ... :
Urban Drainage and Design of Wastewater Treatment Plants
Industrial Waste Water

19. Medienform:

20. Angeboten von: Abfallwirtschaft und Abluft
### Modul: 19150 German as a Foreign Language

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>4. SWS:</td>
<td>8</td>
<td>7. Sprache:</td>
</tr>
<tr>
<td>8. Modulverantwortlicher:</td>
<td>John Nixon</td>
<td></td>
</tr>
<tr>
<td>10. Zuordnung zum Curriculum in diesem Studiengang:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Empfohlene Voraussetzungen:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Lernziele:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Inhalt:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Literatur:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Lehrveranstaltungen und -formen:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>191501 Seminar German as a Foreign Language I</td>
<td></td>
</tr>
<tr>
<td></td>
<td>191502 Seminar German as a Foreign Language II</td>
<td></td>
</tr>
<tr>
<td>16. Abschätzung Arbeitsaufwand:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Prüfungsnummer/n und -name:</td>
<td></td>
<td></td>
</tr>
<tr>
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<td>19151 German as a Foreign Language I (BSL), Schriftlich oder Mündlich, Gewichtung: 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>19152 German as a Foreign Language II (BSL), Schriftlich oder Mündlich, Gewichtung: 1</td>
<td></td>
</tr>
<tr>
<td>18. Grundlage für ...:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. Medienform:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. Angeboten von:</td>
<td>II/3 Interkultureller Unterricht</td>
<td></td>
</tr>
</tbody>
</table>
Modul: 19310 Urban Drainage and Design of Wastewater Treatment Plants

2. Modulkürzel: 021210251
5. Modulduauer: Einsemestrig

3. Leistungspunkte: 6 LP
6. Turnus: Sommersemester

4. SWS: 5
7. Sprache: Englisch

8. Modulverantwortlicher: Manuel Krauß

9. Dozenten: Harald Schönberger
Manuel Krauß
Peter Maurer
Carsten Meyer

10. Zuordnung zum Curriculum in diesem Studiengang:

11. Empfohlene Voraussetzungen:

12. Lernziele:

13. Inhalt:

14. Literatur:


• Henze, M., Harremoes, J. la Coour Jansen, J., Arvin, E: Wastewater treatment. Springer Verlag Berlin

• Lens, P, Zeeman,G., Lettinga, G.: Decentralised Sanitation and reuse. IWA publishing, London

• Different German standards (DWA, Hennef)

• Lecture notes

15. Lehrveranstaltungen und -formen:

• 193101 Vorlesung und Übung Design of Sewer System and Stormwater Treatment
• 193104 Exkursion
• 193102 Vorlesung und Übung Design of Wastewater Treatment Plants
• 193103 Seminar Case Study

16. Abschätzung Arbeitsaufwand:

17. Prüfungsnummer/n und -name: 19311 Urban Drainage and Design of Wastewater Treatment Plants (PL), Schriftlich, 120 Min., Gewichtung: 1

18. Grundlage für ... :

19. Medienform:

20. Angeboten von: Siedlungswasserbau und Wassergütwirtschaft
Modul: 50090 Environmental Fluid Mechanics I

2. Modulkürzel: 021420012  
5. Modulduer: Einsemestrig

3. Leistungspunkte: 6 LP  
6. Turnus: Wintersemester

4. SWS: 5  
7. Sprache: Englisch

8. Modulverantwortlicher: apl. Prof. Dr.-Ing. Holger Class

9. Dozenten: 
   Holger Class  
   Jürgen Braun  
   Sergey Oladyshkin

10. Zuordnung zum Curriculum in diesem Studiengang:

11. Empfohlene Voraussetzungen: 
   Technical Mechanics  
   • Introduction to the statics of rigid bodies  
   • Introduction to elastostatics  
   • Introduction to the mechanics of incompressible fluids  
   Higher Mathematics  
   • Partial differential equations  
   • Vector analysis  
   • Numerical integration  
   Fundamentals of Flow Mechanics  
   • Conservation equations for mass, momentum, energy  
   • Navier-Stokes, Euler, Reynolds, Bernoulli equation

12. Lernziele:  
   Students have fundamental knowledge of flow in various natural hydrosystems and its application in civil and environmental engineering.

13. Inhalt:  
   The lecture deals with flow in natural hydrosystems with particular emphasis on groundwater / seepage flow and on flow in surface water / open channels. Groundwater hydraulics includes flow in confined, semi-confined and unconfined groundwater aquifers, wells, pumping tests and other hydraulic investigation methods for exploring groundwater aquifers. In addition, questions concerning regional groundwater management (z.B. recharge, unsaturated zone, saltwater intrusion) are discussed. Using the example of groundwater flow, fundamentals of CFD (Computational Fluid Dynamics) are explained, particularly the numerical discretisation techniques finite volume and finite difference. The hydraulics of surface water deals with shallow water equations / Saint Venant equations, unstationary channel flow, turbulence and layered systems. Calculation methods such as the methods of characteristics are explained. The contents are:  
   • Potential flow and groundwater flow  
   • Computational Fluid Dynamics  
   • Shallow water equations for surface water  
   • Charakteristikenmethode  
   • Examples from civil and environmental engineering

14. Literatur:  
   Lecture notes: Hydromechanics, Helmig and Class
Lecture notes: Ausbreitung- und Transportvorgänge in Strömungen, Cirpka

<table>
<thead>
<tr>
<th>15. Lehrveranstaltungen und -formen:</th>
<th>500901 Lecture and Excercise Environmental Fluid Mechanics I</th>
</tr>
</thead>
<tbody>
<tr>
<td>16. Abschätzung Arbeitsaufwand:</td>
<td>Sum 180 h</td>
</tr>
<tr>
<td>17. Prüfungsnummer/n und -name:</td>
<td>50091 Environmental Fluid Mechanics I (PL), Schriftlich, 120 Min., Gewichtung: 1</td>
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<tr>
<td></td>
<td>V Vorleistung (USL-V), Schriftlich</td>
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<tr>
<td>18. Grundlage für ... :</td>
<td>Environmental Fluid Mechanics II</td>
</tr>
<tr>
<td>19. Medienform:</td>
<td>Fundamentals will be developed using the blackboard and presentation tools.</td>
</tr>
<tr>
<td>20. Angeboten von:</td>
<td>Hydromechanik und Hydro systemmodellierung</td>
</tr>
</tbody>
</table>
**Modul: 72750 Requirements of Professional Life and Engineering in Practise**

<table>
<thead>
<tr>
<th>2. Modulkürzel:</th>
<th>021410901</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Leistungspunkte:</td>
<td>3 LP</td>
</tr>
<tr>
<td>4. SWS:</td>
<td>3</td>
</tr>
<tr>
<td>5. Modul:</td>
<td>Dreisemestrig</td>
</tr>
<tr>
<td>6. Turnus:</td>
<td>Wintersemester/ Sommersemester</td>
</tr>
<tr>
<td>7. Sprache:</td>
<td>Englisch</td>
</tr>
<tr>
<td>8. Modulverantwortlicher:</td>
<td>Anne Weiß</td>
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<td>10. Zuordnung zum Curriculum in diesem Studiengang:</td>
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<td>11. Empfohlene Voraussetzungen:</td>
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<tr>
<td>12. Lernziele:</td>
<td>Capability to summarize a water-related topic or the investigations of a scientific, water related problem in terms of presentations, discussion on the topic after presenting. Ability to participate in a scientific discussion, asking questions to presenters. Writing a summary of a visit at a technical site, condense information to a short report.</td>
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<td>13. Inhalt:</td>
<td>Scientific discussions of water related topics or recent scientific problems in an international research environment. These discussions require the specialization in the related field of research and the acquisition of the necessary knowledge. Workshop: presentation techniques. This course covers the basics of presentation structure, layout, voice and body language as it relates to presentation delivery. The aim is to provide students with means to give lively and effective presentations. Instructions for scientific work. Correct citation in scientific papers, visualizing of graphs, time management. The students will learn about scientific argumentation, the importance of correct citations, as well as formal ways to make citations visible and comprehensible.</td>
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<tr>
<td>14. Literatur:</td>
<td>Recent literature on water related topics/ scientific problems.</td>
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</table>
| 15. Lehrveranstaltungen und -formen: | • 727501 Seminar Requirements of Professional Life and Engineering in Practise  
• 727502 Excursion Requirements of Professional Life and Engineering in Practise |
| 16. Abschätzung Arbeitsaufwand: | 90 h  
contact time: Seminar, workshops 50 h, self study 40 h |
| 17. Prüfungsnummer/n und -name: | 72751 Requirements of Professional Life and Engineering in Practise  
(BSL), Sonstige, Gewichtung: 1  
• Presentation of a water related topic (20 Minutes)  
• BSL: presentation(20%)/slide layout (20%)/written version (paper, min. 4 pages) of the presentation (60%) |
• Mandatory attendance in workshops "Presentation Techniques", and "Scientific Work", seminar
• mandatory excursion: description and report of a visit at a technical site

18. Grundlage für ... :

19. Medienform:

20. Angeboten von:
222 Wahlmodule

Zugeordnete Module:
- 15010 Integrated River Management and Engineering
- 15160 Water and Power Supply
- 34420 Regional and Urban Planning II
- 50130 Integrated Watershed Modeling
- 50140 Modeling of Hydrosystems
- 50210 Geohydrology and Geoengineering
- 50230 Hydrogeological Investigations
- 50260 Measurements in the Watercycle
- 50330 Regional and Urban Planning I
- 50620 Hydraulic Structures
- 50850 Planning and Design of Water Supply Facilities
- 58100 Constructed wetlands for wastewater treatment
- 75550 Data, Statistics and Optimization
## Modul: 15010 Integrated River Management and Engineering

<table>
<thead>
<tr>
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<td>8. Modulverantwortlicher:</td>
<td>Ph.D. Stefan Haun</td>
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</tr>
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| 9. Dozenten: | Markus Noack  
Stefan Haun |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | |
| 11. Empfohlene Voraussetzungen: | none (BAU), advisable LWW_Wabau  
one (UMW), advisable LWW_Gew  
Hydraulic Structures (WAREM) |
| 12. Lernziele: | |
| **River Engineering and Sediment Management** | |
| The students, | |
| • are aware of rivers must be regarded and managed based on an integrated approach | |
| • know the basic concept of the European Water Framework Directive (WFD) and the German legal framework for river basin management | |
| • are able to analyze and estimate the consequences of the WFD based inventory for future management | |
| • are aware of sediment transport processes and of the complexity of the interactions and relations | |
| • recognize the possibilities and limitations of sediment management strategies | |
| **Integrated Flood Protection Measures** | |
| The students, | |
| • are aware of the fact that flood protection is an integral process, based on different components (e.g. technical flood protection measures, prevention) | |
| • know the basic physical processes: dynamics of flood events, calculation of discharges and water depths, flood wave propagation, functionality of retention and protection structures: reservoirs, dams and dikes | |
| • know 1-D and 2-D numerical hydro-dynamic models | |
| • are able to apply their knowledge on practical engineering problems related to flood protection | |
| 13. Inhalt: | The module consists of two lectures:  
**River Engineering and Sediment Management** | |
| | • Basic approaches of river basin management (legal framework) | |
| | • Systematics and results of basic inventory due to the WFD | |
| | • Anthropogenic impacts on river basins | |
| | • Origin of sediments and fundamental principles of transport | |
• Sediment management measures on different scales

**Integrated Flood Protection Measures**
• Socio-economic aspects of flood damage
• Calculation of water depths
• Hydro-dynamic flood wave calculation, Saint Venant-equation
• Technical flood protection measures
• Design and operation of retention basins
• Set-up of damage and risk maps, design of overtopping earthen dams and dikes
• Probability of failure, reliability calculation, flood risk management

14. Literatur: Lecture notes and exercise material can be downloaded from the internet. Hints are given for additional literature from the internet as well as libraries.

15. Lehrveranstaltungen und -formen: • 150101 Vorlesung River Engineering and Sediment Management
• 150102 Vorlesung Integrated Flood Protection

16. Abschätzung Arbeitsaufwand: Time of attendance: 55 h
Private study: 125 h

17. Prüfungsnummer/n und -name: 15011 Integrated River Management and Engineering (PL), Schriftlich oder Mündlich, 120 Min., Gewichtung: 1

18. Grundlage für ... :

19. Medienform:

20. Angeboten von: Wasserbau und Wassermengenwirtschaft
Modul: 15160 Water and Power Supply

4. SWS: 0  7. Sprache: Englisch

8. Modulverantwortlicher: Dr. Sabine-Ulrike Gerbersdorf
9. Dozenten: Ralf Minke
              Sabine-Ulrike Gerbersdorf

10. Zuordnung zum Curriculum in diesem Studiengang:

11. Empfohlene Voraussetzungen: None

12. Lernziele:

**Power Demand, Supply and Distribution:**

The students,

- know the German, European and worldwide energy markets related to demand, supply and its distribution capabilities
- are aware of that non-renewable energy sources are strictly limited and time-scales for conversion of energy markets long
- have an idea about the relations between energy, politics, social changes and influences on environment
- have a basic knowledge about present energy conversion systems, theoretical limits of efficiencies, and the potential to enhance applied technology
- have a basic understanding about where and how energy is provided and distributed
- comprehend the balance between load and supply in electrical grids and the resulting necessity for control energy.

**Water Demand, Supply and Distribution:**

The students,

- know the German and worldwide water systems related to demand, supply and its distribution capabilities
- have an overview on the water supply situation all over the world.
- recognize the different possibilities and levels of water supply
- have an idea of the relations between water, politics, social changes and influences on environment.

13. Inhalt:

**Power Demand, Supply and Distribution:**

- Energy demand, energy supply
- Energy generation
  - overview of different types of power plants
  - renewable energy
  - thermal power plants (conventional and nuclear)
- Areas of application of different power plants
• Emission control techniques
• Cooling of thermal power plants
  - methods
  - water resources aspects
• Energy transport and energy storage
• Net techniques
• Energy market
  - trade
  - politics
  - law
• social changes due to energy supply

**Water Demand, Supply and Distribution:**
• Water supply and water distribution: necessity, basic requirements, elements, hydrological cycle
• Water demand calculation: water consumption, water demand, consumer groups, losses, forecasting, design periods
• Water collection: Selection of source, groundwater withdrawal, springwater tapping, surface water intakes, rainwater harvesting, seawater desalination, recycling of treated sewage, drinking water protection areas
• Water transmission and distribution: necessity, hydraulic basics, dimensioning and calculation of branched and closed loop systems.
• Pumps and pumping stations: necessity, types, hydraulics for pumping design, pumping stations and pressure boosters
• Water storage: necessity, types and functions of tanks and reservoirs
• Case study: planning and design of a water supply system for a small town

14. Literatur: Lecture notes can be downloaded from the internet. Hints are given for additional literature from the internet as well as libraries.

15. Lehrveranstaltungen und -formen:
• 151602 Vorlesung Water Demand, Supply and Distribution
• 151601 Vorlesung Energy Demand, Supply and Distribution

16. Abschätzung Arbeitsaufwand:
Time of attendance: 45 h
Private Study: 135 h

17. Prüfungsnummer/n und -name: 15161 Water and Power Supply (PL), Schriftlich, 120 Min., Gewichtung: 1

18. Grundlage für ... :

19. Medienform:

20. Angeboten von: Wasserbau und Wassermengenwirtschaft
Modul: 34420 Regional and Urban Planning II

4. SWS: 4 7. Sprache: Englisch

8. Modulverantwortlicher: Univ.-Prof. Dr.-Ing. Jörn Birkmann
9. Dozenten: Astrid Ley
Jörn Birkmann

10. Zuordnung zum Curriculum in diesem Studiengang:
11. Empfohlene Voraussetzungen: prerequisite modules: Regional and Urban Planning I
12. Lernziele:
The students are acquainted with basic methods of analysis and assessment in spatial planning. The students are able to cope with function, prerequisites and methodical problems of the methods presented. The lectures demonstrate the usage of planning instruments and methods based on planning cases from Germany and other countries.

13. Inhalt:
The course Regional Planning II deals with the following planning methods:
- Indicator-based monitoring and evaluation methods
- Multi-criteria decision analysis (e.g. cost-benefit analysis, utility value analysis, analytic hierarchy process)
- Methods of impact assessment
- Techniques of demand forecast and land suitability analysis
- Hazard and vulnerability analysis (climate change adaptation)

The course Urban Planning II gives an overview on:
- Levels of spatial planning in urban areas
- Urban development planning
- Urban analysis
- Urban renewal
- Urban planning instruments
- Land use planning and implementation planning
- Legal framework

14. Literatur:
Skript Regional and Urban Planning II

15. Lehrveranstaltungen und -formen:
- 344201 Vorlesung Regional Planning II
- 344202 Vorlesung Urban Planning II

16. Abschätzung Arbeitsaufwand:
Time of attendance: approx. 45 hours
Private Study: approx. 120 hours

17. Prüfungszahl und -name:
- 34421 Regional Planning II (LBP), Gewichtung: 1
- 34422 Urban Planning II (LBP), Gewichtung: 1

18. Grundlage für ... :

19. Medienform:
Optional

20. Angeboten von:
Raumentwicklungs- und Umweltplanung
**Modul: 50130 Integrated Watershed Modeling**

<table>
<thead>
<tr>
<th>2. Modulkürzel:</th>
<th>021430009</th>
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<tr>
<td>3. Leistungspunkte:</td>
<td>6 LP</td>
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<td>4. SWS:</td>
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<tr>
<td>5. Moduldauer:</td>
<td>Einsemestrig</td>
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<tr>
<td>6. Turnus:</td>
<td>Sommersemester</td>
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<td>7. Sprache:</td>
<td>Englisch</td>
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<tr>
<td>8. Modulverantwortlicher:</td>
<td>Dr. Sergey Oladyshkin</td>
</tr>
<tr>
<td>9. Dozenten:</td>
<td>Andras Bardossy, Sergey Oladyshkin</td>
</tr>
<tr>
<td>10. Zuordnung zum Curriculum in diesem Studiengang:</td>
<td></td>
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<tr>
<td>11. Empfohlene Voraussetzungen:</td>
<td>Recommended background knowledge: basic knowledge of environmental fluid mechanics, hydrology and geohydrology Prerequisite module: none</td>
</tr>
<tr>
<td>12. Lernziele:</td>
<td><strong>Hydrological Modeling:</strong> Construction of models for each part in the runoff process and how these models are used and integrated in different environment management systems. <strong>Integrated model systems for the groundwater management:</strong> Groundwater and hydrological modelling, Calibration and Validation, Stochastic modelling</td>
</tr>
<tr>
<td>13. Inhalt:</td>
<td><strong>Hydrological Modeling:</strong> What happens to the rain? This is the basic question that needs to be addressed in order to predict the amount of discharge at a certain location in a river system at a given time. Which parts of the fate of rainfall can be determined on a physical basis, and which are still left to empirical searching? Beside the qualitative determination of e.g. the processes of evapotranspiration, infiltration, interflow etc. we also need to describe the quantities of these processes to be able to forecast e.g. flood events. Hydrological watershed modelling is fundamental to integrated water management. There are complex interactions between the elements of the environmental continuum. In order to predict future behaviour and to quantify effects of management changes, quantitative mathematical descriptions are needed. A number of advanced hydrological watershed models have been developed in the last 30 years. A few of them will be reviewed in terms of their data needs and their predictive power. The participants are encouraged to form groups and to use their selected models for the same catchment so that the different approaches are compared. <strong>Integrated model systems for the groundwater management:</strong> Water is unique – no other element is so ubiquitous, vital, vulnerable and threatening at the same time. We must secure our access to clean water, shield our civilization from droughts and floods, use water sustainably in food and energy production, and protect water as part of our environment. However our</td>
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</table>
surroundings behave non-trivially in various time and spatial scales. Moreover, many environmental systems such as hydrological systems (precipitation, evaporation, infiltration, groundwater flow, surface flow, etc.) are heterogeneous, non-linear and dominated by real-time influences of external driving forces. Unfortunately, a complete picture of surroundings water systems is not available, because many of these systems cannot be observed directly and only can be derived using sparse measurements. Modeling plays a very important role in reconstructing (as far as possible) the complete and complex picture of the surroundings water systems and offers a unique way to predict behavior of such multifaceted systems. The current course deals with Integrated Watershed Modelling. The main modelling principles are discussed that helps adequately describe the natural system and its behavior on the basis of the corresponding physical processes. It's imply assumptions about physical concepts, numerical schemes, mathematical formulations, boundary conditions and modelling parameters. The course offers concepts how to incorporate the data into the modelling process, how to calibrate the established model and how to perform validate against the available observation data. The course introduces theoretical concepts and demonstrates how to transfer them into practical applications using hydrological and groundwater modelling. This course is offering insights into the MODFLOW Software that is the USGS's modular hydrologic model. MODFLOW is considered an international standard for simulating and predicting groundwater conditions and groundwater/surface-water interactions. Additionally course is exploring some features of MATLAB software as one of most productive software environment for engineers and scientists.

14. Literatur:

15. Lehrveranstaltungen und -formen:
• 501301 Lecture and excercise Hydrological Modeling
• 501302 Lecture and excercise Integrated model systems for the groundwater management

16. Abschätzung Arbeitsaufwand:

17. Prüfungsnr/n und -name:
50131 Integrated Watershed Modeling (PL), Schriftlich, 120 Min., Gewichtung: 1

18. Grundlage für ... :

19. Medienform:

20. Angeboten von: Stochastische Simulation und Sicherheitsforschung für Hydrosysteme
## Modul: 50140 Modeling of Hydrosystems

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<td>4. SWS:</td>
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<td>7. Sprache:</td>
<td>Englisch</td>
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</table>

8. Modulverantwortlicher: Univ.-Prof. Dr.-Ing. Rainer Helmig

9. Dozenten: Bernd Flemisch, Rainer Helmig

10. Zuordnung zum Curriculum in diesem Studiengang:

11. Empfohlene Voraussetzungen: Recommended background knowledge:
   Higher Mathematics:
   - Partial differential equations
   - Numerical integration
   
   Fundamentals of fluid mechanics:
   - Conservation equations for mass, momentum, energy
   - Mathematical descr

12. Lernziele: Students can select suitable numerical methods for solving problems from fluid mechanics and have basic knowledge of implementing a numerical model in C.

13. Inhalt: Discretisation methods:
   - Knowledge of the common methods (finite differences, finite elements, finite volume) and the differences between them
   - Advantages and disadvantages and of the methods and thus of their applicability
   - Derivation of the various methods
   - Use and choice of the correct boundary conditions for the various methods

   Time discretisation:
   - Knowledge of the various possibilities
   - Assessment of stability, computational effort, precision
   - Courant number, CFL criterion

   Transport equation:
   - Various discretisation possibilities
   - Physical background
   - Stability criteria of the methods (Peclet number)

   Clarification of concepts: model, simulation
   Application of the finite element method to the stationary groundwater equation Setting-up of a simulation programme for modeling groundwater:
   - Programme requirements
   - Programming individual routines

   Fundamentals of programming in C:
   - Control structures
- Functions
- Arrays
- Debugging

Visualisation of the simulation results

| 14. Literatur:                  | Lecture notes: Modeling of Hydrosystems, Helmig  |

| 15. Lehrveranstaltungen und -formen: | • 501403 Lecture and Excercise Modeling of Hydrosystems 2, Applications  |
|                                    | • 501401 Lecture and Excercise Modeling of Hydrosystems 1, Fundamentals |

| 16. Abschätzung Arbeitsaufwand: | Sum: 180h |

| 17. Prüfungsnummer/n und -name: | 50141 Modeling of Hydrosystems (PL), Schriftlich, 120 Min., Gewichtung: 1 |

| 18. Grundlage für ... :         | Fundamentals will be developed using the blackboard and presentation tools. Group exercises help in understanding the obtained theoretical basis. |

| 20. Angeboten von:              | Hydromechanik und Hydrosystemmodellierung |
Modul: 50210 Geohydrology and Geoengineering

2. Modulkürzel: 021430004
5. Modulduer: Einsemestrig
3. Leistungspunkte: 6 LP
6. Turnus: Sommersemester
4. SWS: 4
7. Sprache: Englisch
8. Modulverantwortlicher: Univ.-Prof. Dr.-Ing. Christian Moormann
9. Dozenten: Christian Moormann

11. Empfohlene Voraussetzungen:
Recommended background knowledge:
Geoengineering:
Basic knowledge of mechanics and groundwater flow
Geohydrology: Basic knowledge of groundwater hydraulics
Prerequisite module: none

12. Lernziele:
Geoengineering:
The students have the required skills to treat fundamental soil mechanics problems such as: groundwater flow, consolidation, slope stability, settlement and soil strength calculations.

Geohydrology:
The students have a strong foundation in the applied skills required to locate, analyse, assess, develop, and protect groundwater resources.

13. Inhalt:
Geoengineering:
This course includes information about the origin of soils and soil classification methods. It also includes the basics of groundwater flow as used in soil mechanics. Common geotechnical problems such as slope stability and soil consolidation are discussed and clarified. The stresses in soil, stiffness of soils and strength of soils are explained in details.

Geohydrology:
Covers the most important concepts of geology and hydrogeology, the interpretation of hydrogeological information from maps, aerial photographs, geophysical measurements and field data, the principles of groundwater development and the understanding of hydrogeological systems through case studies. A brief overview is given on the analysis of hydrochemical data and isotopes.

14. Literatur:
Geoengineering
Lecture notes can be downloaded from the Internet, PowerPoint presentations

Geohydrology:

Lecture notes can be downloaded from the Internet via the ILIAS system, PowerPoint presentations
Wichtig: mindestens ein konkreter Titel (Monographie, Artikel o.ä.) ist anzugeben

15. Lehrveranstaltungen und -formen:
   • 502102 Lecture Geohydrology
   • 502101 Lecture Geoengineering

16. Abschätzung Arbeitsaufwand:
   Geoengineering: 84h
   Geohydrology: 54h

17. Prüfungsnummer/n und -name:
   50211 Geohydrology and Geoengineering (PL), Schriftlich, 120 Min., Gewichtung: 1

18. Grundlage für ... :

19. Medienform:

20. Angeboten von: Geotechnik
## Modul: 50230 Hydrogeological Investigations

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<td>4. SWS:</td>
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<td>8. Modulverantwortlicher:</td>
<td>Dr. Jochen Seidel</td>
</tr>
<tr>
<td>9. Dozenten:</td>
<td>Jochen Seidel, Jürgen Braun, Oliver Trötschler</td>
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<tr>
<td>11. Empfohlene Voraussetzungen:</td>
<td>Kenntnisse im Bereich Hydrologie, Hydrogeologie, Fluidmechanik</td>
</tr>
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</table>

### 12. Lernziele:

### 13. Inhalt:
Die Veranstaltung besteht aus einer eingehenden Vorlesung und einem praktischen Teil in Form eines 2-tägigen Geländepraktikums.

**Vorlesungsteil:**
Theoretischer Hintergrund der auf dem Feld und im Labor angewandten Methoden, d.h. Grundlagen von Grundwasserhydraulik, Hydrogeologie und den entsprechenden Untersuchungsmethoden wie Pumpversuche und Traceversuche.

**Feldpraktikum auf dem Testgelände "Horkheim" (Neckar):**
- Bodenproben / Rammkernsondierung
- Vermessung
- Piezometrische Höhe / Pumpversuch - Wiederanstiegsversuch (recovery test)
- Piezometer test / Slugtest
- Tracer-Versuch
- Grundwasserchemie
- Hydrogeologische Geländeerkundung

**Laborversuche:**
- Säulenexperimente zum Dispersionskoeffizienten und der hydraulischen Durchlässigkeit
- Korngrößenverteilung (Bodencharakterisierung)

### 14. Literatur:

### 15. Lehrveranstaltungen und -formen:
- 502301 Lecture Field Course Hydrology
- 502302 Lecture Pumping Test Analysis

### 16. Abschätzung Arbeitsaufwand:
<table>
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<tr>
<th>17. Prüfungsnummer/n und -name:</th>
<th>50231 Hydrogeological Investigations (PL), Schriftlich, 120 Min., Gewichtung: 1</th>
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<tbody>
<tr>
<td></td>
<td>- Referat (unbenotete Prüfungsleistung)</td>
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<td></td>
<td>- Klausur (120 Min.)</td>
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<td>- Die Teilnahme am 2-tägigen Feldpraktikum ist verpflichtend.</td>
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<th>18. Grundlage für ... :</th>
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| 20. Angeboten von:            | Hydrologie und Geohydrologie                                                     |
Modul: 50260 Measurements in the Watercycle

4. SWS: 4  7. Sprache: Englisch

8. Modulverantwortlicher: Univ.-Prof. Dr. Johan Alexander Huisman

10. Zuordnung zum Curriculum in diesem Studiengang:

11. Empfohlene Voraussetzungen: Recommended background knowledge:
(I) Basic knowledge in Hydromechanics/Hydraulics corresponding to a lecture with approx. 6-8 ECTS
(II) Basic physics of electricity and wave propagation

12. Lernziele: The relevant principles of key measurement methodologies used to characterize the water cycle will be introduced and discussed so that the students can assess the advantages and disadvantages of the available measurements methodologies. In addition, the students will be sensitized for potential sources of error and uncertainty of measurements.

13. Inhalt: (I) Measuring surface hydrological fluxes
- Precipitation measurements
- Evaporation and evapotranspiration measurements
- Discharge measurements
- Water quality measurements

(II) Measuring subsurface hydrological fluxes
- Infiltration measurements
- Water potential measurements
- Physical principles of water content measurements
- Electromagnetic methods (TDR, GPR, Remote sensing)
- Electrical methods (ERT, SP, SIP)


15. Lehrveranstaltungen und -formen: • 502601 Lecture Hydrometry and Remote Sensing
• 502602 Lecture Hydrogeophysics

16. Abschätzung Arbeitsaufwand: Sum 180h

17. Prüfungsnummer/n und -name: 50261 Measurements in the Watercycle (BSL), Schriftlich oder Mündlich, 120 Min., Gewichtung: 1

18. Grundlage für ... :
19. Medienform:

20. Angeboten von: Hydrogeophysik
Modul: 50330 Regional and Urban Planning I

4. SWS: 4  7. Sprache: Englisch

8. Modulverantwortlicher: Univ.-Prof. Dr.-Ing. Jörn Birkmann
9. Dozenten: Jörn Birkmann, Astrid Ley

11. Empfohlene Voraussetzungen:

12. Lernziele:
The students understand the major challenges, objectives, strategies and instruments in spatial planning and urban development in Europe as well as in developing and countries in transition. The students are acquainted with the legal framework of comprehensive and sector planning and know the capabilities and limits of public planning as "positive" and "negative" planning.

13. Inhalt:
The course Regional Planning I covers the following topics:
- International Planning studies
- Overview on current planning issues
- Basic Terms of Spatial Planning
- Strategies in Spatial Planning
- Instruments of Spatial Planning
- Performance of Plans, Assessing Plans

The course Urban Planning I provides an overview on the origin of planned urban development, starting in Greece and the Roman Empire, passing through all important periods up to the 21st century. The second part introduces urbanisation processes in third world countries, planned and unplanned urban conglomerations, including Mega Cities and Global Cities.

14. Literatur:
Birkmann et al. (2010): Adaptive urban governance: nes challenges for the second generation of urban adaptation studies to climate change In: Sustainability science 5

15. Lehrveranstaltungen und -formen:
- 503301 Lecture Regional Planning I
- 503302 Lecture Urban Planning I

16. Abschätzung Arbeitsaufwand:
Time of attendance: approx. 45 hours
Private Study: approx. 135 hours

17. Prüfungsnummer/n und -name:
50331 Regional and Urban Planning I (LBP), Schriftlich, 120 Min., Gewichtung: 1

18. Grundlage für ...:
19. Medienform:

20. Angeboten von: Raumentwicklungs- und Umweltplanung
Modul: 50620 Hydraulic Structures

2. Modulkürzel: 021410106
5. Moduldauer: Zweisemestrig
3. Leistungspunkte: 6 LP
6. Turnus: Wintersemester
4. SWS: 4
7. Sprache: Englisch

8. Modulverantwortlicher: Univ.-Prof. Dr.-Ing. Silke Wieprecht
9. Dozenten: Silke Wieprecht
Kristina Terheiden
Katharina Sauer
Jan Görtz

10. Zuordnung zum Curriculum in diesem Studiengang:

11. Empfohlene Voraussetzungen:

12. Lernziele:

**Advanced Studies in Hydraulic Structures**: The students,

- know about the basic features of hydraulic structures
- have an overview what are the main components and know how to arrange them in order to ensure a satisfying operation
- are able to dimension all parts of different hydraulic structures
- are aware of implicating river works into an overall context of a fluvial system and know how to act and to evaluate in spatial and temporal interrelation
- are able to realize the economic and ecologic significance of hydraulic structures as dams, reservoirs and hydro power plants

**Case Study in Hydraulic Structures**: The students,

- are able to use of the gained theoretical knowledge with the help of a practical example
- are aware of the technical relations and their effects on non-technical areas of interest
- can give a well-founded argumentation of chosen estimations and are able to present their own results
- can give a convincing presentation
- are able to assess objectively different planning alternatives

13. Inhalt:

**Advanced Studies in Hydraulic Structures**: The course deals with main structural components of hydraulic engineering schemes such as weirs, dams, hydro power plants, pipelines and ancillary works. The main features as hydraulic and structural dimensioning are treated. The application of structural power plants, reservoirs and river development works is discussed. Conventional engineering methods as well as approaches with improved environmental compatibility are taken into consideration.

**Case Study in Hydraulic Structures**: The case study uses the content of the lecture "Advanced Studies in Hydraulic Structures". In working groups of 3 to 5 students a real hydraulic structures will be planned and completely dimensioned. There are hydraulic
calculations to be carried out as hydraulic capacity of spillway, dimensioning of stilling basin, hydrological and sedimentological calculations. As well the stabilities of the structures itself has to be checked. Additionally an analysis of the demand of potentially provided electricity, drinking water or irrigation water, resp. is required. The intermediate results will be presented by the groups. Every student has to deliver at least one presentation. Finally a poster for the final presentation and assessment has to be designed. This is the basis for the development of the assessment criteria for the different alternatives.

14. Literatur: Lecture notes can be downloaded from the internet. Additional detailed information for the case study will be provided during the lectures.

15. Lehrveranstaltungen und -formen: • 506201 Lecture and Practice Advanced Studies in Hydraulic Structures
• 506202 Lecture and Presentation Case Study in Hydraulic Structures

16. Abschätzung Arbeitsaufwand: Sum 180h

17. Prüfungsnummer/n und -name: 50621 Hydraulic Structures (LBP), Schriftlich, 120 Min., Gewichtung: 1

18. Grundlage für ... : 

19. Medienform: 

20. Angeboten von: Wasserbau und Wassermengenwirtschaft
Modul: 50650 Planning and Design of Water Supply Facilities

4. SWS: 4  7. Sprache: Englisch
8. Modulverantwortlicher: Ralf Minke
9. Dozenten: Ralf Minke


12. Lernziele:

The students,

- Are able to plan and design centralised water supply systems as a part of rural and urban infrastructure.
- Are able to calculate dimensions of all elements of centralised water supply systems.
- Are able to calculate costs of all elements of centralised water supply systems.
- have an idea of the relations between water, politics, social changes and influences on environment and on planning process.
- Are able to design in detail all elements of centralised water supply systems.

13. Inhalt:

- Planning process as function of topografical, economical, social, environmental boundaries.
- Water demand calculation: water consumption, water demand, consumer groups, losses, forecasting, design periods.
- Water collection: Selection of source, groundwater withdrawal, springwater tapping, surface water intakes, rainwater harvesting, seawater desalination, recycling of treated sewage, drinking water protection areas, details of planning and design.
- Water transmission and distribution: necessity, hydraulic basics, dimensioning and calculation of branched and closed loop systems, details of planning and design.
- Pumps and pumping stations: necessity, types, hydraulics for pumping design, pumping stations and pressure boosters, details of planning and design.
- Water storage: necessity, types and functions of tanks, water towers and reservoirs, details of planning and design.
- Cost calculation: Cost functions for different facilities, Calculation process, calculation of water tariff.

14. Literatur:

Lecture notes can be downloaded from the internet.
- Mutschmann, J, Stimmelmayr, F.: Taschenbuch der Wasserversorgung, Vieweg-Verlag
Hints are given for additional literature from the internet as well as libraries.

15. Lehrveranstaltungen und -formen:

- 506503 Excursions to planning area and water supply company
- 506502 Case Study Planning and design of water supply facilities
- 506501 Lecture Planning and design of water supply facilities

16. Abschätzung Arbeitsaufwand:

Sum 180h

17. Prüfungsnummer/n und -name:

50651 Planning and Design of Water Supply Facilities (LBP), Schriftlich, Gewichtung: 1

18. Grundlage für ... :

19. Medienform:

20. Angeboten von:

Siedlungswasserbau und Wassergüterwirtschaft
Modul: 58100 Constructed wetlands for wastewater treatment

3. Leistungspunkte: 3 LP 6. Turnus: Unregelmäßig
4. SWS: 2 7. Sprache: Englisch

8. Modulverantwortlicher: Anne Weiß
9. Dozenten: Dr.-Ing. Christos Akratos

10. Zuordnung zum Curriculum in diesem Studiengang:

11. Empfohlene Voraussetzungen: Chemistry and Biology for Engineers
Sanitary Engineering

12. Lernziele:

The goal of this course is to provide advanced knowledge of the processes and concepts of constructed wetlands systems to the students. They will get familiar with the existing scientific, technical, and economic practices of using constructed wetlands for wastewater and sewage sludge treatment. For this reason all late scientific developments concerning municipal industrial and agro-industrial wastewater treatment and sewage sludge treatment will be presented. At the end of the course the students will be able to:

- Understanding constructed wetlands' main mechanisms.
- Perform a rough design of constructed wetlands treating various waste waters and sewage sludge

13. Inhalt:

Basic principles of constructed wetlands
- Attached growth treatment systems
- Constructed wetlands (basic principles, types, vegetation, porous media, etc)
- Pollutant removal mechanisms and kinetics (organic matter, nitrogen, phosphorus, heavy metals, suspended solids)
- Sewage sludge treatment (de-watering mechanisms, mineralisation processes)

Design of constructed wetlands
- Constructed wetlands' design models (hydrodynamic and pollutant removal models)
- Determination of required constructed wetland area
- Sewage sludge treatment (sludge loading rates, duration of loading and resting periods)

Case studies
- Municipal wastewater treatment
- Agro-industrial wastewater treatment
- Sewage sludge treatment

14. Literatur:

<table>
<thead>
<tr>
<th>15. Lehrveranstaltungen und -formen:</th>
<th>• 581001 Vorlesung Design of constructed wetlands</th>
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<tr>
<td>17. Prüfungsnummer/n und -name:</td>
<td>58101 Constructed wetlands for wastewater treatment (BSL), Schriftlich, 120 Min., Gewichtung: 1 report</td>
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<td>19. Medienform:</td>
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<td>20. Angeboten von:</td>
<td>Wasser- und Umweltsystemmodellierung</td>
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Modul: 75550 Data, Statistics and Optimization

2. Modulkürzel: 021440002
5. Modulsdauer: Einsemestrig

3. Leistungspunkte: 6 LP
6. Turnus: Wintersemester

4. SWS: -
7. Sprache: Englisch

8. Modulverantwortlicher: Univ.-Prof. Dr.-Ing. Wolfgang Nowak

9. Dozenten: Prof. Dr.-Ing. Wolfgang Nowak
Dr. Anneli Guthke

10. Zuordnung zum Curriculum in diesem Studiengang:

11. Empfohlene Voraussetzungen:

12. Lernziele:

Teil „Data and Statistics“:

Teil „Optimierung“:

13. Inhalt:

Teil „Data and Statistics“:
• Preprocessing, Visualisierung und Analyse von Daten
• Uni- und bivariate deskriptive Statistik
• Lineare Regression
• Grundlagen der Wahrscheinlichkeitsrechnung
• Ausgewählte Verteilungen
• Zufallssimulation

Teil “Optimization”:
• Definition und Klassifizierung von Optimierungsproblemen
• No-Free-Lunch Theorem
• Einführung von Optimierungsalgorithmen mit Anwendungsbeispielen
• Simplex
• Steepest Descent, Newton, Levenberg-Marquardt
• Heuristiken: Evolutionäre Algorithmen, Simulated Annealing
Modellkalibrierung als Optimierungsproblem und als bedingte Zufallssimulation

14. Literatur:
slides, script
Part „Data and Statistics“:
Part „Optimization“:

15. Lehrveranstaltungen und -formen:
• 755501 Data, Statistics and Optimization; Vorlesung mit Übung

16. Abschätzung Arbeitsaufwand:
Data, Statistics and Optimization; Vorlesung mit Übung; 4,0 SWS

17. Prüfungsnummer/n und -name:
75551 Data, Statistics and Optimization (PL), 120 Min., Gewichtung: 1
Prüfungsleistung (PL): Klausur (120 Minuten) zur Vorlesung „Daten, Statistik und Optimierung“

18. Grundlage für ...:
Integrated Watershed Modelling, Stochastical Modelling and Geostatistics

19. Medienform:
Powerpoint, Tafel, Computerübungen (Excel, MATLAB)

20. Angeboten von:
Modul: 72050 Module Chalmers University of Technology

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<th>5. Moduldauer:</th>
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<td>3. Leistungspunkte:</td>
<td>60 LP</td>
<td>6. Turnus:</td>
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8. Modulverantwortlicher:

9. Dozenten:

10. Zuordnung zum Curriculum in diesem Studiengang:

11. Empfohlene Voraussetzungen:

12. Lernziele:

13. Inhalt:

14. Literatur:

15. Lehrveranstaltungen und -formen:

16. Abschätzung Arbeitsaufwand:

17. Prüfungsnummer/n und -name: 72051 Module Chalmers University of Technology (PL), Gewichtung: 1

18. Grundlage für ... :

19. Medienform:

20. Angeboten von: Berufspädagogik mit Schwerpunkt Technikdidaktik