# Modulhandbuch

## Studiengang Double Masters Degrees Water Resources Engineering and Management

Prüfungsordnung: 2012

Wintersemester 2015/16
Stand: 08. Oktober 2015

Universität Stuttgart
Keplerstr. 7
70174 Stuttgart

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# 110 Incoming

Zugeordnete Module:

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| 111 | Compulsory Modules |
| 112 | Elective Moduls |
| 80990 | Master`s Thesis WAREM |

# 111 Compulsory Modules

Zugeordnete Module:

| | |
|---|---|
| 19330 | Industrial Waste Water |
| 50090 | Environmental Fluid Mechanics I |
| 50120 | Environmental Informatics |
| 55980 | Seminar Module |
| 55990 | German Language |

# Modul: 50090 Environmental Fluid Mechanics I

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| 2. Modulkürzel: | 021420012 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, WiSe |
| 4. SWS: | 5.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Apl. Prof. Holger Class |
| 9. Dozenten: | • Jürgen Braun<br>• Holger Class<br>• Sergey Oladyshkin |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Incoming -->Semi-Compulsory Modules<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Pflichtmodule<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Incoming -->Compulsory Modules<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Pflichtmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Vertiefungsmodule -->Vertiefungsmodule Pflicht<br>➞ |
| 11. Empfohlene Voraussetzungen: | Technical Mechanics<br>• Introduction to the statics of rigid bodies<br>• Introduction to elastostatics<br>• Introduction to the mechanics of incompressible fluids<br>Higher Mathematics<br>• Partial differential equations<br>• Vector analysis<br>• Numerical integration<br>Fundamentals of Flow Mechanics<br>• Conservation equations for mass, momentum, energy<br>• 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 und finite difference. The |

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| | hydraulics of surface water deals with shallow water equations / Saint Venant equations, unstationary channel flow, turbulence und layered systems. Calculation methods such as the methods of characteisitcs are explained. The contents are:<br><br>• Potential flow and groundwater flow<br>• Computational Fluid Dynamics<br>• Shallow water equations for surface water<br>• Charakteristikenmethode<br>• Examples from civil and environmental engineering |
| 14. Literatur: | Lecture notes: Hydromechanics, Helmig and Class<br>Lecture notes: Ausbreitungs- und Transportvorgänge in Strömungen, Cirpka<br>White, F.M.: Fluid Mechanics, WCB/McGraw-Hill, New York, 1999<br>Freeze, R.A. and Cherry J.A.: Groundwater, Prentice Hall, 1979 |
| 15. Lehrveranstaltungen und -formen: | 500901 Lecture and Excercise Environmental Fluid Mechanics I |
| 16. Abschätzung Arbeitsaufwand: | Sum 180 h |
| 17. Prüfungsnummer/n und -name: | • 50091 Environmental Fluid Mechanics I (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0<br>• V Vorleistung (USL-V), schriftliche Prüfung |
| 18. Grundlage für ... : | 50170 Environmental Fluid Mechanics II |
| 19. Medienform: | Fundamentals will be developed using the blackboard and presentation tools. |
| 20. Angeboten von: | Institut für Wasser- und Umweltsystemmodellierung |

# Modul: 50120 Environmental Informatics

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| 2. Modulkürzel: | 021430002 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, WiSe |
| 4. SWS: | 4.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Univ.-Prof. Andras Bardossy |
| 9. Dozenten: | Johannes Riegger |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Incoming -->Semi-Compulsory Modules<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Wahlmodule<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Incoming -->Compulsory Modules<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Wahlmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Spezialisierungsmodule<br>M.Sc. Water Resources Engineering and Management<br>➞ Vertiefungsmodule -->Vertiefungsmodule Wahlpflicht<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Zusatzmodule |
| 11. Empfohlene Voraussetzungen: | |
| 12. Lernziele: | Skills in Spreadsheet Calculations for Data Processing,Design, Creation, Handling and Application of Relational Database Management Systems for Environmental Issues, Creation and display of Environmental GIS data sets .Use of GIS functionalities to investigate spatial and attribute relationships |
| 13. Inhalt: | **Information Processing & Environmental Data Management** (Excel & Access):<br>Environmental Database Design, Relational Database Management, Data Normalization, Data Security<br>**GIS Tools in Environmental Engineering (ArcGIS):**<br>Basics of GIS, Data implementation, Spatial Structures and Attributes, Display of Environmental Information, Charts & Diagrams, Digitization, Spatial and Logical Queries, Data Links, Geo-Referencing, Field Calculations |
| 14. Literatur: | Script: J. Riegger ‘Environmental Informatics’<br>User Handbooks for Excel, Access, ArcGIS<br>**Getting to know ArcGIS Desktop ISBN: 9781589482609** |
| 15. Lehrveranstaltungen und -formen: | • 501201 Lecture Environmental Data Management<br>• 501202 Lecture GIS Tools in Environmental Engineering |
| 16. Abschätzung Arbeitsaufwand: | Time of attendance: approx. 56 hours<br>Private Study: approx. 124 hours during semester |

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| | Sum: 180h |
| 17. Prüfungsnummer/n und -name: | • 50121 Environmental Informatics (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0<br>• V Vorleistung (USL-V), schriftliche Prüfung |
| 18. Grundlage für ... : | |
| 19. Medienform: | |
| 20. Angeboten von: | |

# Modul: 55990 German Language

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|---|---|---|---|
| 2. Modulkürzel: | - | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 3.0 LP | 6. Turnus: | unregelmäßig |
| 4. SWS: | 0.0 | 7. Sprache: | - |

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| 8. Modulverantwortlicher: | John Nixon |
| 9. Dozenten: | |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Incoming -->Compulsory Modules<br>➞ |
| 11. Empfohlene Voraussetzungen: | |
| 12. Lernziele: | |
| 13. Inhalt: | |
| 14. Literatur: | |
| 15. Lehrveranstaltungen und -formen: | |
| 16. Abschätzung Arbeitsaufwand: | |
| 17. Prüfungsnummer/n und -name: | 55991 German Language (BSL), schriftliche Prüfung, Gewichtung: 1.0 |
| 18. Grundlage für ... : | |
| 19. Medienform: | |
| 20. Angeboten von: | |

# Modul: 19330 Industrial Waste Water

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|---|---|---|---|
| 2. Modulkürzel: | 021210151 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, WiSe |
| 4. SWS: | 4.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Prof./Uni.Reg.deBlumenau Uwe Menzel |
| 9. Dozenten: | • Uwe Menzel<br>• Michael Koch |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Incoming -->Semi-Compulsory Modules<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Incoming -->Compulsory Modules<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Spezialisierungsmodule<br>M.Sc. Water Resources Engineering and Management<br>➞ Zusatzmodule |
| 11. Empfohlene Voraussetzungen: | |
| 12. Lernziele: | Students have:<br>• a basic understanding for the problems and requirements of industrial waste water treatment<br>• an overview of measures for production integrated environmental protection, relevant treatment methods for process water and its characterization<br>• an overview of water analysis including sampling, the main principles of different analytical techniques and the ways to assure the quality of chemical analysis |
| 13. Inhalt: | Fundamentals of industrial waste water treatment Determiniation of current situation possible process integrated measures measures for reuse and recirculation of water mass and concentration balance Basic elements and examples for applications to the advanced purification processes: biological waste water treatment Sampling and analytical techniques using: onsite measurements oxidation - reduction acids and bases sum parameters photometry spectrometry chromatography Analytical quality assurance |
| 14. Literatur: | -lecture notes (approx. 400 pages) -exercisis -Lehr- und Handbuch der Abwassertechnik, 4. revised edition, volume I. GFA-Verlag St. Augustin 1994. -ATV V: Lehr- und Handbuch der Abwassertechnik, volume v: Organisch verschmutzte Abwässer der Lebensmittelindustrie, Wilhelm Ernst & Sohn Verlag, Berlin. -ATV VII: Lehr- und Handbuch der Abwassertechnik, volume VII: Industrieabwässer mit anorganischen Inhaltsstoffen, Wilhelm Ernst & Sohn Verlag, Berlin. (in each case the current edition) -Deutsche Einheitsverfahren zur Wasser-, Abwasser und Schlammuntersuchung -Standard Methods for the Examination of Water and Wastewater -Wenclawiak, Koch, Hajicostas: Quality Assurance in Analytical Chemistry. Springerverlag 2003 |
| 15. Lehrveranstaltungen und -formen: | • 193301 Lecture Treatment of Industrial Waste Water<br>• 193302 Lecture Water Analysis and Analytical Quality Control |

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| 16. Abschätzung Arbeitsaufwand: | Time of attendance:<br>I Treatment of Industrial Waste Water: 2 SWS = 24 hours<br>II Water Analysis and Analytical Quality Control: 2 SWS = 24 hours<br>Exam: 2 hours<br>sum of attendance: 50 hours<br>self-study: 130 hours<br>**total: 180 hours** |
| 17. Prüfungsnummer/n und -name: | 19331 Industrial Waste Water (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0 |
| 18. Grundlage für ... : | |
| 19. Medienform: | power-point-presentation, blackboard and over-head projector |
| 20. Angeboten von: | Siedlungswasserwirtschaft und Wasserrecycling |

# Modul: 55980 Seminar Module

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| 2. Modulkürzel: | [pord.modulcode] | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 3.0 LP | 6. Turnus: | jedes Semester |
| 4. SWS: | 2.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Anne Weiß |
| 9. Dozenten: | |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Incoming -->Compulsory Modules<br>➞ |
| 11. Empfohlene Voraussetzungen: | |
| 12. Lernziele: | Capability to summarize a water-related topic or the investigations of a scientific, water related problem in terms of two 20 min presentations, discussion on the topic after presenting.<br><br>Ability to participate in a scientific discussion, asking questions to presenters.<br><br>Writing a summary of a visit at a technical site, condense information to a short report. |
| 13. Inhalt: | Treatment of a water related topic or a recent scientific problem in an international research environment.<br><br>The successful treatment of the scientific problem requires the specialisation in the related field of research and the acquisition of the necessary knowledge.<br><br>Week-end workshop regarding 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<br><br>Course:Correct Citation in scientific papers.The students will know about the importance of correct citations, see different types of citations and learn formal ways to make citations visible and comprehensible. |
| 14. Literatur: | Recent literature on the water related topic/ scientific problem |
| 15. Lehrveranstaltungen und -formen: | |
| 16. Abschätzung Arbeitsaufwand: | 90h (contact time 70h) |
| 17. Prüfungsnummer/n und -name: | 55981 Seminar Module (BSL), Sonstiges, Gewichtung: 1.0, Course achievements: Compulsary attendance in: seminar, workshop "presentation techniques", course "Correct Citation in scientific papers", excursions. Two presentations, one written short report (USL) |
| 18. Grundlage für ... : | |
| 19. Medienform: | |
| 20. Angeboten von: | |

# 112 Elective Moduls

Zugeordnete Module: 19100 Chemistry and Biology for Environmental Engineers

# Modul: 19100 Chemistry and Biology for Environmental Engineers

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|---|---|---|---|
| 2. Modulkürzel: | 021230502 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, WiSe |
| 4. SWS: | 6.0 | 7. Sprache: | - |

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| 8. Modulverantwortlicher: | Univ.-Prof. Jörg Metzger |
| 9. Dozenten: | • Jörg Metzger<br>• Karl Heinrich Engesser<br>• Brigitte Schwederski<br>• Bertram Kuch<br>• Daniel Dobslaw |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Incoming -->Semi-Compulsory Modules<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Pflichtmodule<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Incoming -->Elective Moduls<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Pflichtmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Spezialisierungsmodule<br>M.Sc. Water Resources Engineering and Management<br>➞ Vertiefungsmodule -->Vertiefungsmodule Wahlpflicht<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Zusatzmodule |
| 11. Empfohlene Voraussetzungen: | |
| 12. Lernziele: | |

**Lecture: Inorganic chem istry**

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

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| | • Implication of engineer work on ecosystems /environment protection problems<br><br>Some test systems for estimation of (bio)degradability of chemicals will be evaluated |
| 14. Literatur: | Lecture notes<br><br>pdf download of powerpoint slides for lectures<br><br>Exercises as hand-out or download (pdf) |
| 15. Lehrveranstaltungen und -formen: | • 191001 Lecture Inorganic chemistry<br>• 191002 Lecture Organic chemistry<br>• 191003 Lecture Biology and ecology of water, soil and air systems<br>• 191004 Lecture Technical and medical microbiology for engineers |
| 16. Abschätzung Arbeitsaufwand: | Time of attendance:<br>Inorganic chemistry (Schwederski): Lecture, 1 SWS = 14 hours<br>Organic chemistry (Metzger/Kuch): Lecture, 1 SWS = 14 hours<br>Biology and ecology of water, soil and air systems (Engesser): Lecture, 1 SWS = 14 hours<br>Technical and medical microbiology for engineers (Engesser): Lecture, 1 SWS = 14 hours<br>Exercises for Chemistry and Biology for environmental engineers, 2 SWS = 28 hours<br>Exam: 2 hours<br>Sum of attendance: 86 hours<br>Exercises (group work with presentations): 28 hours<br>Self -study: 94 hours: |
| 17. Prüfungsnummer/n und -name: | 19101 Chemistry and Biology for Environmental Engineers (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0 |
| 18. Grundlage für ... : | |
| 19. Medienform: | Video projector (powerpoint) presentation<br>explanations on blackboard, group work with presentations |
| 20. Angeboten von: | Hydrochemie und Hydrobiologie in der Siedlungswasserwirtschaft |

# Modul: 80990 Master`s Thesis WAREM

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|---|---|---|---|
| 2. Modulkürzel: | - | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 30.0 LP | 6. Turnus: | jedes Semester |
| 4. SWS: | 20.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Univ.-Prof. Silke Wieprecht |
| 9. Dozenten: | |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Incoming<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Incoming<br>➞<br>M.Sc. Water Resources Engineering and Management |
| 11. Empfohlene Voraussetzungen: | The topic of the Master Thesis can be handed out only the moment at least 78 credit points have been acquired already by the candidate. One month after 90 credit points have been acquired the candidate is supposed to start the work on his master thesis or to ask for the assignment of the topic at the latest. |
| 12. Lernziele: | Capability to implement an independently composed project schedule for the treatment of a recent scientific problem in an international research environment.<br>Effective scientific work in a team, enforcement of strategies internally and particularly externally. Acquire the necessary stamina to not be discouraged by unexpected problems and throwbacks in scientific projects and to finally be successful by the formulation of alternative methods of resolution.<br>Multidisciplinarity through contacts with representatives of other fields like Chemistry, Mathematics, Informatics, etc.<br>Obtaining the capability to discuss the own results of research in the environment of the recent international research comprehensively and to represent them in written (Master’s Thesis) and oral (talk) form. |
| 13. Inhalt: | Treatment of a recent scientific problem in an international research environment.<br>The successful treatment of the scientific problem requires the specialisation in the related field of research and the acquisition of the necessary knowledge. |
| 14. Literatur: | Recent literature on the topic of the scientific problem |
| 15. Lehrveranstaltungen und -formen: | |
| 16. Abschätzung Arbeitsaufwand: | 900 h (Contact time: 900 h) |
| 17. Prüfungsnummer/n und -name: | |
| 18. Grundlage für ... : | |
| 19. Medienform: | |
| 20. Angeboten von: | |

# 120 Outgoing

Zugeordnete Module:
- 121 Pflichtmodule
- 122 Wahlmodule

# 121 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 |
| 50110 | Requirements of Professional Life and Engineering in Practise |
| 56000 | Requirements of Professional Life and Engineering in Practise 2 |

# Modul: 19100 Chemistry and Biology for Environmental Engineers

| | | | |
|---|---|---|---|
| 2. Modulkürzel: | 021230502 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, WiSe |
| 4. SWS: | 6.0 | 7. Sprache: | - |

| | |
|---|---|
| 8. Modulverantwortlicher: | Univ.-Prof. Jörg Metzger |
| 9. Dozenten: | • Jörg Metzger<br>• Karl Heinrich Engesser<br>• Brigitte Schwederski<br>• Bertram Kuch<br>• Daniel Dobslaw |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Incoming -->Semi-Compulsory Modules<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Pflichtmodule<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Incoming -->Elective Moduls<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Pflichtmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Spezialisierungsmodule<br>M.Sc. Water Resources Engineering and Management<br>➞ Vertiefungsmodule -->Vertiefungsmodule Wahlpflicht<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Zusatzmodule |
| 11. Empfohlene Voraussetzungen: | |
| 12. Lernziele: | |

**Lecture: Inorganic chem istry**

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

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| | • Implication of engineer work on ecosystems /environment protection problems<br><br>Some test systems for estimation of (bio)degradability of chemicals will be evaluated |
| 14. Literatur: | Lecture notes<br><br>pdf download of powerpoint slides for lectures<br><br>Exercises as hand-out or download (pdf) |
| 15. Lehrveranstaltungen und -formen: | • 191001 Lecture Inorganic chemistry<br>• 191002 Lecture Organic chemistry<br>• 191003 Lecture Biology and ecology of water, soil and air systems<br>• 191004 Lecture Technical and medical microbiology for engineers |
| 16. Abschätzung Arbeitsaufwand: | Time of attendance:<br>Inorganic chemistry (Schwederski): Lecture, 1 SWS = 14 hours<br>Organic chemistry (Metzger/Kuch): Lecture, 1 SWS = 14 hours<br>Biology and ecology of water, soil and air systems (Engesser): Lecture, 1 SWS = 14 hours<br>Technical and medical microbiology for engineers (Engesser): Lecture, 1 SWS = 14 hours<br>Exercises for Chemistry and Biology for environmental engineers, 2 SWS = 28 hours<br>Exam: 2 hours<br>Sum of attendance: 86 hours<br>Exercises (group work with presentations): 28 hours<br>Self -study: 94 hours: |
| 17. Prüfungsnummer/n und -name: | 19101 Chemistry and Biology for Environmental Engineers (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0 |
| 18. Grundlage für ... : | |
| 19. Medienform: | Video projector (powerpoint) presentation<br>explanations on blackboard, group work with presentations |
| 20. Angeboten von: | Hydrochemie und Hydrobiologie in der Siedlungswasserwirtschaft |

# Modul: 50090 Environmental Fluid Mechanics I

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| 2. Modulkürzel: | 021420012 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, WiSe |
| 4. SWS: | 5.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Apl. Prof. Holger Class |
| 9. Dozenten: | • Jürgen Braun<br>• Holger Class<br>• Sergey Oladyshkin |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Incoming -->Semi-Compulsory Modules<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Pflichtmodule<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Incoming -->Compulsory Modules<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Pflichtmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Vertiefungsmodule -->Vertiefungsmodule Pflicht<br>➞ |
| 11. Empfohlene Voraussetzungen: | Technical Mechanics<br>• Introduction to the statics of rigid bodies<br>• Introduction to elastostatics<br>• Introduction to the mechanics of incompressible fluids<br>Higher Mathematics<br>• Partial differential equations<br>• Vector analysis<br>• Numerical integration<br>Fundamentals of Flow Mechanics<br>• Conservation equations for mass, momentum, energy<br>• 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 und finite difference. The |

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| | hydraulics of surface water deals with shallow water equations / Saint Venant equations, unstationary channel flow, turbulence und layered systems. Calculation methods such as the methods of characteisitcs are explained. The contents are:<br><br>• Potential flow and groundwater flow<br>• Computational Fluid Dynamics<br>• Shallow water equations for surface water<br>• Charakteristikenmethode<br>• Examples from civil and environmental engineering |
| 14. Literatur: | Lecture notes: Hydromechanics, Helmig and Class<br>Lecture notes: Ausbreitungs- und Transportvorgänge in Strömungen, Cirpka<br>White, F.M.: Fluid Mechanics, WCB/McGraw-Hill, New York, 1999<br>Freeze, R.A. and Cherry J.A.: Groundwater, Prentice Hall, 1979 |
| 15. Lehrveranstaltungen und -formen: | 500901 Lecture and Excercise Environmental Fluid Mechanics I |
| 16. Abschätzung Arbeitsaufwand: | Sum 180 h |
| 17. Prüfungsnummer/n und -name: | • 50091 Environmental Fluid Mechanics I (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0<br>• V Vorleistung (USL-V), schriftliche Prüfung |
| 18. Grundlage für ... : | 50170 Environmental Fluid Mechanics II |
| 19. Medienform: | Fundamentals will be developed using the blackboard and presentation tools. |
| 20. Angeboten von: | Institut für Wasser- und Umweltsystemmodellierung |

# Modul: 19150 German as a Foreign Language

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| 2. Modulkürzel: | SZ | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | unregelmäßig |
| 4. SWS: | 8.0 | 7. Sprache: | - |

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| 8. Modulverantwortlicher: | John Nixon |
| 9. Dozenten: | |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Pflichtmodule<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Pflichtmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Deutschkurse |
| 11. Empfohlene Voraussetzungen: | |
| 12. Lernziele: | |
| 13. Inhalt: | |
| 14. Literatur: | |
| 15. Lehrveranstaltungen und -formen: | • 191501 Seminar German as a Foreign Language I<br>• 191502 Seminar German as a Foreign Language II |
| 16. Abschätzung Arbeitsaufwand: | |
| 17. Prüfungsnummer/n und -name: | • 19151 German as a Foreign Language I (PL), schriftlich oder mündlich, Gewichtung: 1.0<br>• 19152 German as a Foreign Language II (PL), schriftlich oder mündlich, Gewichtung: 1.0 |
| 18. Grundlage für ... : | |
| 19. Medienform: | |
| 20. Angeboten von: | |

# Modul: 50110 Requirements of Professional Life and Engineering in Practise

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| 2. Modulkürzel: | 021410901 | 5. Moduldauer: | 3 Semester |
| 3. Leistungspunkte: | 3.0 LP | 6. Turnus: | jedes Semester |
| 4. SWS: | 2.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Anne Weiß |
| 9. Dozenten: | |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Pflichtmodule<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Pflichtmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Vertiefungsmodule -->Vertiefungsmodule Pflicht<br>➞ |
| 11. Empfohlene Voraussetzungen: | |
| 12. Lernziele: | • Capability to summarize a water-related topic or the investigations of a scientific, water related problem in terms of two 20 min presentations, discussion on the topic after presenting.<br>• Ability to participate in a scientific discussion, asking questions to presenters.<br>• Writing a summary of a visit at a technical site, condense information to a short report. |
| 13. Inhalt: | |
| 14. Literatur: | Recent literature on the water related topic/ scientific problem,. |
| 15. Lehrveranstaltungen und -formen: | • 501101 Seminar Requirements of Professional Life and Engineering in Practise<br>• 501102 Excursion Requirements of Professional Life and Engineering in Practise |
| 16. Abschätzung Arbeitsaufwand: | 90 h (Contact time: 70 h) |
| 17. Prüfungsnummer/n und -name: | 50111 Requirements of Professional Life and Engineering in Practise (USL), Sonstiges, Gewichtung: 1.0, Course achievements: Compulsary attendance in: seminar, workshop "presentation techniques", course "Correct Citation in scientific papers", excursions. Two presentations, one written short report (USL) |
| 18. Grundlage für ... : | |
| 19. Medienform: | |
| 20. Angeboten von: | |

# Modul: 56000 Requirements of Professional Life and Engineering in Practise 2

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|---|---|---|---|
| 2. Modulkürzel: | Warem | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 3.0 LP | 6. Turnus: | jedes Semester |
| 4. SWS: | 2.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Anne Weiß |
| 9. Dozenten: | |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Pflichtmodule<br>➞<br><br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Pflichtmodule<br>➞ |
| 11. Empfohlene Voraussetzungen: | none |
| 12. Lernziele: | Capability to summarize a water-related topic or the investigations of a scientific, water related problem in terms of two 20 min presentations, discussion on the topic after presenting.<br><br>Ability to participate in a scientific discussion, asking questions to presenters.<br><br>Writing a summary of a visit at a technical site, condense information to a short report. |
| 13. Inhalt: | Treatment of a water related topic or a recent scientific problem in an international research environment.<br><br>The successful treatment of the scientific problem requires the specialisation in the related field of research and the acquisition of the necessary knowledge.<br><br>Week-end workshop regarding 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.<br><br>Course:Correct Citation in scientific papers.The students will know about the importance of correct citations, see different types of citations and learn formal ways to make citations visible and comprehensible. |
| 14. Literatur: | Recent literature on the water related topic/ scientific problem |
| 15. Lehrveranstaltungen und -formen: | |
| 16. Abschätzung Arbeitsaufwand: | 90 h (contact time 70h) |
| 17. Prüfungsnummer/n und -name: | 56001 Requirements of Professional Life and Engineering in Practise 2 (USL), schriftliche Prüfung, Gewichtung: 1.0, Course achievements: Compulsary attendance in: seminar, workshop "presentation techniques", course "Correct Citation in scientific papers", excursions. Two presentations, one written short report (USL) |
| 18. Grundlage für ... : | |

19. Medienform:

20. Angeboten von:

# Modul: 19120 Sanitary Engineering

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| 2. Modulkürzel: | 021220012 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, WiSe |
| 4. SWS: | 4.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Klaus Fischer |
| 9. Dozenten: | • Klaus Fischer<br>• Heidrun Steinmetz |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Pflichtmodule<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Pflichtmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Vertiefungsmodule -->Vertiefungsmodule Pflicht<br>➞ |
| 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.<br>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:<br>• Waste generation and waste composition<br>• National and international regulations for waste<br>• Waste avoidance<br>• Collection and transport of waste |

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| | • Separate collection of recyclables<br>• Sorting of recyclables<br>• Recycling technologies for paper, glass, metal, plastic<br>• Biological treatment of waste<br>• Waste Disposal<br>• Ecological indicator systems<br><br>Waste Water Technology:<br>• Basics of urban drainage and municipal wastewater treatment<br>• Quantity and Composition of Wastewater<br>• Urban drainage systems<br>• stormwater treatment<br>• mechanical wastewater treatment<br>• biological wastewater treatment<br>• sludge treatment<br>• natural close and ECOSAN systems |
| 14. Literatur: | Lecture Manuscripts Solid Waste Management<br>G. Tchobanoglous et. Al.: Handbook of solid waste management;<br>Biliteski, B. et.al.: Waste Management, Springer 1994 ISBN: 3-540-59210-5<br>Butler, D., Davies, J.W: .Urban drainage, Spon press London,<br>Henze, M., Harremoes, J., la Coour Jansen, J., Arvin, E: Wastewater treatment. Springer Verlag Berlin |
| 15. Lehrveranstaltungen und -formen: | • 191201 Vorlesung Solid Waste Management<br>• 191202 Vorlesung Waste Water<br>• 191203 Exkursion Sanitary Engineering |
| 16. Abschätzung Arbeitsaufwand: | Time of attendance:<br>I Solid Waste Management, lecture: 2.0 SWS = 28 hours<br>II Waste Water: 2 SWS = 28 hours<br>excursion: 12 hours<br>exam: 2 hours<br>sum of attendance: 70 hours<br>self-study: 110 hours<br>total: 180 hours |
| 17. Prüfungsnummer/n und -name: | • 19121 Solid Waste Management and Waste Water Technology (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0<br>• V Vorleistung (USL-V), schriftlich, eventuell mündlich |
| 18. Grundlage für ... : | • 19310 Urban Drainage and Design of Wastewater Treatment Plants<br>• 19330 Industrial Waste Water |
| 19. Medienform: | |
| 20. Angeboten von: | |

# Modul: 19310 Urban Drainage and Design of Wastewater Treatment Plants

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| 2. Modulkürzel: | 021210251 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, SoSe |
| 4. SWS: | 5.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Ulrich Dittmer |
| 9. Dozenten: | • Heidrun Steinmetz<br>• Ulrich Dittmer |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Pflichtmodule<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Pflichtmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Spezialisierungsmodule<br>M.Sc. Water Resources Engineering and Management<br>➞ Vertiefungsmodule -->Vertiefungsmodule Wahlpflicht<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Zusatzmodule |
| 11. Empfohlene Voraussetzungen: | Chemistry and Biology for Environmental Engineers<br><br>Sanitary Engineering |
| 12. Lernziele: | Advanced knowledge of processes and concepts for urban drainage and municipal wastewater treatment systems<br><br>Basics of construction and dimensioning of different urban drainage systems, stormwater treatment facilities and wastewater treatment plants as a base for dimensioning and discussion of proved and innovative technologies<br><br>Deeper understanding for system connections as base for a decisions during the planning process |
| 13. Inhalt: | Design of sewer systems and stormwater treatment<br><br>(Dr.- Ing. Ulrich Dittmer)<br><br>principles of collection and disposal<br>design of combined and separate sewer systems<br>Sustainable urban drainage systems (SUDS) and low impact design(LID)<br>Application of rainfall runoff models (computer exercise using U.S. EPA Stormwater Management Model)<br>different techniques for treatment and retention<br>design of treatment facilities<br><br>Design of wastewater treatment plants (Prof. Dr.-Ing. Heidrun Steinmetz)<br><br>Municipal wastewater treatment<br>different techniques for advanced biological wastewater treatment (nitrogen and phosphorous removal) |

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| | principles of process engineering<br>design of biological wastewater treatment plants and the main important aggregates<br>design of sludge treatment plants<br><br>Seminar: feasibility studies<br><br>(Prof. Dr.- Ing. Heidrun Steinmetz and external consultants)<br><br>special examples for sanitation concepts for world wide application<br>Ecological sanitation and resource orientated systems<br><br>case studies |
| 14. Literatur: | • Butler, D., Davies, J.W) .Urban drainage, Spon press London, US EPA: SWMM 5.0 users manual<br>• Henze, M., Harremoes, J. la Coour Jansen, J., Arvin, E: Wastewater treatment. Springer Verlag Berlin<br>• Lens, P, Zeeman,G., Lettinga, G.: Decentralised Sanitation and reuse. IWA publishing, London<br>• Different German standards (DWA, Hennef)<br>• Lecture notes |
| 15. Lehrveranstaltungen und -formen: | • 193101 Vorlesung und Übung Design of Sewer System and Stormwater Treatment<br>• 193102 Vorlesung und Übung Design of Wastewater Treatment Plants<br>• 193103 Seminar Case Study<br>• 193104 Exkursion |
| 16. Abschätzung Arbeitsaufwand: | Time of attendance: approx. 70 hours (including 4*4hours for excursion) 1,5 SWS<br><br>Private Study: approx. 110 hours<br><br>Lecture 1 Presence time: 28 hours, self study 30 hours, project 0, Sum: **58 hours**<br><br>Lecture 2: Presence time: 28 hours, self study 30 hours, project 40, Sum: **58 hours**<br><br>Case study: Presence time: 14 hours, self study 10 hours, project 0, Sum: **25 hours** |
| 17. Prüfungsnummer/n und -name: | 19311 Urban Drainage and Design of Wastewater Treatment Plants (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0 |
| 18. Grundlage für ... : | |
| 19. Medienform: | |
| 20. Angeboten von: | Siedlungswasserwirtschaft und Wasserrecycling |

# 122 Wahlmodule

Zugeordnete Module:

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| 15160 | Water and Power Supply |
| 34420 | Regional and Urban Planning II |
| 50120 | Environmental Informatics |
| 50130 | Integrated Watershed Modeling |
| 50190 | Geohydrological Modelling I and II |
| 50330 | Regional and Urban Planning I |

# Modul: 50120 Environmental Informatics

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| 2. Modulkürzel: | 021430002 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, WiSe |
| 4. SWS: | 4.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Univ.-Prof. Andras Bardossy |
| 9. Dozenten: | Johannes Riegger |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Incoming -->Semi-Compulsory Modules<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Wahlmodule<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Incoming -->Compulsory Modules<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Wahlmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Spezialisierungsmodule<br>M.Sc. Water Resources Engineering and Management<br>➞ Vertiefungsmodule -->Vertiefungsmodule Wahlpflicht<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Zusatzmodule |
| 11. Empfohlene Voraussetzungen: | |
| 12. Lernziele: | Skills in Spreadsheet Calculations for Data Processing,Design, Creation, Handling and Application of Relational Database Management Systems for Environmental Issues, Creation and display of Environmental GIS data sets .Use of GIS functionalities to investigate spatial and attribute relationships |
| 13. Inhalt: | **Information Processing & Environmental Data Management** (Excel & Access):<br>Environmental Database Design, Relational Database Management, Data Normalization, Data Security<br>**GIS Tools in Environmental Engineering (ArcGIS):**<br>Basics of GIS, Data implementation, Spatial Structures and Attributes, Display of Environmental Information, Charts & Diagrams, Digitization, Spatial and Logical Queries, Data Links, Geo-Referencing, Field Calculations |
| 14. Literatur: | Script: J. Riegger ‘Environmental Informatics’<br>User Handbooks for Excel, Access, ArcGIS<br>**Getting to know ArcGIS Desktop ISBN: 9781589482609** |
| 15. Lehrveranstaltungen und -formen: | • 501201 Lecture Environmental Data Management<br>• 501202 Lecture GIS Tools in Environmental Engineering |
| 16. Abschätzung Arbeitsaufwand: | Time of attendance: approx. 56 hours<br>Private Study: approx. 124 hours during semester |

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| | Sum: 180h |
| 17. Prüfungsnummer/n und -name: | • 50121 Environmental Informatics (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0<br>• V Vorleistung (USL-V), schriftliche Prüfung |
| 18. Grundlage für ... : | |
| 19. Medienform: | |
| 20. Angeboten von: | |

# Modul: 50190 Geohydrological Modelling I and II

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|---|---|---|---|
| 2. Modulkürzel: | 021430007 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, WiSe |
| 4. SWS: | 4.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Univ.-Prof. Andras Bardossy |
| 9. Dozenten: | Johannes Riegger |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Wahlmodule<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Wahlmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Spezialisierungsmodule<br>M.Sc. Water Resources Engineering and Management<br>➞ Zusatzmodule |
| 11. Empfohlene Voraussetzungen: | Contents of Geohydrology and Geoengineering |
| 12. Lernziele: | • Setup of a Geohydrological Model<br>• Spatial and temporal Discretization (Stability Criteria)<br>• Adequate Transfer of Nature into a Model<br>• Simplification of complex Geohydrological Systems<br>• Choice of adequate Numerical Scheme<br>• Unique Calibration of Flow and Transport<br>• Assessment of Geohydrological Model Approaches and Model Realizations |
| 13. Inhalt: | Geohydrological Modelling 1:<br>Groundwater Flow, Conceptual Model, Numerical Model, Modelling of Natural Systems, Calibration Process, Sensitivity Analysis, Model Verification and Validation.<br>Geohydrological Modelling 2:<br>Complex & Transient Systems, 3D-Flow, Fractured Systems, Double Porosity, Advective and Dispersive Transport, Numerical Methods for Transport, Stability Criteria, Chemical Reactions, Measurement of Transport Parameters, Transport Calibration |
| 14. Literatur: | Script: J. Riegger ‘Geohydrological Modelling’<br>Anderson & Woessner ‘Applied Groundwater Modelling’<br>Spitz & Moreno : ‘A Practical Guide to Groundwater and Solute Transport Modeling’<br>Freeze & Cherry: ‘Groundwater’ |
| 15. Lehrveranstaltungen und -formen: | • 501901 Lecture Geohydrological Modelling 1<br>• 501902 Lecture Geohydrological Modelling 2 |
| 16. Abschätzung Arbeitsaufwand: | Sum: 180h |
| 17. Prüfungsnummer/n und -name: | 50191 Geohydrological Modelling I and II (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0 |
| 18. Grundlage für ... : | |
| 19. Medienform: | |

20. Angeboten von:

# Modul: 50130 Integrated Watershed Modeling

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| 2. Modulkürzel: | 021430009 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, SoSe |
| 4. SWS: | 4.0 | 7. Sprache: | Deutsch |

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| 8. Modulverantwortlicher: | Univ.-Prof. Andras Bardossy |
| 9. Dozenten: | • Johannes Riegger<br>• Andras Bardossy |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Wahlmodule<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Wahlmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Spezialisierungsmodule<br>M.Sc. Water Resources Engineering and Management<br>➞ Vertiefungsmodule -->Vertiefungsmodule Wahlpflicht<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Zusatzmodule |
| 11. Empfohlene Voraussetzungen: | Recommended background knowledge: Basic knowledge of hydrology and geohydrology<br>Prerequisite module: none |
| 12. Lernziele: | **Hydrological Modeling:**<br>Construction of models for each part in the runoff process and how these models are used and integrated in different environment management systems.<br>**Integrated model systems for the groundwater management:**<br>Design of hydrogeological databases, visualization of data, GIS-Operations for the groundwater and hydrological modeling, Geostatistic, stochastic modeling, Monte Carlo Methods. |
| 13. Inhalt: | **Hydrological Modeling:**<br>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.<br>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 there 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. |

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| | **Integrated model systems for the groundwater management:**<br>Modern integrated model systems require techniques for the efficient construction of ground water models and their integration in “Decision Support Systems” as well as strategies for the handling of uncertainties. The course will discuss the specific “GIS-Methods” that are important for the integrations of databases, the visualization of data and the calculation of spatial data like ground water recharge. Special focus is laid on GIS supported hydrological modeling of the ground water recharge and the runoff parameters as well as adequate choice of the hydrological model concepts for the calculation of the local water balance in different data situations. To handle the model uncertainties, geostatistic methods and associated stochastic modeling attempts like the “Monte Carlo Simulation” will be mentioned. |
| 14. Literatur: | Hydrological Modeling:<br>Beven, K.J., 2000. Rainfall-Runoff Modelling: The Primer. Wiley, 360pp.<br>Singh, V.P. (Ed.), 1995. Computer Models of Watershed Hydrology. Water Resource Publications, Littleton, Colorado, USA. |
| 15. Lehrveranstaltungen und -formen: | • 501301 Lecture and excercise Hydrological Modeling<br>• 501302 Lecture and excercise Integrated model systems for the groundwater management |
| 16. Abschätzung Arbeitsaufwand: | Sum: 180h |
| 17. Prüfungsnummer/n und -name: | 50131 Integrated Watershed Modeling (PL), schriftliche Prüfung, 150 Min., Gewichtung: 1.0 |
| 18. Grundlage für ... : | |
| 19. Medienform: | |
| 20. Angeboten von: | |

# Modul: 50330 Regional and Urban Planning I

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| 2. Modulkürzel: | 021100010 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, WiSe |
| 4. SWS: | 4.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Univ.-Prof. Jörn Birkmann |
| 9. Dozenten: | • Jörn Birkmann<br>• Astrid Ley |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Wahlmodule<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Wahlmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Spezialisierungsmodule<br>M.Sc. Water Resources Engineering and Management<br>➞ Zusatzmodule |
| 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:<br>• International Planning studies<br>• Overview on current planning issues<br>• Basic Terms of Spatial Planning<br>• Strategies in Spatial Planning<br>• Instruments of Spatial Planning<br>• Performance of Plans, Assessing Plans<br>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: | Berke, P.R. et al. (2006): Urban Land Use Planning. Urbana/Chicago: University of Illinois Press<br>Birkmann et al. (2010): Adaptive urban governance: nes challenges for the second generation of urban adaptation studies to climate change In: Sustanability science 5<br>Hall, P. (2002): Urban and Regional Planning. New York: Routledge |
| 15. Lehrveranstaltungen und -formen: | • 503301 Lecture Regional Planning I<br>• 503302 Lecture Urban Planning I |

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| 16. Abschätzung Arbeitsaufwand: | Time of attendance: approx. 45 hours<br>Private Study: approx.135 hours |
| 17. Prüfungsnummer/n und -name: | 50331 Regional and Urban Planning I (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0 |
| 18. Grundlage für ... : | |
| 19. Medienform: | |
| 20. Angeboten von: | |

# Modul: 34420 Regional and Urban Planning II

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| 2. Modulkürzel: | - | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, SoSe |
| 4. SWS: | 4.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Univ.-Prof. Jörn Birkmann |
| 9. Dozenten: | • Jörn Birkmann<br>• Astrid Ley<br>• Stefan Fina<br>• Torsten Welle |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Wahlmodule<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Wahlmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Spezialisierungsmodule<br>M.Sc. Water Resources Engineering and Management<br>➞ Zusatzmodule |
| 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 present-ed.The lectures demonstrate the usage of planning instruments and methods based on planning cases from Germanyand other countries. |
| 13. Inhalt: | The course Regional Planning II deals with the following planning methods:<br>• Indicator-based monitoring and evaluation methods<br>• Multi-criteria decision analysis (e.g. cost-benefit analysis, utility value analyis, analytic hierarchy process)<br>• Methods of impact assessment<br>• Techniques of demand forecast and land suitability analysis<br>• Hazard and vulnerability analysis (climate change adaptation)<br>The course Urban Planning II gives an overview on:<br>• Levels of spatial planning in urban areas<br>• Urban development planning<br>• Urban analysis<br>• Urban renewal<br>• Urban planning instruments<br>• Land use planning and implementation planning<br>• Legal framework |
| 14. Literatur: | Skript "Regional and Urban Planning II" |
| 15. Lehrveranstaltungen und -formen: | • 344201 Vorlesung Regional Planning II<br>• 344202 Vorlesung Urban Planning II |
| 16. Abschätzung Arbeitsaufwand: | Time of attendance: approx.45hours<br>Private Study: approx. 120 hours |

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| 17. Prüfungsnummer/n und -name: | • 34421 Regional Planning II (PL), schriftliche Prüfung, 60 Min., Gewichtung: 1.0<br>• 34422 Urban Planning II (PL), schriftliche Prüfung, 60 Min., Gewichtung: 1.0 |
| 18. Grundlage für ... : | |
| 19. Medienform: | Optional |
| 20. Angeboten von: | |

# Modul: 15160 Water and Power Supply

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| 2. Modulkürzel: | 021410105 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, WiSe |
| 4. SWS: | 0.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Sabine-Ulrike Gerbersdorf |
| 9. Dozenten: | • Sabine-Ulrike Gerbersdorf<br>• Ralf Minke |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Wahlmodule<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Wahlmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Spezialisierungsmodule<br>M.Sc. Water Resources Engineering and Management<br>➞ Vertiefungsmodule -->Vertiefungsmodule Wahlpflicht<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Zusatzmodule |
| 11. Empfohlene Voraussetzungen: | None |
| 12. Lernziele: | **Power Demand, Supply and Distribution:**<br><br>The students…<br><br>• know the German, European and worldwide energy markets related to demand, supply and its distribution capabilities<br>• are aware of that non-renewable energy sources are strictly limited and time-scales for conversion of energy markets long<br>• have an idea about the relations between energy, politics, social changes and influences on environment<br>• have a basic knowledge about present energy conversion systems, theoretical limits of efficiencies, and the potential to enhance applied technology<br>• have a basic understanding about where and how energy is provided and distributed<br>• comprehend the balance between load and supply in electrical grids and the resulting necessity for control energy.<br><br>**Water Demand, Supply and Distribution:**<br><br>The students…<br><br>• know the German and worldwide water systems related to demand, supply and its distribution capabilities<br>• have an overview on the water supply situation all over the world.<br>• recognize the different possibilities and levels of water supply<br>• 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

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| 14. Literatur: | Lecture notes can be downloaded from the internet.<br>Hints are given for additional literature from the internet as well as libraries. |
| 15. Lehrveranstaltungen und -formen: | • 151601 Vorlesung Energy Demand, Supply and Distribution<br>• 151602 Vorlesung Water Demand, Supply and Distribution |
| 16. Abschätzung Arbeitsaufwand: | Time of attendance: 45 h<br>Private Study: 135 h |
| 17. Prüfungsnummer/n und -name: | 15161 Water and Power Supply (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0 |
| 18. Grundlage für ... : | |
| 19. Medienform: | |
| 20. Angeboten von: | |

# 200 Chalmers

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| Zugeordnete Module: | 210 | Incoming |
| | 220 | Outgoing |

# 210 Incoming

Zugeordnete Module:

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| 211 | Semi-Compulsory Modules |
| 80990 | Master`s Thesis WAREM |

# 211 Semi-Compulsory Modules

Zugeordnete Module:

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| 15150 | Fuzzy Logic and Operation Research |
| 19100 | Chemistry and Biology for Environmental Engineers |
| 19330 | Industrial Waste Water |
| 36450 | Special Aspects of Urban Water Management |
| 50090 | Environmental Fluid Mechanics I |
| 50120 | Environmental Informatics |
| 50620 | Hydraulic Structures |

# Modul: 19100 Chemistry and Biology for Environmental Engineers

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| 2. Modulkürzel: | 021230502 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, WiSe |
| 4. SWS: | 6.0 | 7. Sprache: | - |

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| 8. Modulverantwortlicher: | Univ.-Prof. Jörg Metzger |
| 9. Dozenten: | • Jörg Metzger<br>• Karl Heinrich Engesser<br>• Brigitte Schwederski<br>• Bertram Kuch<br>• Daniel Dobslaw |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Incoming -->Semi-Compulsory Modules<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Pflichtmodule<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Incoming -->Elective Moduls<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Pflichtmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Spezialisierungsmodule<br>M.Sc. Water Resources Engineering and Management<br>➞ Vertiefungsmodule -->Vertiefungsmodule Wahlpflicht<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Zusatzmodule |
| 11. Empfohlene Voraussetzungen: | |
| 12. Lernziele: | **Lecture: Inorganic chem istry**<br><br>The students<br><br>• know the fundamental concepts of chemistry (atomic structure, periodic system, chemical formulae, stoichiometry, molecular structures) and are able to use them,<br>• know the principle types of chemical substances and chemical reactions and can apply their knowledge to synthetic problems,<br>• know about the most important industrial compounds, their preparation and environmental aspects in their application.<br><br>**Lecture: Organic chemistry**<br><br>The students<br><br>- 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

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| | • Implication of engineer work on ecosystems /environment protection problems<br><br>Some test systems for estimation of (bio)degradability of chemicals will be evaluated |
| 14. Literatur: | Lecture notes<br><br>pdf download of powerpoint slides for lectures<br><br>Exercises as hand-out or download (pdf) |
| 15. Lehrveranstaltungen und -formen: | • 191001 Lecture Inorganic chemistry<br>• 191002 Lecture Organic chemistry<br>• 191003 Lecture Biology and ecology of water, soil and air systems<br>• 191004 Lecture Technical and medical microbiology for engineers |
| 16. Abschätzung Arbeitsaufwand: | Time of attendance:<br>Inorganic chemistry (Schwederski): Lecture, 1 SWS = 14 hours<br>Organic chemistry (Metzger/Kuch): Lecture, 1 SWS = 14 hours<br>Biology and ecology of water, soil and air systems (Engesser): Lecture, 1 SWS = 14 hours<br>Technical and medical microbiology for engineers (Engesser): Lecture, 1 SWS = 14 hours<br>Exercises for Chemistry and Biology for environmental engineers, 2 SWS = 28 hours<br>Exam: 2 hours<br>Sum of attendance: 86 hours<br>Exercises (group work with presentations): 28 hours<br>Self -study: 94 hours: |
| 17. Prüfungsnummer/n und -name: | 19101 Chemistry and Biology for Environmental Engineers (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0 |
| 18. Grundlage für ... : | |
| 19. Medienform: | Video projector (powerpoint) presentation<br>explanations on blackboard, group work with presentations |
| 20. Angeboten von: | Hydrochemie und Hydrobiologie in der Siedlungswasserwirtschaft |

# Modul: 50090 Environmental Fluid Mechanics I

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| 2. Modulkürzel: | 021420012 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, WiSe |
| 4. SWS: | 5.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Apl. Prof. Holger Class |
| 9. Dozenten: | • Jürgen Braun<br>• Holger Class<br>• Sergey Oladyshkin |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Incoming -->Semi-Compulsory Modules<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Pflichtmodule<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Incoming -->Compulsory Modules<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Pflichtmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Vertiefungsmodule -->Vertiefungsmodule Pflicht<br>➞ |
| 11. Empfohlene Voraussetzungen: | Technical Mechanics<br>• Introduction to the statics of rigid bodies<br>• Introduction to elastostatics<br>• Introduction to the mechanics of incompressible fluids<br>Higher Mathematics<br>• Partial differential equations<br>• Vector analysis<br>• Numerical integration<br>Fundamentals of Flow Mechanics<br>• Conservation equations for mass, momentum, energy<br>• 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 und finite difference. The |

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| | hydraulics of surface water deals with shallow water equations / Saint Venant equations, unstationary channel flow, turbulence und layered systems. Calculation methods such as the methods of characteisitcs are explained. The contents are:<br><br>• Potential flow and groundwater flow<br>• Computational Fluid Dynamics<br>• Shallow water equations for surface water<br>• Charakteristikenmethode<br>• Examples from civil and environmental engineering |
| 14. Literatur: | Lecture notes: Hydromechanics, Helmig and Class<br>Lecture notes: Ausbreitungs- und Transportvorgänge in Strömungen, Cirpka<br>White, F.M.: Fluid Mechanics, WCB/McGraw-Hill, New York, 1999<br>Freeze, R.A. and Cherry J.A.: Groundwater, Prentice Hall, 1979 |
| 15. Lehrveranstaltungen und -formen: | 500901 Lecture and Excercise Environmental Fluid Mechanics I |
| 16. Abschätzung Arbeitsaufwand: | Sum 180 h |
| 17. Prüfungsnummer/n und -name: | • 50091 Environmental Fluid Mechanics I (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0<br>• V Vorleistung (USL-V), schriftliche Prüfung |
| 18. Grundlage für ... : | 50170 Environmental Fluid Mechanics II |
| 19. Medienform: | Fundamentals will be developed using the blackboard and presentation tools. |
| 20. Angeboten von: | Institut für Wasser- und Umweltsystemmodellierung |

# Modul: 50120 Environmental Informatics

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| 2. Modulkürzel: | 021430002 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, WiSe |
| 4. SWS: | 4.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Univ.-Prof. Andras Bardossy |
| 9. Dozenten: | Johannes Riegger |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Incoming -->Semi-Compulsory Modules<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Wahlmodule<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Incoming -->Compulsory Modules<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Wahlmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Spezialisierungsmodule<br>M.Sc. Water Resources Engineering and Management<br>➞ Vertiefungsmodule -->Vertiefungsmodule Wahlpflicht<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Zusatzmodule |
| 11. Empfohlene Voraussetzungen: | |
| 12. Lernziele: | Skills in Spreadsheet Calculations for Data Processing,Design, Creation, Handling and Application of Relational Database Management Systems for Environmental Issues, Creation and display of Environmental GIS data sets .Use of GIS functionalities to investigate spatial and attribute relationships |
| 13. Inhalt: | **Information Processing & Environmental Data Management** (Excel & Access):<br>Environmental Database Design, Relational Database Management, Data Normalization, Data Security<br>**GIS Tools in Environmental Engineering (ArcGIS):**<br>Basics of GIS, Data implementation, Spatial Structures and Attributes, Display of Environmental Information, Charts & Diagrams, Digitization, Spatial and Logical Queries, Data Links, Geo-Referencing, Field Calculations |
| 14. Literatur: | Script: J. Riegger ‘Environmental Informatics’<br>User Handbooks for Excel, Access, ArcGIS<br>**Getting to know ArcGIS Desktop ISBN: 9781589482609** |
| 15. Lehrveranstaltungen und -formen: | • 501201 Lecture Environmental Data Management<br>• 501202 Lecture GIS Tools in Environmental Engineering |
| 16. Abschätzung Arbeitsaufwand: | Time of attendance: approx. 56 hours<br>Private Study: approx. 124 hours during semester |

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| | Sum: 180h |
| 17. Prüfungsnummer/n und -name: | • 50121 Environmental Informatics (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0<br>• V Vorleistung (USL-V), schriftliche Prüfung |
| 18. Grundlage für ... : | |
| 19. Medienform: | |
| 20. Angeboten von: | |

# Modul: 15150 Fuzzy Logic and Operation Research

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| 2. Modulkürzel: | 021430004 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, SoSe |
| 4. SWS: | 4.0 | 7. Sprache: | Deutsch |

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| 8. Modulverantwortlicher: | Univ.-Prof. Andras Bardossy |
| 9. Dozenten: | Andras Bardossy |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Incoming -->Semi-Compulsory Modules<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Spezialisierungsmodule<br>M.Sc. Water Resources Engineering and Management<br>➞ Zusatzmodule |
| 11. Empfohlene Voraussetzungen: | Modul Statistik und Informatik |
| 12. Lernziele: | Die Studierenden sind mit den Grundlagen der Fuzzy-Modellierung wie Fuzzy Zahlen, Fuzzy Regeln, Fuzzy Sets, Membership Funktionen vertraut und können einfache auf Fuzzy-Logik basierende Modelle erstellen. Zudem kennen sie die Anwendungsmöglichkeiten von Fuzzy-Modellen ebenso wie deren Limitierungen. Die Studierenden erkennen die Problematik der Steuerung und Optimierung von komplexen Systemen für verschiedene Zielvorgaben. Sie beherrschen die grundlegenden Methoden der Systemsteuerung und können diese anwenden. |
| 13. Inhalt: | **Fuzzy-Logic:**<br><br>Um komplexe Prozesse und Zusammenhänge unserer Umwelt zu beschreiben und mögliche Folgen von Eingriffen abschätzen zu können, ist es notwendig, diese in mathematischen Modellen abzubilden. Fuzzy-Logik (oder Unscharfe-Logik) bietet einfache Werkzeuge, um derartige Modelle zu erstellen: Fuzzy-Sets, Membership Funktionen, Fuzzy Zahlen, Fuzzy Regeln<br><br>**Operation Research:**<br><br>Die Steuerung von Systemen mit komplexer Mehrfachzielsetzung ist eine Problemstellung wie sie beispielsweise auftritt bei der Steuerung von Wasserreservoirs, die für die Trinkwasserversorgung als auch den Hochwasserschutz eingesetzt werden. Die Optimierung der kombinierten Nutzung eines Wasserspeichers für verschiedene Wasserbereitstellungen mit unterschiedlicher Versorgungssicherheit ist ein weiteres Beispiel. Die Vorlesung gibt eine Einführung in die prinzipiellen Methoden der Systemsteuerung am Beispiel der Wasserwirtschaft. |
| 14. Literatur: | Fuzzy rule based modeling with applications to geophysical, biological and engineering systems / András Bárdossy; Lucien Duckstein. - Boca Raton [u.a.] : CRC Press, 1995 |
| 15. Lehrveranstaltungen und -formen: | • 151501 Vorlesung Fuzzy Logic<br>• 151502 Vorlesung Operation Research |

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| 16. Abschätzung Arbeitsaufwand: | Präsenzzeit: | 40 h |
| | Selbststudium: | 140 h |
| | Gesamt: | 180 h |
| 17. Prüfungsnummer/n und -name: | 15151 | Fuzzy Logic and Operation Research (PL), schriftliche Prüfung, 90 Min., Gewichtung: 1.0 |
| 18. Grundlage für ... : | | |
| 19. Medienform: | | |
| 20. Angeboten von: | | |

# Modul: 50620 Hydraulic Structures

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| 2. Modulkürzel: | 021410106 | 5. Moduldauer: | 2 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, WiSe |
| 4. SWS: | 4.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Univ.-Prof. Silke Wieprecht |
| 9. Dozenten: | • Silke Wieprecht<br>• Kristina Terheiden<br>• Daniel Stolz |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Incoming -->Semi-Compulsory Modules<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Wahlmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Vertiefungsmodule -->Vertiefungsmodule Pflicht<br>➞ |
| 11. Empfohlene Voraussetzungen: | |
| 12. Lernziele: | **Advanced Studies in Hydraulic Structures:** The students…<br>• Know about the basic features of hydraulic structures<br>• have an overview what are the main components and know how to arrange them in order to ensure a satisfying operation<br>• are able to dimension all parts of different hydraulic structures<br>• 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<br>• are able to realize the economic and ecologic significance of hydraulic structures as dams, reservoirs and hydro power plants<br>**Case Study in Hydraulic Structures** : The students…<br>• are able to use of the gained theoretical knowledge with the help of a practical example<br>• are aware of the technical relations and their effects on non-technical areas of interest<br>• can give a well-founded argumentation of chosen estimations and are able to present their own results<br>• can give a convincing presentation<br>• 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.<br>**Case Study in Hydraulic Structures** : The case study uses the content of the lecture „Advanced Studies in Hydraulic Structures“. In working |

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| | groups of 3 to five 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<br>• 506202 Lecture and Presentation Case Study in Hydraulic Structures, |
| 16. Abschätzung Arbeitsaufwand: | Sum 180h |
| 17. Prüfungsnummer/n und -name: | 50621 Hydraulic Structures (LBP), schriftlich oder mündlich, 90 Min., Gewichtung: 1.0 |
| 18. Grundlage für ... : | |
| 19. Medienform: | |
| 20. Angeboten von: | |

# Modul: 19330 Industrial Waste Water

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| 2. Modulkürzel: | 021210151 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, WiSe |
| 4. SWS: | 4.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Prof./Uni.Reg.deBlumenau Uwe Menzel |
| 9. Dozenten: | • Uwe Menzel<br>• Michael Koch |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Incoming -->Semi-Compulsory Modules<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Incoming -->Compulsory Modules<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Spezialisierungsmodule<br>M.Sc. Water Resources Engineering and Management<br>➞ Zusatzmodule |
| 11. Empfohlene Voraussetzungen: | |
| 12. Lernziele: | Students have:<br>• a basic understanding for the problems and requirements of industrial waste water treatment<br>• an overview of measures for production integrated environmental protection, relevant treatment methods for process water and its characterization<br>• an overview of water analysis including sampling, the main principles of different analytical techniques and the ways to assure the quality of chemical analysis |
| 13. Inhalt: | Fundamentals of industrial waste water treatment Determiniation of current situation possible process integrated measures measures for reuse and recirculation of water mass and concentration balance Basic elements and examples for applications to the advanced purification processes: biological waste water treatment Sampling and analytical techniques using: onsite measurements oxidation - reduction acids and bases sum parameters photometry spectrometry chromatography Analytical quality assurance |
| 14. Literatur: | -lecture notes (approx. 400 pages) -exercisis -Lehr- und Handbuch der Abwassertechnik, 4. revised edition, volume I. GFA-Verlag St. Augustin 1994. -ATV V: Lehr- und Handbuch der Abwassertechnik, volume v: Organisch verschmutzte Abwässer der Lebensmittelindustrie, Wilhelm Ernst & Sohn Verlag, Berlin. -ATV VII: Lehr- und Handbuch der Abwassertechnik, volume VII: Industrieabwässer mit anorganischen Inhaltsstoffen, Wilhelm Ernst & Sohn Verlag, Berlin. (in each case the current edition) -Deutsche Einheitsverfahren zur Wasser-, Abwasser und Schlammuntersuchung -Standard Methods for the Examination of Water and Wastewater -Wenclawiak, Koch, Hajicostas: Quality Assurance in Analytical Chemistry. Springerverlag 2003 |
| 15. Lehrveranstaltungen und -formen: | • 193301 Lecture Treatment of Industrial Waste Water<br>• 193302 Lecture Water Analysis and Analytical Quality Control |

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| 16. Abschätzung Arbeitsaufwand: | Time of attendance:<br>I Treatment of Industrial Waste Water: 2 SWS = 24 hours<br>II Water Analysis and Analytical Quality Control: 2 SWS = 24 hours<br>Exam: 2 hours<br>sum of attendance: 50 hours<br>self-study: 130 hours<br>**total: 180 hours** |
| 17. Prüfungsnummer/n und -name: | 19331 Industrial Waste Water (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0 |
| 18. Grundlage für ... : | |
| 19. Medienform: | power-point-presentation, blackboard and over-head projector |
| 20. Angeboten von: | Siedlungswasserwirtschaft und Wasserrecycling |

# Modul: 36450 Special Aspects of Urban Water Management

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| 2. Modulkürzel: | 021210006 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, WiSe |
| 4. SWS: | 4.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Ralf Minke |
| 9. Dozenten: | • Ralf Minke<br>• Ulrich Dittmer<br>• Klaus Werner König |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Incoming -->Semi-Compulsory Modules<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Spezialisierungsmodule<br>M.Sc. Water Resources Engineering and Management<br>➞ Zusatzmodule |
| 11. Empfohlene Voraussetzungen: | Inhaltlich:<br>Grundlegende Kenntnisse der Gesamt¬zusammenhänge der Siedlungswasser- und Wasserwirtschaft.<br>Vertiefte Kenntnisse der Abwassertechnik, der Wassergütewirtschaft, der Wasserversorgung oder des allgemeinen Managements von Wasserressourcen.<br>Formal:<br>Wasserversorgungstechnik I oder<br>Abwassertechnik I oder<br>Waste Water Technology oder Water Quality and Treatment |
| 12. Lernziele: | Fachlich:<br>Die Studierenden entwickeln ein Verständnis für Zusammenhänge über ihre Teildisziplin hinaus. Sie können bei Entscheidungen und Planungen zwischen konkurrierenden Belangen der Siedlungswasserwirtschaft, Wasserwirtschaft und anderer Infrastrukturbereiche fachlich fundiert abwägen.<br>Methodisch:<br>Die Studierenden können selbständig mit internationaler wissenschaftlicher Literatur zu ihrem jeweiligen Fachgebiet umgehen, Ergebnisse kritisch bewerten und so ein eigenes Bild des Standes der Wissenschaft erarbeiten und präsentieren. |
| 13. Inhalt: | - Wechselwirkungen zwischen Teilbereichen der Siedlungswasserwirtschaft am Beispiel des Umgangs mit Regenwasser<br>- Jährlich wechselnde Spezialthemen entsprechend dem wissenschaftlichen und technischen Fortschritt |
| 14. Literatur: | Gujer, W. Siedlungswasserwirtschaft, Springer Verlag GmbH<br>Mutschmann, J; Stimmelmayr, F.: Taschenbuch der Wasserversorgung, Vieweg-Verlag<br>Jeweils die aktuellen Auflagen |

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| | Nationale und internationale Fachzeitschriften, z.B. GWF-Wasser/ Abwasser, KA Abwasser, Abfall, Hrsg. und Verlag GFA, W.Sci.Tech., Wat. Res., Wasser und Abfall<br>Diverse Merk- und Arbeitsblätter des DVGW und der DWA |
| 15. Lehrveranstaltungen und -formen: | • 364501 Scientific Seminar<br>• 364502 Lecture Rainwater Harvesting and Management<br>• 364503 Excursions |
| 16. Abschätzung Arbeitsaufwand: | |
| 17. Prüfungsnummer/n und -name: | 36451 Special Aspects of Urban Water Management (Seminar presentation) (LBP), schriftlich, eventuell mündlich, Gewichtung: 1.0 |
| 18. Grundlage für ... : | |
| 19. Medienform: | |
| 20. Angeboten von: | Siedlungswasserwirtschaft und Wasserrecycling |

# Modul: 80990 Master`s Thesis WAREM

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| 2. Modulkürzel: | - | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 30.0 LP | 6. Turnus: | jedes Semester |
| 4. SWS: | 20.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Univ.-Prof. Silke Wieprecht |
| 9. Dozenten: | |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Incoming<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Incoming<br>➞<br>M.Sc. Water Resources Engineering and Management |
| 11. Empfohlene Voraussetzungen: | The topic of the Master Thesis can be handed out only the moment at least 78 credit points have been acquired already by the candidate. One month after 90 credit points have been acquired the candidate is supposed to start the work on his master thesis or to ask for the assignment of the topic at the latest. |
| 12. Lernziele: | Capability to implement an independently composed project schedule for the treatment of a recent scientific problem in an international research environment.<br>Effective scientific work in a team, enforcement of strategies internally and particularly externally. Acquire the necessary stamina to not be discouraged by unexpected problems and throwbacks in scientific projects and to finally be successful by the formulation of alternative methods of resolution.<br>Multidisciplinarity through contacts with representatives of other fields like Chemistry, Mathematics, Informatics, etc.<br>Obtaining the capability to discuss the own results of research in the environment of the recent international research comprehensively and to represent them in written (Master's Thesis) and oral (talk) form. |
| 13. Inhalt: | Treatment of a recent scientific problem in an international research environment.<br>The successful treatment of the scientific problem requires the specialisation in the related field of research and the acquisition of the necessary knowledge. |
| 14. Literatur: | Recent literature on the topic of the scientific problem |
| 15. Lehrveranstaltungen und -formen: | |
| 16. Abschätzung Arbeitsaufwand: | 900 h (Contact time: 900 h) |
| 17. Prüfungsnummer/n und -name: | |
| 18. Grundlage für ... : | |
| 19. Medienform: | |
| 20. Angeboten von: | |

# 220 Outgoing

Zugeordnete Module:
221 Pflichtmodule
222 Wahlmodule

# 221 Pflichtmodule

Zugeordnete Module:

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| 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 |
| 50110 | Requirements of Professional Life and Engineering in Practise |
| 56000 | Requirements of Professional Life and Engineering in Practise 2 |

# Modul: 19100 Chemistry and Biology for Environmental Engineers

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| 2. Modulkürzel: | 021230502 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, WiSe |
| 4. SWS: | 6.0 | 7. Sprache: | - |

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| 8. Modulverantwortlicher: | Univ.-Prof. Jörg Metzger |
| 9. Dozenten: | • Jörg Metzger<br>• Karl Heinrich Engesser<br>• Brigitte Schwederski<br>• Bertram Kuch<br>• Daniel Dobslaw |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Incoming -->Semi-Compulsory Modules<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Pflichtmodule<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Incoming -->Elective Moduls<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Pflichtmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Spezialisierungsmodule<br>M.Sc. Water Resources Engineering and Management<br>➞ Vertiefungsmodule -->Vertiefungsmodule Wahlpflicht<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Zusatzmodule |
| 11. Empfohlene Voraussetzungen: | |
| 12. Lernziele: | |

**Lecture: Inorganic chem istry**

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

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| | • Implication of engineer work on ecosystems /environment protection problems<br><br>Some test systems for estimation of (bio)degradability of chemicals will be evaluated |
| 14. Literatur: | Lecture notes<br><br>pdf download of powerpoint slides for lectures<br><br>Exercises as hand-out or download (pdf) |
| 15. Lehrveranstaltungen und -formen: | • 191001 Lecture Inorganic chemistry<br>• 191002 Lecture Organic chemistry<br>• 191003 Lecture Biology and ecology of water, soil and air systems<br>• 191004 Lecture Technical and medical microbiology for engineers |
| 16. Abschätzung Arbeitsaufwand: | Time of attendance:<br>Inorganic chemistry (Schwederski): Lecture, 1 SWS = 14 hours<br>Organic chemistry (Metzger/Kuch): Lecture, 1 SWS = 14 hours<br>Biology and ecology of water, soil and air systems (Engesser): Lecture, 1 SWS = 14 hours<br>Technical and medical microbiology for engineers (Engesser): Lecture, 1 SWS = 14 hours<br>Exercises for Chemistry and Biology for environmental engineers, 2 SWS = 28 hours<br>Exam: 2 hours<br>Sum of attendance: 86 hours<br>Exercises (group work with presentations): 28 hours<br>Self -study: 94 hours: |
| 17. Prüfungsnummer/n und -name: | 19101 Chemistry and Biology for Environmental Engineers (PL), schriftlich oder mündlich, 120 Min., Gewichtung: 1.0 |
| 18. Grundlage für ... : | |
| 19. Medienform: | Video projector (powerpoint) presentation<br>explanations on blackboard, group work with presentations |
| 20. Angeboten von: | Hydrochemie und Hydrobiologie in der Siedlungswasserwirtschaft |

# Modul: 50090 Environmental Fluid Mechanics I

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| 2. Modulkürzel: | 021420012 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, WiSe |
| 4. SWS: | 5.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Apl. Prof. Holger Class |
| 9. Dozenten: | • Jürgen Braun<br>• Holger Class<br>• Sergey Oladyshkin |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Incoming -->Semi-Compulsory Modules<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Pflichtmodule<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Incoming -->Compulsory Modules<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Pflichtmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Vertiefungsmodule -->Vertiefungsmodule Pflicht<br>➞ |
| 11. Empfohlene Voraussetzungen: | Technical Mechanics<br>• Introduction to the statics of rigid bodies<br>• Introduction to elastostatics<br>• Introduction to the mechanics of incompressible fluids<br>Higher Mathematics<br>• Partial differential equations<br>• Vector analysis<br>• Numerical integration<br>Fundamentals of Flow Mechanics<br>• Conservation equations for mass, momentum, energy<br>• 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 und finite difference. The |

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| | hydraulics of surface water deals with shallow water equations / Saint Venant equations, unstationary channel flow, turbulence und layered systems. Calculation methods such as the methods of characteisitcs are explained. The contents are:<br><br>• Potential flow and groundwater flow<br>• Computational Fluid Dynamics<br>• Shallow water equations for surface water<br>• Charakteristikenmethode<br>• Examples from civil and environmental engineering |
| 14. Literatur: | Lecture notes: Hydromechanics, Helmig and Class<br>Lecture notes: Ausbreitungs- und Transportvorgänge in Strömungen, Cirpka<br>White, F.M.: Fluid Mechanics, WCB/McGraw-Hill, New York, 1999<br>Freeze, R.A. and Cherry J.A.: Groundwater, Prentice Hall, 1979 |
| 15. Lehrveranstaltungen und -formen: | 500901 Lecture and Excercise Environmental Fluid Mechanics I |
| 16. Abschätzung Arbeitsaufwand: | Sum 180 h |
| 17. Prüfungsnummer/n und -name: | • 50091 Environmental Fluid Mechanics I (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0<br>• V Vorleistung (USL-V), schriftliche Prüfung |
| 18. Grundlage für ... : | 50170 Environmental Fluid Mechanics II |
| 19. Medienform: | Fundamentals will be developed using the blackboard and presentation tools. |
| 20. Angeboten von: | Institut für Wasser- und Umweltsystemmodellierung |

# Modul: 19150 German as a Foreign Language

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| 2. Modulkürzel: | SZ | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | unregelmäßig |
| 4. SWS: | 8.0 | 7. Sprache: | - |

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| 8. Modulverantwortlicher: | John Nixon |
| 9. Dozenten: | |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Pflichtmodule<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Pflichtmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Deutschkurse |
| 11. Empfohlene Voraussetzungen: | |
| 12. Lernziele: | |
| 13. Inhalt: | |
| 14. Literatur: | |
| 15. Lehrveranstaltungen und -formen: | • 191501 Seminar German as a Foreign Language I<br>• 191502 Seminar German as a Foreign Language II |
| 16. Abschätzung Arbeitsaufwand: | |
| 17. Prüfungsnummer/n und -name: | • 19151 German as a Foreign Language I (PL), schriftlich oder mündlich, Gewichtung: 1.0<br>• 19152 German as a Foreign Language II (PL), schriftlich oder mündlich, Gewichtung: 1.0 |
| 18. Grundlage für ... : | |
| 19. Medienform: | |
| 20. Angeboten von: | |

# Modul: 50110 Requirements of Professional Life and Engineering in Practise

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| 2. Modulkürzel: | 021410901 | 5. Moduldauer: | 3 Semester |
| 3. Leistungspunkte: | 3.0 LP | 6. Turnus: | jedes Semester |
| 4. SWS: | 2.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Anne Weiß |
| 9. Dozenten: | |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Pflichtmodule<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Pflichtmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Vertiefungsmodule -->Vertiefungsmodule Pflicht<br>➞ |
| 11. Empfohlene Voraussetzungen: | |
| 12. Lernziele: | • Capability to summarize a water-related topic or the investigations of a scientific, water related problem in terms of two 20 min presentations, discussion on the topic after presenting.<br>• Ability to participate in a scientific discussion, asking questions to presenters.<br>• Writing a summary of a visit at a technical site, condense information to a short report. |
| 13. Inhalt: | |
| 14. Literatur: | Recent literature on the water related topic/ scientific problem,. |
| 15. Lehrveranstaltungen und -formen: | • 501101 Seminar Requirements of Professional Life and Engineering in Practise<br>• 501102 Excursion Requirements of Professional Life and Engineering in Practise |
| 16. Abschätzung Arbeitsaufwand: | 90 h (Contact time: 70 h) |
| 17. Prüfungsnummer/n und -name: | 50111 Requirements of Professional Life and Engineering in Practise (USL), Sonstiges, Gewichtung: 1.0, Course achievements: Compulsary attendance in: seminar, workshop "presentation techniques", course "Correct Citation in scientific papers", excursions. Two presentations, one written short report (USL) |
| 18. Grundlage für ... : | |
| 19. Medienform: | |
| 20. Angeboten von: | |

# Modul: 56000 Requirements of Professional Life and Engineering in Practise 2

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|---|---|---|---|
| 2. Modulkürzel: | Warem | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 3.0 LP | 6. Turnus: | jedes Semester |
| 4. SWS: | 2.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Anne Weiß |
| 9. Dozenten: | |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Pflichtmodule<br>➞<br><br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Pflichtmodule<br>➞ |
| 11. Empfohlene Voraussetzungen: | none |
| 12. Lernziele: | Capability to summarize a water-related topic or the investigations of a scientific, water related problem in terms of two 20 min presentations, discussion on the topic after presenting.<br><br>Ability to participate in a scientific discussion, asking questions to presenters.<br><br>Writing a summary of a visit at a technical site, condense information to a short report. |
| 13. Inhalt: | Treatment of a water related topic or a recent scientific problem in an international research environment.<br><br>The successful treatment of the scientific problem requires the specialisation in the related field of research and the acquisition of the necessary knowledge.<br><br>Week-end workshop regarding 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.<br><br>Course:Correct Citation in scientific papers.The students will know about the importance of correct citations, see different types of citations and learn formal ways to make citations visible and comprehensible. |
| 14. Literatur: | Recent literature on the water related topic/ scientific problem |
| 15. Lehrveranstaltungen und -formen: | |
| 16. Abschätzung Arbeitsaufwand: | 90 h (contact time 70h) |
| 17. Prüfungsnummer/n und -name: | 56001 Requirements of Professional Life and Engineering in Practise 2 (USL), schriftliche Prüfung, Gewichtung: 1.0, Course achievements: Compulsary attendance in: seminar, workshop "presentation techniques", course "Correct Citation in scientific papers", excursions. Two presentations, one written short report (USL) |
| 18. Grundlage für ... : | |

19. Medienform:

20. Angeboten von:

# Modul: 19120 Sanitary Engineering

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| 2. Modulkürzel: | 021220012 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, WiSe |
| 4. SWS: | 4.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Klaus Fischer |
| 9. Dozenten: | • Klaus Fischer<br>• Heidrun Steinmetz |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Pflichtmodule<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Pflichtmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Vertiefungsmodule -->Vertiefungsmodule Pflicht<br>➞ |
| 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.<br>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:<br>• Waste generation and waste composition<br>• National and international regulations for waste<br>• Waste avoidance<br>• Collection and transport of waste |

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| | • Separate collection of recyclables<br>• Sorting of recyclables<br>• Recycling technologies for paper, glass, metal, plastic<br>• Biological treatment of waste<br>• Waste Disposal<br>• Ecological indicator systems<br><br>Waste Water Technology:<br>• Basics of urban drainage and municipal wastewater treatment<br>• Quantity and Composition of Wastewater<br>• Urban drainage systems<br>• stormwater treatment<br>• mechanical wastewater treatment<br>• biological wastewater treatment<br>• sludge treatment<br>• natural close and ECOSAN systems |
| 14. Literatur: | Lecture Manuscripts Solid Waste Management<br>G. Tchobanoglous et. Al.: Handbook of solid waste management;<br>Biliteski, B. et.al.: Waste Management, Springer 1994 ISBN: 3-540-59210-5<br>Butler, D., Davies, J.W: .Urban drainage, Spon press London,<br>Henze, M., Harremoes, J., la Coour Jansen, J., Arvin, E: Wastewater treatment. Springer Verlag Berlin |
| 15. Lehrveranstaltungen und -formen: | • 191201 Vorlesung Solid Waste Management<br>• 191202 Vorlesung Waste Water<br>• 191203 Exkursion Sanitary Engineering |
| 16. Abschätzung Arbeitsaufwand: | Time of attendance:<br>I Solid Waste Management, lecture: 2.0 SWS = 28 hours<br>II Waste Water: 2 SWS = 28 hours<br>excursion: 12 hours<br>exam: 2 hours<br>sum of attendance: 70 hours<br>self-study: 110 hours<br>total: 180 hours |
| 17. Prüfungsnummer/n und -name: | • 19121 Solid Waste Management and Waste Water Technology (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0<br>• V Vorleistung (USL-V), schriftlich, eventuell mündlich |
| 18. Grundlage für ... : | • 19310 Urban Drainage and Design of Wastewater Treatment Plants<br>• 19330 Industrial Waste Water |
| 19. Medienform: | |
| 20. Angeboten von: | |

# Modul: 19310 Urban Drainage and Design of Wastewater Treatment Plants

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| 2. Modulkürzel: | 021210251 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, SoSe |
| 4. SWS: | 5.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Ulrich Dittmer |
| 9. Dozenten: | • Heidrun Steinmetz<br>• Ulrich Dittmer |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Pflichtmodule<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Pflichtmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Spezialisierungsmodule<br>M.Sc. Water Resources Engineering and Management<br>➞ Vertiefungsmodule -->Vertiefungsmodule Wahlpflicht<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Zusatzmodule |
| 11. Empfohlene Voraussetzungen: | Chemistry and Biology for Environmental Engineers<br><br>Sanitary Engineering |
| 12. Lernziele: | Advanced knowledge of processes and concepts for urban drainage and municipal wastewater treatment systems<br><br>Basics of construction and dimensioning of different urban drainage systems, stormwater treatment facilities and wastewater treatment plants as a base for dimensioning and discussion of proved and innovative technologies<br><br>Deeper understanding for system connections as base for a decisions during the planning process |
| 13. Inhalt: | Design of sewer systems and stormwater treatment<br><br>(Dr.- Ing. Ulrich Dittmer)<br><br>principles of collection and disposal<br>design of combined and separate sewer systems<br>Sustainable urban drainage systems (SUDS) and low impact design(LID)<br>Application of rainfall runoff models (computer exercise using U.S. EPA Stormwater Management Model)<br>different techniques for treatment and retention<br>design of treatment facilities<br><br>Design of wastewater treatment plants (Prof. Dr.-Ing. Heidrun Steinmetz)<br><br>Municipal wastewater treatment<br>different techniques for advanced biological wastewater treatment (nitrogen and phosphorous removal) |

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| | principles of process engineering<br>design of biological wastewater treatment plants and the main important aggregates<br>design of sludge treatment plants<br><br>Seminar: feasibility studies<br><br>(Prof. Dr.- Ing. Heidrun Steinmetz and external consultants)<br><br>special examples for sanitation concepts for world wide application<br>Ecological sanitation and resource orientated systems<br><br>case studies |
| 14. Literatur: | • Butler, D., Davies, J.W) .Urban drainage, Spon press London, US EPA: SWMM 5.0 users manual<br>• Henze, M., Harremoes, J. la Coour Jansen, J., Arvin, E: Wastewater treatment. Springer Verlag Berlin<br>• Lens, P, Zeeman,G., Lettinga, G.: Decentralised Sanitation and reuse. IWA publishing, London<br>• Different German standards (DWA, Hennef)<br>• Lecture notes |
| 15. Lehrveranstaltungen und -formen: | • 193101 Vorlesung und Übung Design of Sewer System and Stormwater Treatment<br>• 193102 Vorlesung und Übung Design of Wastewater Treatment Plants<br>• 193103 Seminar Case Study<br>• 193104 Exkursion |
| 16. Abschätzung Arbeitsaufwand: | Time of attendance: approx. 70 hours (including 4*4hours for excursion) 1,5 SWS<br><br>Private Study: approx. 110 hours<br><br>Lecture 1 Presence time: 28 hours, self study 30 hours, project 0, Sum: **58 hours**<br><br>Lecture 2: Presence time: 28 hours, self study 30 hours, project 40, Sum: **58 hours**<br><br>Case study: Presence time: 14 hours, self study 10 hours, project 0, Sum: **25 hours** |
| 17. Prüfungsnummer/n und -name: | 19311 Urban Drainage and Design of Wastewater Treatment Plants (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0 |
| 18. Grundlage für ... : | |
| 19. Medienform: | |
| 20. Angeboten von: | Siedlungswasserwirtschaft und Wasserrecycling |

# 222 Wahlmodule

Zugeordnete Module:

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| 15010 | Integrated River Management and Engineering |
| 15160 | Water and Power Supply |
| 34420 | Regional and Urban Planning II |
| 50120 | Environmental Informatics |
| 50130 | Integrated Watershed Modeling |
| 50140 | Modeling of Hydrosystems |
| 50150 | Stochastical Modeling and Geostatistics |
| 50190 | Geohydrological Modelling I and II |
| 50210 | Geohydrology and Geoengineering |
| 50230 | Hydrogeological Investigations |
| 50260 | Measurements in the Watercycle |
| 50330 | Regional and Urban Planning I |
| 50620 | Hydraulic Structures |
| 50650 | Planning and Design of Water Supply Facilities |

# Modul: 50120 Environmental Informatics

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| 2. Modulkürzel: | 021430002 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, WiSe |
| 4. SWS: | 4.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Univ.-Prof. Andras Bardossy |
| 9. Dozenten: | Johannes Riegger |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Incoming -->Semi-Compulsory Modules<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Wahlmodule<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Incoming -->Compulsory Modules<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Wahlmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Spezialisierungsmodule<br>M.Sc. Water Resources Engineering and Management<br>➞ Vertiefungsmodule -->Vertiefungsmodule Wahlpflicht<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Zusatzmodule |
| 11. Empfohlene Voraussetzungen: | |
| 12. Lernziele: | Skills in Spreadsheet Calculations for Data Processing,Design, Creation, Handling and Application of Relational Database Management Systems for Environmental Issues, Creation and display of Environmental GIS data sets .Use of GIS functionalities to investigate spatial and attribute relationships |
| 13. Inhalt: | **Information Processing & Environmental Data Management** (Excel & Access):<br>Environmental Database Design, Relational Database Management, Data Normalization, Data Security<br>**GIS Tools in Environmental Engineering (ArcGIS):**<br>Basics of GIS, Data implementation, Spatial Structures and Attributes, Display of Environmental Information, Charts & Diagrams, Digitization, Spatial and Logical Queries, Data Links, Geo-Referencing, Field Calculations |
| 14. Literatur: | Script: J. Riegger ‘Environmental Informatics’<br>User Handbooks for Excel, Access, ArcGIS<br>**Getting to know ArcGIS Desktop ISBN: 9781589482609** |
| 15. Lehrveranstaltungen und -formen: | • 501201 Lecture Environmental Data Management<br>• 501202 Lecture GIS Tools in Environmental Engineering |
| 16. Abschätzung Arbeitsaufwand: | Time of attendance: approx. 56 hours<br>Private Study: approx. 124 hours during semester |

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| | Sum: 180h |
| 17. Prüfungsnummer/n und -name: | • 50121 Environmental Informatics (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0<br>• V Vorleistung (USL-V), schriftliche Prüfung |
| 18. Grundlage für ... : | |
| 19. Medienform: | |
| 20. Angeboten von: | |

# Modul: 50190 Geohydrological Modelling I and II

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| 2. Modulkürzel: | 021430007 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, WiSe |
| 4. SWS: | 4.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Univ.-Prof. Andras Bardossy |
| 9. Dozenten: | Johannes Riegger |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Wahlmodule<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Wahlmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Spezialisierungsmodule<br>M.Sc. Water Resources Engineering and Management<br>➞ Zusatzmodule |
| 11. Empfohlene Voraussetzungen: | Contents of Geohydrology and Geoengineering |
| 12. Lernziele: | • Setup of a Geohydrological Model<br>• Spatial and temporal Discretization (Stability Criteria)<br>• Adequate Transfer of Nature into a Model<br>• Simplification of complex Geohydrological Systems<br>• Choice of adequate Numerical Scheme<br>• Unique Calibration of Flow and Transport<br>• Assessment of Geohydrological Model Approaches and Model Realizations |
| 13. Inhalt: | Geohydrological Modelling 1:<br>Groundwater Flow, Conceptual Model, Numerical Model, Modelling of Natural Systems, Calibration Process, Sensitivity Analysis, Model Verification and Validation.<br>Geohydrological Modelling 2:<br>Complex & Transient Systems, 3D-Flow, Fractured Systems, Double Porosity, Advective and Dispersive Transport, Numerical Methods for Transport, Stability Criteria, Chemical Reactions, Measurement of Transport Parameters, Transport Calibration |
| 14. Literatur: | Script: J. Riegger ‘Geohydrological Modelling’<br>Anderson & Woessner ‘Applied Groundwater Modelling’<br>Spitz & Moreno : ‘A Practical Guide to Groundwater and Solute Transport Modeling’<br>Freeze & Cherry: ‘Groundwater’ |
| 15. Lehrveranstaltungen und -formen: | • 501901 Lecture Geohydrological Modelling 1<br>• 501902 Lecture Geohydrological Modelling 2 |
| 16. Abschätzung Arbeitsaufwand: | Sum: 180h |
| 17. Prüfungsnummer/n und -name: | 50191 Geohydrological Modelling I and II (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0 |
| 18. Grundlage für ... : | |
| 19. Medienform: | |

20. Angeboten von:

# Modul: 50210 Geohydrology and Geoengineering

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| 2. Modulkürzel: | 021430004 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, SoSe |
| 4. SWS: | 4.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Univ.-Prof. Christian Moormann |
| 9. Dozenten: | Christian Moormann |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Wahlmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Spezialisierungsmodule<br>M.Sc. Water Resources Engineering and Management<br>➞ Zusatzmodule |
| 11. Empfohlene Voraussetzungen: | Recommended background knowledge:<br>Geoengineering:<br>Basic knowledge of mechanics and groundwater flow<br>Geohydrology: Basic knowledge of groundwater hydraulics<br>Prerequisite module: none |
| 12. Lernziele: | **Geoengineering:**<br>The students have the required skills to treat fundamental soil mechanics problems such as: groundwater flow, consolidation, slope stability, settlement and soil strength calculations.<br>**Geohydrology:**<br>The students have a strong foundation in the applied skills required to locate, analyse, assess, develop, and protect groundwater resources. |
| 13. Inhalt: | **Geoengineering:**<br><br>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.<br><br>**Geohydrology:**<br><br>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<br>Lecture notes can be downloaded from the Internet; PowerPoint presentations<br><br>Lancellotta, R. (1998): “Geotechnical Engineering”; A.A. Balkema, Rotterdam,NetherlandDas, B.M. (1999): “Principles of Geotechnical Engineering”; PSW, Internat Thomson Public., Boston, USASutton, B.H.C. (1994): “Solving problems in Soil Mechanics”; McGraw-Hill |

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| | Book Company, London, UKScott, C.R. (1994): “An introduction to Soil Mechanics and Foundation”; E & FN Spon, London, UK<br><br>Geohydrology:<br><br>Lecture notes can be downloaded from the Internet via the ILIAS system; PowerPoint presentations<br><br>Fetter, C.W. (2001): Applied Hydrogeology, 4th edition. Prentice Hall; 598 pages<br><br>Wichtig: mindestens ein konkreter Titel (Monographie, Artikel o.ä.) ist anzugeben |
| 15. Lehrveranstaltungen und -formen: | • 502101 Lecture Geoengineering<br>• 502102 Lecture Geohydrology |
| 16. Abschätzung Arbeitsaufwand: | Geoengineering: 84h<br><br>Geohydrology : 54h |
| 17. Prüfungsnummer/n und -name: | 50211 Geohydrology and Geoengineering (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0 |
| 18. Grundlage für ... : | |
| 19. Medienform: | |
| 20. Angeboten von: | |

# Modul: 50620 Hydraulic Structures

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| 2. Modulkürzel: | 021410106 | 5. Moduldauer: | 2 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, WiSe |
| 4. SWS: | 4.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Univ.-Prof. Silke Wieprecht |
| 9. Dozenten: | • Silke Wieprecht<br>• Kristina Terheiden<br>• Daniel Stolz |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Incoming -->Semi-Compulsory Modules<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Wahlmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Vertiefungsmodule -->Vertiefungsmodule Pflicht<br>➞ |
| 11. Empfohlene Voraussetzungen: | |
| 12. Lernziele: | **Advanced Studies in Hydraulic Structures:** The students…<br>• Know about the basic features of hydraulic structures<br>• have an overview what are the main components and know how to arrange them in order to ensure a satisfying operation<br>• are able to dimension all parts of different hydraulic structures<br>• 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<br>• are able to realize the economic and ecologic significance of hydraulic structures as dams, reservoirs and hydro power plants<br>**Case Study in Hydraulic Structures** : The students…<br>• are able to use of the gained theoretical knowledge with the help of a practical example<br>• are aware of the technical relations and their effects on non-technical areas of interest<br>• can give a well-founded argumentation of chosen estimations and are able to present their own results<br>• can give a convincing presentation<br>• 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.<br>**Case Study in Hydraulic Structures** : The case study uses the content of the lecture „Advanced Studies in Hydraulic Structures“. In working |

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| | groups of 3 to five 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<br>• 506202 Lecture and Presentation Case Study in Hydraulic Structures, |
| 16. Abschätzung Arbeitsaufwand: | Sum 180h |
| 17. Prüfungsnummer/n und -name: | 50621 Hydraulic Structures (LBP), schriftlich oder mündlich, 90 Min., Gewichtung: 1.0 |
| 18. Grundlage für ... : | |
| 19. Medienform: | |
| 20. Angeboten von: | |

# Modul: 50230 Hydrogeological Investigations

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| 2. Modulkürzel: | 021430008 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, SoSe |
| 4. SWS: | 4.0 | 7. Sprache: | Deutsch |

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| 8. Modulverantwortlicher: | Univ.-Prof. Andras Bardossy |
| 9. Dozenten: | • Johannes Riegger<br>• Jochen Seidel |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Wahlmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Spezialisierungsmodule<br>M.Sc. Water Resources Engineering and Management<br>➞ Zusatzmodule |
| 11. Empfohlene Voraussetzungen: | Recommended background knowledge:<br>Hydrology, Hydrogeology, Fluid Mechanics |
| 12. Lernziele: | **Field Course Hydrogeology:**<br>The students know the most common field investigations used in groundwater. This includes the relevant theoretical basics on groundwater hydraulics, hydrogeology and field methods. When applying theoretical knowledge on practical problems, the participants are able to recognise critical points and develop appropriate solutions.<br><br>**Pumping Test Analysis**<br>The participants know the basic theories to analyse pumping tests and are able to use computer based methods like Spreadsheet Calculations for Analysis like Theis, Cooper-Jacob, Diagnostic Plots, Inverse Normalized Diagnostics, Recognition of Inner / Outer Boundaries, Heterogeneity, Well Effects and Handling of noise and trends. |
| 13. Inhalt: | **Field Course Hydrogeology:**<br>In the field:<br><br>• Soil Sampling / Drilling<br>• Surveying / Levelling<br>• Piezometric Heads / Potentiometric Surfaces<br>• Pumping Test - Recovery Test<br>• Piezometer test / Slug test<br>• Tracer Test<br>• Geophysical Borehole measurements / Natural groundwater velocity<br>• Groundwater Chemistry<br>• Hydrogeological Site Assessment<br><br>In the lab:<br><br>• Column Experiments to Determine the Hydrodynamic Dispersion Coefficient and the Hydraulic Conductivity<br>• Particle-Size Distribution and Soil Characterisation<br>• Rocks: Definitions, Characterisation, Classification, Genesis, Hydraulic Properties<br><br>In the classroom: |

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| | • Theoretical background of the methods applied in the field and in the laboratory (see above)<br><br>**Pumping Test Analysis** :<br><br>Basic theory and computer exercises to evaluate and analyse the pumping tests.<br>Analytical techniques, Diagnostic Plots, stationary / transient conditions, interior / outer boundary conditions, step-drawdown tests and Well Performance Tests, spatial distribution of parameters, regional parameters, effective parameters |
| 14. Literatur: | **Field Course Hydrogeology:**<br>Marsily: Quantitative Hydrogeology. Groundwater Hydrology for Engineers.<br>Lecture Notes: Barthel/Seidel Field Course Hydrogeology<br>**Pumping Test Analysis**<br>Script: J. Riegger 'Pumping Test Analysis'<br>Kruseman & de Ridder: 'Analysis and Evaluation of Pumping Test Data' |
| 15. Lehrveranstaltungen und -formen: | • 502301 Lecture Field Course Hydrology<br>• 502302 Lecture Pumping Test Analysis |
| 16. Abschätzung Arbeitsaufwand: | Sum 180h |
| 17. Prüfungsnummer/n und -name: | 50231 Hydrogeological Investigations (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0 |
| 18. Grundlage für ... : | |
| 19. Medienform: | |
| 20. Angeboten von: | |

# Modul: 15010 Integrated River Management and Engineering

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| 2. Modulkürzel: | 021410102 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, SoSe |
| 4. SWS: | 0.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Markus Noack |
| 9. Dozenten: | • Markus Noack<br>• Stefan Haun |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Wahlmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Spezialisierungsmodule<br>M.Sc. Water Resources Engineering and Management<br>➞ Vertiefungsmodule -->Vertiefungsmodule Wahlpflicht<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Zusatzmodule |
| 11. Empfohlene Voraussetzungen: | none (BAU), advisable LWW_Wabau<br>none (UMW), advisable LWW_Gew<br>Hydraulic Structures (WAREM) |
| 12. Lernziele: | **River Engineering and Sediment Management**<br>The students…<br>• are aware of rivers must be regarded and managed based on an integrated approach<br>• know the basic concept of the European Water Framework Directive (WFD) and the German legal framework for river basin management<br>• are able to analyze and estimate the consequences of the WFD based inventory for future management<br>• are aware of sediment transport processes and of the complexity of the interactions and relations<br>• recognize the possibilities and limitations of sediment managements strategies<br><br>**Integrated Flood Protection Measures**<br>The students…<br>• are aware of the fact that flood protection is an integral process, based on different components (e.g. technical flood protection measures, prevention)<br>• 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<br>• know 1-D and 2-D numerical hydro-dynamic models<br>• are able to apply their knowledge on practical engineering problems related to flood protection |
| 13. Inhalt: | The module consists of two lectures:<br>**River Engineering and Sediment Management**<br>• 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

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| 14. Literatur: | Lecture notes and exercise material can be downloaded from the internet.<br>Hints are given for additional literature from the internet as well as libraries. |
| 15. Lehrveranstaltungen und -formen: | • 150101 Vorlesung River Engineering and Sediment Management<br>• 150102 Vorlesung Integrated Flood Protection<br>• 150103 Übung Integrated Flood Protection |
| 16. Abschätzung Arbeitsaufwand: | Time of attendance: 55 h<br>Private study: 125 h |
| 17. Prüfungsnummer/n und -name: | 15011 Integrated River Management and Engineering (PL), schriftliche Prüfung, 150 Min., Gewichtung: 1.0 |
| 18. Grundlage für ... : | |
| 19. Medienform: | |
| 20. Angeboten von: | |

# Modul: 50130 Integrated Watershed Modeling

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| 2. Modulkürzel: | 021430009 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, SoSe |
| 4. SWS: | 4.0 | 7. Sprache: | Deutsch |

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| 8. Modulverantwortlicher: | Univ.-Prof. Andras Bardossy |
| 9. Dozenten: | • Johannes Riegger<br>• Andras Bardossy |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Wahlmodule<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Wahlmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Spezialisierungsmodule<br>M.Sc. Water Resources Engineering and Management<br>➞ Vertiefungsmodule -->Vertiefungsmodule Wahlpflicht<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Zusatzmodule |
| 11. Empfohlene Voraussetzungen: | Recommended background knowledge: Basic knowledge of hydrology and geohydrology<br>Prerequisite module: none |
| 12. Lernziele: | **Hydrological Modeling:**<br>Construction of models for each part in the runoff process and how these models are used and integrated in different environment management systems.<br>**Integrated model systems for the groundwater management:**<br>Design of hydrogeological databases, visualization of data, GIS-Operations for the groundwater and hydrological modeling, Geostatistic, stochastic modeling, Monte Carlo Methods. |
| 13. Inhalt: | **Hydrological Modeling:**<br>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.<br>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 there 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. |

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| | **Integrated model systems for the groundwater management:**<br>Modern integrated model systems require techniques for the efficient construction of ground water models and their integration in “Decision Support Systems” as well as strategies for the handling of uncertainties. The course will discuss the specific “GIS-Methods” that are important for the integrations of databases, the visualization of data and the calculation of spatial data like ground water recharge. Special focus is laid on GIS supported hydrological modeling of the ground water recharge and the runoff parameters as well as adequate choice of the hydrological model concepts for the calculation of the local water balance in different data situations. To handle the model uncertainties, geostatistic methods and associated stochastic modeling attempts like the “Monte Carlo Simulation” will be mentioned. |
| 14. Literatur: | Hydrological Modeling:<br>Beven, K.J., 2000. Rainfall-Runoff Modelling: The Primer. Wiley, 360pp.<br>Singh, V.P. (Ed.), 1995. Computer Models of Watershed Hydrology. Water Resource Publications, Littleton, Colorado, USA. |
| 15. Lehrveranstaltungen und -formen: | • 501301 Lecture and excercise Hydrological Modeling<br>• 501302 Lecture and excercise Integrated model systems for the groundwater management |
| 16. Abschätzung Arbeitsaufwand: | Sum: 180h |
| 17. Prüfungsnummer/n und -name: | 50131 Integrated Watershed Modeling (PL), schriftliche Prüfung, 150 Min., Gewichtung: 1.0 |
| 18. Grundlage für ... : | |
| 19. Medienform: | |
| 20. Angeboten von: | |

# Modul: 50260 Measurements in the Watercycle

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| 2. Modulkürzel: | 040401001 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, SoSe |
| 4. SWS: | 4.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Univ.-Prof. Johan Alexander Huisman |
| 9. Dozenten: | • Johan Alexander Huisman<br>• Jochen Seidel<br>• Rudolf Widmer-Schnidrig |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Wahlmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Spezialisierungsmodule<br>M.Sc. Water Resources Engineering and Management<br>➞ Zusatzmodule |
| 11. Empfohlene Voraussetzungen: | Recommended background knowledge:<br>(I) Basic knowledge in Hydromechanics/Hydraulics corresponding to a lecture with approx. 6-8 ECTS<br>(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**<br>• Precipitation measurements<br>• Evaporation and evapotranspiration measurements<br>• Discharge measurements<br>• Water quality measurements<br>**(II) Measuring subsurface hydrological fluxes**<br>• Infiltration measurements<br>• Water potential measurements<br>• Physical principles of water content measurements<br>• Electromagnetic methods (TDR, GPR, Remote sensing)<br>• Electrical methods (ERT, SP, SIP) |
| 14. Literatur: | R. Herschey, Streamflow Measurement, Taylor & Francis, 3rd edition, 2009.<br>S. Emais, Measurements Methods in Atomspheric Sciences, Boerntraeger, 2010.<br>P. V. Sharma, Environmental and engineering geophysics, Cambridge Univ. Press, 1997. |
| 15. Lehrveranstaltungen und -formen: | • 502601 Lecture Hydrometry and Remote Sensing<br>• 502602 Lecture Hydrogeophysics |
| 16. Abschätzung Arbeitsaufwand: | Sum 180h |

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| 17. Prüfungsnummer/n und -name: | 50261 | Measurements in the Watercycle (BSL), schriftlich, eventuell mündlich, 120 Min., Gewichtung: 1.0 |
| 18. Grundlage für ... : | | |
| 19. Medienform: | | |
| 20. Angeboten von: | | |

# Modul: 50140 Modeling of Hydrosystems

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| 2. Modulkürzel: | 021420011 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, SoSe |
| 4. SWS: | 5.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Univ.-Prof. Rainer Helmig |
| 9. Dozenten: | • Rainer Helmig<br>• Bernd Flemisch<br>• Nicolas Schwenck |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Wahlmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Spezialisierungsmodule<br>M.Sc. Water Resources Engineering and Management<br>➞ Vertiefungsmodule -->Vertiefungsmodule Wahlpflicht<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Zusatzmodule |
| 11. Empfohlene Voraussetzungen: | Recommended background knowledge:<br>Higher Mathematics:<br>• Partial differential equations<br>• Numerical integration<br>Fundamentals of fluid mechanics:<br>• Conservation equations for mass, momentum, energy<br>• 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:<br>• Knowledge of the common methods (finite differences, finite elements, finite volume) and the differences between them<br>• Advantages and disadvantages and of the methods and thus of their applicability<br>• Derivation of the various methods<br>• Use and choice of the correct boundary conditions for the various methods<br>Time discretisation:<br>• Knowledge of the various possibilities<br>• Assessment of stability, computational effort, precision<br>• Courant number, CFL criterion<br>Transport equation:<br>• Various discretisation possibilities<br>• Physical background |

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| | • Stabiity criteria of the methods (Peclet number)<br><br>Clarification of concepts: model, simulation<br><br>Application of the finite element method to the stationary groundwater equation Setting-up of a simulation programme for modeling groundwater:<br><br>• Programme requirements<br>• Programming individual routines<br><br>Fundamentals of programming in C:<br><br>• Control structures<br>• Functions<br>• Arrays<br>• Debugging<br><br>Visualisation of the simulation results |
| 14. Literatur: | Lecture notes: Modeling of Hydrosystems, Helmig<br>Helmig, R.: Multiphase Flow and Transport Processes in the Subsurface, Springer Verlag, 1997 |
| 15. Lehrveranstaltungen und -formen: | • 501401 Lecture and Excercise Modeling of Hydrosystems 1, Fundamentals<br>• 501403 Lecture and Excercise Modeling of Hydrosystems 2, Applications |
| 16. Abschätzung Arbeitsaufwand: | Sum: 180h |
| 17. Prüfungsnummer/n und -name: | 50141 Modeling of Hydrosystems (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0 |
| 18. Grundlage für ... : | |
| 19. Medienform: | Fundamentals will be developed using the blackboard and presentation tools. Group exercises help in understanding the obtained theoretical basis. |
| 20. Angeboten von: | Institut für Wasser- und Umweltsystemmodellierung |

# Modul: 50650 Planning and Design of Water Supply Facilities

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| 2. Modulkürzel: | 021210052 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, SoSe |
| 4. SWS: | 4.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Ralf Minke |
| 9. Dozenten: | Ralf Minke |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Wahlmodule<br>➞ |
| 11. Empfohlene Voraussetzungen: | Knowledge in Sanitary Engineering, Water Supply and Hydraulics<br>Contents of Water and Power Supply |
| 12. Lernziele: | The students…<br>• Are able to plan and design centralised water supply systems as a part of rural and urban infrastructure.<br>• Are able to calculate dimensions of all elements of centralised water supply systems.<br>• Are able to calculate costs of all elements of centralised water supply systems.<br>• have an idea of the relations between water, politics, social changes and influences on environment and on planning process.<br>• 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.<br>• Water demand calculation: water consumption, water demand, consumer groups, losses, forecasting, design periods.<br>• 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.<br>• Water transmission and distribution: necessity, hydraulic basics, dimensioning and calculation of branched and closed loop systems, details of planning and design.<br>• Pumps and pumping stations: necessity, types, hydraulics for pumping design, pumping stations and pressure boosters, details of planning and design.<br>• Water storage: necessity, types and functions of tanks, water towers and reservoirs, details of planning and design.<br>• Cost calculation: Cost functions for different facilities, Calculation process, calculation of water tariff. |
| 14. Literatur: | Lecture notes can be downloaded from the internet.<br>• Karamouz, Mohammad et al.: Urban Water Engineering and Management. Boca Raton: CRC Press, 2010. ISBN 978-1-4398-1310-2<br>• Mutschmann, J; Stimmelmayr, F.: Taschenbuch der Wasserversorgung, Vieweg-Verlag<br>Hints are given for additional literature from the internet as well as libraries. |

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| 15. Lehrveranstaltungen und -formen: | • 506501 Lecture Planning and design of water supply facilities<br>• 506502 Case Study Planning and design of water supply facilities<br>• 506503 Excursions to planning area and water supply company |
| 16. Abschätzung Arbeitsaufwand: | Sum180h |
| 17. Prüfungsnummer/n und -name: | 50651 Planning and Design of Water Supply Facilities (LBP), schriftliche Prüfung, Gewichtung: 1.0 |
| 18. Grundlage für ... : | |
| 19. Medienform: | |
| 20. Angeboten von: | Siedlungswasserwirtschaft und Wasserrecycling |

# Modul: 50330 Regional and Urban Planning I

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| 2. Modulkürzel: | 021100010 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, WiSe |
| 4. SWS: | 4.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Univ.-Prof. Jörn Birkmann |
| 9. Dozenten: | • Jörn Birkmann<br>• Astrid Ley |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Wahlmodule<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Wahlmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Spezialisierungsmodule<br>M.Sc. Water Resources Engineering and Management<br>➞ Zusatzmodule |
| 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:<br>• International Planning studies<br>• Overview on current planning issues<br>• Basic Terms of Spatial Planning<br>• Strategies in Spatial Planning<br>• Instruments of Spatial Planning<br>• Performance of Plans, Assessing Plans<br>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: | Berke, P.R. et al. (2006): Urban Land Use Planning. Urbana/Chicago: University of Illinois Press<br>Birkmann et al. (2010): Adaptive urban governance: nes challenges for the second generation of urban adaptation studies to climate change In: Sustanability science 5<br>Hall, P. (2002): Urban and Regional Planning. New York: Routledge |
| 15. Lehrveranstaltungen und -formen: | • 503301 Lecture Regional Planning I<br>• 503302 Lecture Urban Planning I |

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| 16. Abschätzung Arbeitsaufwand: | Time of attendance: approx. 45 hours<br>Private Study: approx.135 hours |
| 17. Prüfungsnummer/n und -name: | 50331 Regional and Urban Planning I (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0 |
| 18. Grundlage für ... : | |
| 19. Medienform: | |
| 20. Angeboten von: | |

# Modul: 34420 Regional and Urban Planning II

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| 2. Modulkürzel: | - | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, SoSe |
| 4. SWS: | 4.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Univ.-Prof. Jörn Birkmann |
| 9. Dozenten: | • Jörn Birkmann<br>• Astrid Ley<br>• Stefan Fina<br>• Torsten Welle |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Wahlmodule<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Wahlmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Spezialisierungsmodule<br>M.Sc. Water Resources Engineering and Management<br>➞ Zusatzmodule |
| 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 present-ed.The lectures demonstrate the usage of planning instruments and methods based on planning cases from Germanyand other countries. |
| 13. Inhalt: | The course Regional Planning II deals with the following planning methods:<br>• Indicator-based monitoring and evaluation methods<br>• Multi-criteria decision analysis (e.g. cost-benefit analysis, utility value analyis, analytic hierarchy process)<br>• Methods of impact assessment<br>• Techniques of demand forecast and land suitability analysis<br>• Hazard and vulnerability analysis (climate change adaptation)<br>The course Urban Planning II gives an overview on:<br>• Levels of spatial planning in urban areas<br>• Urban development planning<br>• Urban analysis<br>• Urban renewal<br>• Urban planning instruments<br>• Land use planning and implementation planning<br>• Legal framework |
| 14. Literatur: | Skript "Regional and Urban Planning II" |
| 15. Lehrveranstaltungen und -formen: | • 344201 Vorlesung Regional Planning II<br>• 344202 Vorlesung Urban Planning II |
| 16. Abschätzung Arbeitsaufwand: | Time of attendance: approx.45hours<br>Private Study: approx. 120 hours |

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| 17. Prüfungsnummer/n und -name: | • 34421 Regional Planning II (PL), schriftliche Prüfung, 60 Min., Gewichtung: 1.0<br>• 34422 Urban Planning II (PL), schriftliche Prüfung, 60 Min., Gewichtung: 1.0 |
| 18. Grundlage für ... : | |
| 19. Medienform: | Optional |
| 20. Angeboten von: | |

# Modul: 50150 Stochastical Modeling and Geostatistics

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| 2. Modulkürzel: | 021430003 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, SoSe |
| 4. SWS: | 4.0 | 7. Sprache: | Deutsch |

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| 8. Modulverantwortlicher: | Univ.-Prof. Andras Bardossy |
| 9. Dozenten: | Andras Bardossy |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Wahlmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Spezialisierungsmodule<br>M.Sc. Water Resources Engineering and Management<br>➞ Vertiefungsmodule -->Vertiefungsmodule Wahlpflicht<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Zusatzmodule |
| 11. Empfohlene Voraussetzungen: | Recommended background knowledge: Basic knowledge of statistics<br>Prerequisite module: none |
| 12. Lernziele: | **Concepts of Geostatistics:**<br>Knowledge of the basic geostatistical concepts, difference between Kriging and simulation, advantages and disadvantages of the discussed methods, application of Kriging and simulation<br>**Stochastical Modeling:**<br>The participants have skills in basic statistical methods used in hydrology, like time series analysis, extreme value statistics, parameter estimation methods and statistical tests. |
| 13. Inhalt: | **Concepts of Geostatistics:**<br>Geostatistical procedures for the interpolation of measured values, assessment of model parameters and planning of Measuring networks are dealt with.<br>Contents:<br>• Introduction<br>• Statistical hypotheses: Basic concepts; Regionalized variables; Second order stationarity; Intrinsic hypothesis; Comparison of the two hypotheses; Selection of the regionalized variable<br>• The variogram: The experimental variogram; The theoretical variogram; Variogram models; Variogram fitting; Isotropy — anisotropy<br>• Ordinary Kriging: Point kriging; Block kriging; Properties of ordinary kr.; Kr.as an interpolator; Kr. and the variogram; Practice of kr.;Selection of the neighbourhood; Kr. with a “false” variogram; Cross validation; Kr. with uncertain data; Simple Kr.<br>• Non stationary methods: Universal kr.;Intrinsic random functions of order k; External-Drift-Kr.<br>• Indicator Kriging: Indicator Kriging; Applications<br>• Kriging with arbitrary additional information: Markov-Bayes-Kriging; Simple Updating (SU)<br>• Time dependent variables<br>• Simulations: Basic definitions; Monte Carlo; Turning Band; Unconditional simulation; Conditional simulation; Sequential |

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| | Simulation; Simulation using Markov Chains; The Hastings Algorithm; Simulated annealing; Indicator Simulation; Truncated-Gaussian Simulation; Application of simulations<br>• Exercises<br><br>**Stochastical Modeling:**<br>The lecture part stochastic modeling is primarily concerned with the stochastic analysis of temporal and areal arrays, their generation and their use in the hydrological modeling. Calculation and analysis of hydrological data, descriptive statistic and their parameters, possibility analysis, correlation and regression, time series analysis and simulation.<br>Content:<br><br>• Univariate Statistics and multivariate Statistics (e.g. regression analysis)<br>• theory of probabilities<br>• random variables and probability functions (e.g. Poission distribution)<br>• estimation of parameters (e.g. Maximum Likelihood Method)<br>• statistical tests (e.g. Kolmogorov-Smirnov test)<br>• extreme value statistics (analysis of the frequency of occurrence of floods)<br>• time series analysis (e.g.. ARMA Models)<br>• stochastic simulations (Monte-Carlo Methods) |
| 14. Literatur: | **Geostatistics:**<br>Introduction to Geostatistics (Lecture notes, English)<br>Kitanidis, P. K (1997): Introduction to geostatistics: applications to hydrogeology<br>Armstrong, Margaret (1998): Basic linear geostatistics<br>**Stochastical Modeling:**<br>Plate, E. 1994. Statistik und angewandte Wahrscheinlichkeitslehre für Bauingenieure. Berlin.<br>Bras, R. L. and Ignacio Rodriguez-Iturbe. 1993. Random Functions and Hydrology. Dover Publications, Inc. New York.<br>Hipel, K. W. and McLeod. A. I. 1994. Time Series Modeling of Water Resources and Environmental Systems. Elsevier. Amsterdam.<br>Chow, V.-E. 1964. Handbook of applied Hydrology. McGraw-Hill Book. Company. New York.<br>Maniak, U. 1997. Hydrologie und Wasserwirtschaft: Eine Einführung für Ingenieure. 4. überarb. und erw. Auflage. Springer. Berlin |
| 15. Lehrveranstaltungen und -formen: | • 501501 Lecture Concepts of Geostatistics<br>• 501502 Lecture and Excercise Stochastical Modeling |
| 16. Abschätzung Arbeitsaufwand: | Sum:180h |
| 17. Prüfungsnummer/n und -name: | 50151 Stochastical Modeling and Geostatistics (PL), schriftliche Prüfung, 90 Min., Gewichtung: 1.0 |
| 18. Grundlage für ... : | |
| 19. Medienform: | |
| 20. Angeboten von: | |

# Modul: 15160 Water and Power Supply

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| 2. Modulkürzel: | 021410105 | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 6.0 LP | 6. Turnus: | jedes 2. Semester, WiSe |
| 4. SWS: | 0.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Sabine-Ulrike Gerbersdorf |
| 9. Dozenten: | • Sabine-Ulrike Gerbersdorf<br>• Ralf Minke |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Outgoing -->Wahlmodule<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Outgoing -->Wahlmodule<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Spezialisierungsmodule<br>M.Sc. Water Resources Engineering and Management<br>➞ Vertiefungsmodule -->Vertiefungsmodule Wahlpflicht<br>➞<br>M.Sc. Water Resources Engineering and Management<br>➞ Zusatzmodule |
| 11. Empfohlene Voraussetzungen: | None |
| 12. Lernziele: | **Power Demand, Supply and Distribution:**<br><br>The students…<br><br>• know the German, European and worldwide energy markets related to demand, supply and its distribution capabilities<br>• are aware of that non-renewable energy sources are strictly limited and time-scales for conversion of energy markets long<br>• have an idea about the relations between energy, politics, social changes and influences on environment<br>• have a basic knowledge about present energy conversion systems, theoretical limits of efficiencies, and the potential to enhance applied technology<br>• have a basic understanding about where and how energy is provided and distributed<br>• comprehend the balance between load and supply in electrical grids and the resulting necessity for control energy.<br><br>**Water Demand, Supply and Distribution:**<br><br>The students…<br><br>• know the German and worldwide water systems related to demand, supply and its distribution capabilities<br>• have an overview on the water supply situation all over the world.<br>• recognize the different possibilities and levels of water supply<br>• 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

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| 14. Literatur: | Lecture notes can be downloaded from the internet.<br>Hints are given for additional literature from the internet as well as libraries. |
| 15. Lehrveranstaltungen und -formen: | • 151601 Vorlesung Energy Demand, Supply and Distribution<br>• 151602 Vorlesung Water Demand, Supply and Distribution |
| 16. Abschätzung Arbeitsaufwand: | Time of attendance: 45 h<br>Private Study: 135 h |
| 17. Prüfungsnummer/n und -name: | 15161 Water and Power Supply (PL), schriftliche Prüfung, 120 Min., Gewichtung: 1.0 |
| 18. Grundlage für ... : | |
| 19. Medienform: | |
| 20. Angeboten von: | |

# Modul: 80990 Master`s Thesis WAREM

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| 2. Modulkürzel: | - | 5. Moduldauer: | 1 Semester |
| 3. Leistungspunkte: | 30.0 LP | 6. Turnus: | jedes Semester |
| 4. SWS: | 20.0 | 7. Sprache: | Englisch |

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| 8. Modulverantwortlicher: | Univ.-Prof. Silke Wieprecht |
| 9. Dozenten: | |
| 10. Zuordnung zum Curriculum in diesem Studiengang: | DoubleM.D. Water Resources Engineering and Management<br>➞ Chalmers -->Incoming<br>➞<br>DoubleM.D. Water Resources Engineering and Management<br>➞ Mara -->Incoming<br>➞<br>M.Sc. Water Resources Engineering and Management |
| 11. Empfohlene Voraussetzungen: | The topic of the Master Thesis can be handed out only the moment at least 78 credit points have been acquired already by the candidate. One month after 90 credit points have been acquired the candidate is supposed to start the work on his master thesis or to ask for the assignment of the topic at the latest. |
| 12. Lernziele: | Capability to implement an independently composed project schedule for the treatment of a recent scientific problem in an international research environment.<br>Effective scientific work in a team, enforcement of strategies internally and particularly externally. Acquire the necessary stamina to not be discouraged by unexpected problems and throwbacks in scientific projects and to finally be successful by the formulation of alternative methods of resolution.<br>Multidisciplinarity through contacts with representatives of other fields like Chemistry, Mathematics, Informatics, etc.<br>Obtaining the capability to discuss the own results of research in the environment of the recent international research comprehensively and to represent them in written (Master's Thesis) and oral (talk) form. |
| 13. Inhalt: | Treatment of a recent scientific problem in an international research environment.<br>The successful treatment of the scientific problem requires the specialisation in the related field of research and the acquisition of the necessary knowledge. |
| 14. Literatur: | Recent literature on the topic of the scientific problem |
| 15. Lehrveranstaltungen und -formen: | |
| 16. Abschätzung Arbeitsaufwand: | 900 h (Contact time: 900 h) |
| 17. Prüfungsnummer/n und -name: | |
| 18. Grundlage für ... : | |
| 19. Medienform: | |
| 20. Angeboten von: | |