

Module Manual

Master of Science (M.Sc.)

Water and Environmental Engineering

Cohort: Winter Term 2024 Updated: 8th May 2025

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Program description

Content

Master of Science in 'Water and Environmental Engineering'

The Master of Science in Water and Environmental Engineering gives students a choice of three areas of specialization - Water, Environment and City. Graduates of the Master in Water and Environmental Engineering are able to translate the engineering, mathematical and scientific knowledge gained on the course into practice in order to analyze problems scientifically and solve them even when they are unusually or incompletely defined and have complex specifications. Graduates have the ability to work independently, to apply the methods and processes required to solve technical and planning problems, and to apply, critically scrutinize, and further develop new findings. They are also qualified to plan exacting (household) water management projects geared to environmental protection and to plan them paying due attention to the necessary clarifications and examination of existing information and resources. They can

- Collaborate successfully with professional and non-professional players in public administration, industry, and academia
- Independently define research tasks for theoretical and experimental exploration of environmental and water management issues and plan and execute projects in those areas
- Responsibly assess and take into account the concerns of those affected by planning and implementation and of society in general
- work together in international teams on international subjects with cross-cultural competence.

Core Qualification

| Modulo MOE22, Pusin | ass & Management | | | |
|--|---|--|--|--|
| 1odule M0523: Busin | ess & Management | | | |
| Module Responsible | Prof. Matthias Meyer | | | |
| Admission Requirements | uccessful completion of the modul "Foundations of Management" | | | |
| Recommended Previous | None | | | |
| Knowledge | | | | |
| Educational Objectives | After taking part successfully, students have reached the following learning results | | | |
| Professional Competence | | | | |
| Knowledge | Students are able to find their way around selected special areas of management within the scope of business management. Students are able to explain basic theories, categories, and models in selected special areas of business management. Students are able to interrelate technical and management knowledge. | | | |
| Skills | Students are able to apply basic methods in selected areas of business management. Students are able to explain and give reasons for decision proposals on practical issues in areas of business management | | | |
| Personal Competence Social Competence | Students are able to communicate in small interdisciplinary groups and to jointly develop solutions for complex problems | | | |
| Autonomy | • Students are capable of acquiring necessary knowledge independently by means of research and preparation of material | | | |
| Workload in Hours | Depends on choice of courses | | | |
| Credit points | | | | |

Courses

Information regarding lectures and courses can be found in the corresponding module handbook published separately.

| Module Responsible | Dagmar Richter | | | |
|-------------------------------------|---|--|--|--|
| dmission Requirements | None | | | |
| Recommended Previous | None | | | |
| Knowledge | | | | |
| - | After taking part successfully, students have reached the following learning results | | | |
| rofessional Competence Knowledge | The Nontechnical Academic Programms (NTA) | | | |
| | imparts skills that, in view of the TUHH's training profile, professional engineering studies require but are not able to cover fi Self-reliance, self-management, collaboration and professional and personnel management competences. The departm implements these training objectives in its teaching architecture , in its teaching and learning arrangements , in teach areas and by means of teaching offerings in which students can qualify by opting for specific competences and a compete level at the Bachelor's or Master's level. The teaching offerings are pooled in two different catalogues for nontechr complementary courses. | | | |
| | The Learning Architecture | | | |
| | consists of a cross-disciplinarily study offering. The centrally designed teaching offering ensures that courses in the nontechr academic programms follow the specific profiling of TUHH degree courses. | | | |
| | The learning architecture demands and trains independent educational planning as regards the individual developmen competences. It also provides orientation knowledge in the form of "profiles". | | | |
| | The subjects that can be studied in parallel throughout the student's entire study program - if need be, it can be studied in on two semesters. In view of the adaptation problems that individuals commonly face in their first semesters after making transition from school to university and in order to encourage individually planned semesters abroad, there is no obligatio study these subjects in one or two specific semesters during the course of studies. | | | |
| | Teaching and Learning Arrangements | | | |
| | provide for students, separated into B.Sc. and M.Sc., to learn with and from each other across semesters. The challenge of dea with interdisciplinarity and a variety of stages of learning in courses are part of the learning architecture and are delibera encouraged in specific courses. | | | |
| | Fields of Teaching | | | |
| | are based on research findings from the academic disciplines cultural studies, social studies, arts, historical studies communication studies, migration studies and sustainability research, and from engineering didactics. In addition, from the wi semester 2014/15 students on all Bachelor's courses will have the opportunity to learn about business management and start in a goal-oriented way. | | | |
| | The fields of teaching are augmented by soft skills offers and a foreign language offer. Here, the focus is on encouraging g oriented communication skills, e.g. the skills required by outgoing engineers in international and intercultural situations. | | | |
| | The Competence Level | | | |
| | of the courses offered in this area is different as regards the basic training objective in the Bachelor's and Master's fields. Th differences are reflected in the practical examples used, in content topics that refer to different professional application conte and in the higher scientific and theoretical level of abstraction in the B.Sc. | | | |
| | This is also reflected in the different quality of soft skills, which relate to the different team positions and different group leader functions of Bachelor's and Master's graduates in their future working life. | | | |
| | Specialized Competence (Knowledge) | | | |
| | Students can | | | |
| | explain specialized areas in context of the relevant non-technical disciplines, outline basic theories, categories, terminology, models, concepts or artistic techniques in the disciplines represented in learning area, different specialist disciplines relate to their own discipline and differentiate it as well as make connections, sketch the basic outlines of how scientific disciplines, paradigms, models, instruments, methods and forms of representa in the specialized sciences are subject to individual and socio-cultural interpretation and historicity, Can communicate in a foreign language in a manner appropriate to the subject. | | | |
| Skills | Professional Competence (Skills) | | | |
| | In selected sub-areas students can | | | |
| | apply basic and specific methods of the said scientific disciplines, aquestion a specific technical phenomena, models, theories from the viewpoint of another, aforementioned speci discipline, to handle simple and advanced questions in aforementioned scientific disciplines in a sucsessful manner, justify their decisions on forms of organization and application in practical questions in contexts that go beyond | | | |

| Engineering | |
|---------------------|---|
| | |
| | |
| Personal Competence | |
| | Personal Competences (Social Skills) |
| Social competence | |
| | Students will be able |
| | to learn to collaborate in different manner, |
| | to present and analyze problems in the abovementioned fields in a partner or group situation in a manner appropriate to the addressees, |
| | to express themselves competently, in a culturally appropriate and gender-sensitive manner in the language of the country |
| | (as far as this study-focus would be chosen), |
| | to explain nontechnical items to auditorium with technical background knowledge. |
| | |
| | |
| | |
| | |
| | |
| | |
| Autonomy | Personal Competences (Self-reliance) |
| | · · · · · · · · · · · · · · · · · · · |
| | Students are able in selected areas |
| | to reflect on their own profession and professionalism in the context of real-life fields of application |
| | to organize themselves and their own learning processes |
| | to reflect and decide questions in front of a broad education background |
| | to communicate a nontechnical item in a competent way in writen form or verbaly |
| | • to organize themselves as an entrepreneurial subject country (as far as this study-focus would be chosen) |
| | |
| | |
| | |
| Workload in Hours | Depends on choice of courses |
| Credit points | 6 |
| | |
| Courses | |

Information regarding lectures and courses can be found in the corresponding module handbook published separately.

| Module M1974: Enviro | onmental microbiology and | d analytics | | |
|-----------------------------------|---|---|---------|----|
| Courses | | | | |
| Title | | Тур | Hrs/wk | СР |
| Environmental Analysis (L0354) | | Lecture | 2 | 3 |
| Environmental microbiology (L3223 | 3) | Lecture | 2 | 3 |
| Module Responsible | Dr. Dorothea Rechtenbach | | | |
| Admission Requirements | None | | | |
| Recommended Previous | Fundamentals of inorganic/organic che | emistry and biology (knowledge acquired at so | chool). | |
| Knowledge | | | | |
| Educational Objectives | After taking part successfully, student | s have reached the following learning results | | |
| Professional Competence | | | | |
| Knowledge | On completion of this module, students will be able to describe the mechanisms of biological systems. They will know the main biological metabolic routes and can categorise their influence on global metabolic routes. They will be familiar with the basic analytical methods for investigating and assessing the quality of various environmental compartments. | | | |
| Skills | On completion of this module, students will be able to categorise which metabolism will predominate under which environmenta conditions. Students will be able to apply the theoretical principles they have learnt to exemplary sites and assess the resulting relationship: from a technical and conceptual perspective. They will be able to draw comparisons on different investigation strategies and techniques. Model projects can be devised and treated. | | | |
| Personal Competence | | | | |
| Social Competence | The students are able to organize working processes within a team in a targeted way and based on the divison of labour. | | | |
| Autonomy | Students can independently exploit sources, acquire the particular knowledge of the subject and apply it to new problems. | | | |
| Workload in Hours | Independent Study Time 124, Study T | ime in Lecture 56 | | |
| Credit points | 6 | | | |
| Course achievement | None | | | |
| Examination | Written exam | | | |
| Examination duration and | 90 min | | | |
| scale | | | | |
| Assignment for the | Civil Engineering: Specialisation Water | r and Traffic: Elective Compulsory | | |
| Following Curricula | Water and Environmental Engineering | : Core Qualification: Compulsory | | |

| Course L0354: Environmenta | | | | |
|---|---|--|--|--|
| Тур | | | | |
| Hrs/wk | | | | |
| CP | 3 | | | |
| Workload in Hours | Independent Study Time 62, Study Time in Lecture 28 | | | |
| Lecturer | Dr. Dorothea Rechtenbach, Dr. Henning Mangels | | | |
| Language | N | | | |
| Cycle | ViSe | | | |
| Content | ntroduction | | | |
| | Sampling in different environmental compartments, sample transportation, sample storage | | | |
| | Sample preparation | | | |
| | Photometry | | | |
| | Wastewater analysis | | | |
| | Introduction into chromatography | | | |
| | Gas chromatography | | | |
| | HPLC | | | |
| | Mass spectrometry | | | |
| | Optical emission spectrometry | | | |
| | Atom absorption spectrometry | | | |
| | Quality assurance in environmental analysis | | | |
| Literature | Roger Reeve, Introduction to Environmental Analysis, John Wiley & Sons Ltd., 2002 (TUB: USD-728) | | | |
| | Pradyot Patnaik, Handbook of environmental analysis: chemical pollutants in air, water, soil, and solid wastes, CRC Press, Boca Raton, 2010 (TUB: USD-716) | | | |
| | Chunlong Zhang, Fundamentals of Environmental Sampling and Analysis, John Wiley & Sons Ltd., Hoboken, New Jersey, 2007 (TUB: USD-741) | | | |
| | Miroslav Radojević, Vladimir N. Bashkin, Practical Environmental Analysis RSC Publ., Cambridge, 2006 (TUB: USD-720) | | | |
| | Werner Funk, Vera Dammann, Gerhild Donnevert, Sarah lannelli (Translator), Eric lannelli (Translator), Quality Assurance in Analytical Chemistry: Applications in Environmental, Food and Materials Analysis, Biotechnology, and Medical Engineering, 2nd Edition, WILEY-VCH Verlag GmbH & Co. KGaA,Weinheim, 2007 (TUB: CHF-350) | | | |
| | STANDARD METHODS FOR THE EXAMINATION OF WATER AND WASTEWATER, 21st Edition, Andrew D. Eaton, Leonore S. Clesceri, Eugene W. Rice, and Arnold E. Greenberg, editors, 2005 (TUB:CHF-428) | | | |
| | K. Robards, P. R. Haddad, P. E. Jackson, Principles and Practice of Modern Chromatographic Methods, Academic Press | | | |
| | G. Schwedt, Chromatographische Trennmethoden, Thieme Verlag | | | |
| | H. M. McNair, J. M. Miller, Basic Gas Chromatography, Wiley | | | |
| | W. Gottwald, GC für Anwender, VCH | | | |
| | B. A. Bidlingmeyer, Practical HPLC Methodology and Applications, Wiley | | | |
| | K. K. Unger, Handbuch der HPLC, GIT Verlag | | | |
| | G. Aced, H. J. Möckel, Liquidchromatographie, VCH | | | |
| Charles B. Boss and Kenneth J. Fredeen, Concepts, Instrumentation and Techniques in Inductively Coupled Plasm Spectrometry | | | | |
| | Perkin-Elmer Corporation 1997, On-line available at: http://files.instrument.com.cn/bbs/upfile/2006291448.pdf | | | |
| | Atomic absorption spectrometry: theory, design and applications, ed. by S. J. Haswell 1991 (TUB: 2727-5614) | | | |
| | Royal Society of Chemistry, Atomic absorption spectometry (http://www.kau.edu.sa/Files/130002/Files/6785_AAs.pdf) | | | |
| | Ruyai Society of Chemistry, Atomic absorption spectometry (http://www.kau.edu.sa/Files/130002/Files/6785_AAs.pdf) | | | |

| Course L3223: Environmenta | Course L3223: Environmental microbiology | | | | |
|----------------------------|--|--|--|--|--|
| Тур | Lecture | | | | |
| Hrs/wk | | | | | |
| СР | 3 | | | | |
| Workload in Hours | Independent Study Time 62, Study Time in Lecture 28 | | | | |
| Lecturer | Prof. Johannes Gescher | | | | |
| Language | EN | | | | |
| Cycle | WiSe | | | | |
| Content | This lecture deals with the importance of microorganisms for biological material cycles and the health of water and soil. After the development of biochemical and cell biological basics, methods are presented that are necessary to investigate microbial communities and their activity. In addition, the role of microorganisms in the biogas process and in the biorefinery is discussed. The third part presents methods for purifying air, water and soil as well as environmentally friendly production processes involving microorganisms. | | | | |
| Literature | Umweltmikrobiologie; Reineke, W. und Schlömann, M. (2015) 2. Aufl., Springer Spektrum Verlag Brock Mikrobiologie; Michael T. Madigan, Kelly S. Bender, Daniel H. Buckley, W. Matthew Sattley, David A. Stahl (2020) 15. Aufl., Pearson Studium Verlag | | | | |

| Courses | | | | | |
|------------------------------------|---|---|--------------------------|--------------------|--|
| Title | | Тур | Hrs/wk | СР | |
| Circular Economy (L3264) | | Seminar | 2 | 3 | |
| Environment and Sustainability (L0 | | Lecture | 2 | 3 | |
| Module Responsible | Prof. Kerstin Kuchta | | | | |
| Admission Requirements | None | | | | |
| Recommended Previous | none | | | | |
| Knowledge | | | | | |
| Educational Objectives | After taking part successfully, students h | nave reached the following learning results | | | |
| Professional Competence | | | | | |
| Knowledge | Students are able to describe single te | echniques and to give an overview for the f | ield of safety and risk | assessment, Circu | |
| | Economy as well as environmental and s | sustainable engineering, in detail: | | | |
| | basics in safety and reliability of termination | echnical facilities | | | |
| | risk assessment and reliability and | | | | |
| | Circularity of material | | | | |
| | Identification and evaluation of ma | aterial flows | | | |
| | energy production and supply | | | | |
| | sustainable product design | | | | |
| | | | | | |
| | | | | | |
| Skills | Students are able apply interdisciplinar | y system-oriented methods for Circularity ar | nd risk assessment as | well as sustainabi | |
| | reporting. They can evaluate the effort a | nd costs for processes and select economicall | ly feasible treatment co | ncepts. | |
| | | | | | |
| Personal Competence | | | | | |
| Social Competence | | | N. 1 | | |
| Autonomy | | bject area from given sources and transform | | | |
| | define targets for new application or research-oriented duties in for risk management and sustainability concepts accordan the potential social, economic and cultural impact. | | | | |
| | the potential social, economic and cultur | ai impact. | | | |
| Workload in Hours | Independent Study Time 124, Study Time | e in Lecture 56 | | | |
| Credit points | 6 | | | | |
| Course achievement | None | | | | |
| Examination | Written elaboration | | | | |
| Examination duration and | Elaboration and presentation (45 minute | s in groups) | | | |
| scale | | | | | |
| Assignment for the | Civil Engineering: Core Qualification: Cor | npulsory | | | |
| Following Curricula | Bioprocess Engineering: Specialisation | C - Bioeconomic Process Engineering, For | cus Management and | Controlling: Elect | |
| | Compulsory | | | | |
| | Chemical and Bioprocess Engineering: Sp | pecialisation General Process Engineering: Ele | ctive Compulsory | | |
| | Chemical and Bioprocess Engineering: Sp | pecialisation Bioprocess Engineering: Elective | Compulsory | | |
| | Chemical and Bioprocess Engineering: Sp | pecialisation Chemical Process Engineering: E | lective Compulsory | | |
| | Chemical and Bioprocess Engineering: Sp | pecialisation Chemical and Bio process Engine | ering: Elective Compuls | ory | |
| | Environmental Engineering: Specialisation | on Energy and Resources: Elective Compulsory | / | | |
| | Product Development, Materials and Prod | duction: Specialisation Product Development: | Elective Compulsory | | |
| | Product Development, Materials and Prod | duction: Specialisation Production: Elective Co | ompulsory | | |
| | Product Development, Materials and Prod | duction: Specialisation Materials: Elective Com | npulsory | | |
| | Water and Environmental Engineering: C | | | | |

| Course L3264: Circular Economy | | | |
|--------------------------------|--|--|--|
| Тур | Seminar | | |
| Hrs/wk | 2 | | |
| СР | 3 | | |
| Workload in Hours | ependent Study Time 62, Study Time in Lecture 28 | | |
| Lecturer | Marco Ritzkowski | | |
| Language | EN | | |
| Cycle | WiSe | | |
| Content | | | |
| Literature | | | |

| Course L0319: Environment and Sustainability | | | | |
|--|---|--|--|--|
| Тур | Lecture | | | |
| Hrs/wk | | | | |
| СР | | | | |
| Workload in Hours | Independent Study Time 62, Study Time in Lecture 28 | | | |
| Lecturer | Prof. Kerstin Kuchta | | | |
| Language | EN | | | |
| Cycle | WiSe | | | |
| Content | Cycle WiSe Intent This course presents actual methodologies and examples of environmental relevant, sustainable technologies, concepts a strategies in the field of energy supply, product design, water supply, waste water treatment or mobility. The following list shows examples: Production and use of biochar Energy production with algae Environmentally friendly product design Clean development mechanisms Democracy and energy Alternative mobility | | | |
| Literature | Wird in der Veranstaltung bekannt gegeben. | | | |

Specialization Cities

| Module M0923: Integ | rated Transportation Planning | | | | |
|--|--|-------------------------------------|-----------------|---------------------|--|
| Courses | | | | | |
| Title | | Тур | Hrs/wk | СР | |
| Integrated Transportation Planning | (L1068) | Project-/problem-based Learning | 4 | 6 | |
| Module Responsible | Prof. Carsten Gertz | | | | |
| Admission Requirements | None | | | | |
| | some knowledge of transport planning, e.g. through taking th | ne undergraduate class "Transport P | lanning and Tra | ffic Engineerin | |
| Knowledge | | - to the state of the | | | |
| | After taking part successfully, students have reached the follo | owing learning results | | | |
| Professional Competence | Students are able to: | | | | |
| | describe interdependencies between land-use/location choice and transportation/mobility behaviour explain and evaluate the social, ecological and economic effects of transport and land-use policy measures. relate current issues in the area of integrated transport planning and formulate an opinion on them. | | | | |
| Skills | Students are able to: quantify important parameters, which influence travel demand or are influenced by it. comprehensively examine a pre-defined or self-selected topic from a transportation studies perspective and document the results in accordance with scientific conventions. | | | | |
| Personal Competence Social Competence | Students are able to: provide feedback on topical contents and their teachin constructively handle feedback on their own work. produce results in group work and document these. | ıg. | | | |
| Autonomy | Students are able to: assess potential consequences of their future profession independently plan working on a pre-defined project to its execution. | | lge and use app | propriate means for | |
| Workload in Hours | Independent Study Time 124, Study Time in Lecture 56 | | | | |
| Credit points | 6 | | | | |
| Course achievement | None | | | | |
| Examination | Written elaboration | | | | |
| Examination duration and | written assignment with presentation during the semester | | | | |
| scale Assignment for the Following Curricula | Civil Engineering: Specialisation Structural Engineering: Elect Civil Engineering: Specialisation Geotechnical Engineering: El Civil Engineering: Specialisation Coastal Engineering: Elective Civil Engineering: Specialisation Water and Traffic: Compulso | lective Compulsory e Compulsory | | | |
| | Logistics, Infrastructure and Mobility: Specialisation Infrastruc Water and Environmental Engineering: Specialisation Cities: (| | ory | | |

| Course L1068: Integrated Tr | ansportation Planning |
|-----------------------------|---|
| Тур | Project-/problem-based Learning |
| Hrs/wk | 4 |
| CP | 6 |
| Workload in Hours | Independent Study Time 124, Study Time in Lecture 56 |
| Lecturer | Prof. Carsten Gertz, Dr. Philine Gaffron, Jacqueline Bianca Maaß |
| Language | DE |
| Cycle | WiSe |
| | The course will provide students with an understanding of interdependencies between land-use and transportation. Specific topics include a.o.: interactions between transport and the environment and consequent limitations characteristics of integrated planning complex planning processes interdependencies of location choice and mobility behaviour transport and land-use policies project on current issues in transportation studies |
| Literature | Kutter, Eckhard (2019) Stadtstruktur und Erreichbarkeit in der postfossilen Zukunft. Erich Schmidt Verlag. Berlin. Gies, Huber u. a. (Hrsg.) (93. Ergänzung 2022) Handbuch der kommunalen Verkehrsplanung. Herbert Wichmann Verlag. Berlin, Offenbach. (Loseblattsammlung mit kontinuierlichen Ergänzungen) |

| | 11 | | | |
|--|--|--|------------------|----------------------|
| Module M0827: Mode | ling in Water Management | | | |
| Courses | | | | |
| Title | | Тур | Hrs/wk | СР |
| Groundwater Modeling using Modfle | ow (L0543) | Lecture | 1 | 1 |
| Groundwater Modeling using Modfle | | Recitation Section (small) | 2 | 2 |
| Modeling of Water Supply Network | | Project-/problem-based Learning | 1 2 | 3 |
| Module Responsible Admission Requirements | | | | |
| Recommended Previous | | | | |
| Knowledge | Groundwater | | | |
| | groundwater hydraulics and transport | of substances | | |
| | Pipe Systems | | | |
| | Knowledge on urban water infrastru | ctures, in particular drinking water systemsand | urban drainag | e systems including |
| | special structures | | | |
| | Hydraulics of drinking water supply sy | stems and sewer systems | | |
| | Basic knowledge on water manageme | nt | | |
| Educational Objectives | After taking part successfully, students have | reached the following learning results | | |
| Professional Competence | | | | |
| Knowledge | The students are able to describe the modell | ing of groundwater flow and transport as well as u | rban water infra | astructures. They ca |
| | carry out systems analyses and can detect technical and conceptual weak points within the systems in case studies. Besides they | | | |
| | are able to analyse interdependencies of hydraulic and toxic phenomena in soil and water. | | | |
| | | | | |
| | | | | |
| Skills | The students are able to construct and apply scientific groundwater models indipendently. They can work on different scenarios | | | |
| | and can compare or assess different solutions for existing problems by application of selected software products. The students are | | | |
| | able to use different software solutions (e.g. | EPANET, EPA-SWMM). | | |
| | | | | |
| | | | | |
| | | | | |
| Personal Competence | | | | |
| Social Competence | Wird nicht vermittelt. | | | |
| Autonomy | Wird nicht vermittelt. | | | |
| Workload in Hours | Independent Study Time 110, Study Time in | Lecture 70 | | |
| Credit points | | | | |
| Course achievement | | | | |
| Examination | | | | |
| Examination duration and | 30 min | | | |
| scale | | | | |
| • | Civil Engineering: Specialisation Structural En | | | |
| Following Curricula | Civil Engineering: Specialisation Geotechnica Civil Engineering: Specialisation Coastal Engi | | | |
| | Civil Engineering: Specialisation Coastal Engl Civil Engineering: Specialisation Water and T | • | | |
| | Civil Engineering: Specialisation Water and T | | | |
| | | | | |
| | Water and Environmental Engineering: Speci | alisation Environment: Elective Compulsory | | |
| | Water and Environmental Engineering: Speci Water and Environmental Engineering: Speci | | | |

| Course L0543: Groundwater Modeling using Modflow | | | |
|--|--|--|--|
| Тур | Lecture | | |
| Hrs/wk | 1 | | |
| СР | 1 | | |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 | | |
| Lecturer | Sonja Götz | | |
| Language | DE/EN | | |
| Cycle | SoSe | | |
| Content | Introduction and application of the groundwater model MODFLOW (PMWIN); theoretical backround of the modell, students do work | | |
| | with the model PMWIN for practical case studies. | | |
| Literature | MODFLOW-Handbuch | | |
| | Chiang, Wen Hsien: PMWIN | | |
| | | | |

| Course L0544: Groundwater | Course L0544: Groundwater Modeling using Modflow | | | |
|---------------------------|---|--|--|--|
| Тур | Recitation Section (small) | | | |
| Hrs/wk | 2 | | | |
| СР | 2 | | | |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 | | | |
| Lecturer | Sonja Götz | | | |
| Language | DE/EN | | | |
| Cycle | SoSe | | | |
| Content | See interlocking course | | | |
| Literature | See interlocking course | | | |

| Course L0875: Modeling of Water Supply Network | | | |
|--|--|--|--|
| Тур | Project-/problem-based Learning | | |
| Hrs/wk | 2 | | |
| СР | 3 | | |
| Workload in Hours | Independent Study Time 62, Study Time in Lecture 28 | | |
| Lecturer | Dr. Klaus Johannsen | | |
| Language | DE | | |
| Cycle | SoSe | | |
| Content | | | |
| Literature | Mutschmann/Stimmelmayr: Taschenbuch der Wasserversorgung, 16. Auflage. Springer Vieweg - Verlag. Wiesbaden 2014. | | |

| Module M0828: Urbar | n Environmental Management | | | |
|-------------------------------|---|-----------------------------------|-----------------|---------------------|
| Courses | | | | |
| Title | 1 | Гур | Hrs/wk | СР |
| Noise Protection (L1109) | | .ecture | 2 | 2 |
| Jrban Infrastructures (L0874) | F | Project-/problem-based Learning | 2 | 4 |
| Module Responsible | Dr. Dorothea Rechtenbach | | | |
| Admission Requirements | None | | | |
| Recommended Previous | • Knowledge on Urban planning | | | |
| Knowledge | Knowledge on Urban planning | | | |
| | Knowledge on measures for climate protection General knowledge of scientific writing/working | | | |
| | General knowledge of scientific writing/working | | | |
| Educational Objectives | After taking part successfully, students have reached the following | learning results | | |
| Professional Competence | | | | |
| Knowledge | Students can describe urban development corridors as well as cur | rrent and future urban environr | nental proble | ms. They are able |
| | explain the causes of environmental problems (like noise). | | | |
| | Students can specify applications for various technical innovations | s and explain why these contril | oute to the im | provement of urba |
| | life. They can, for example, derive and discuss measures for effect | ive noise abatement. | | |
| Skille | Students are able to develop specific solutions for correctin | a existing or future environ | mont-related | problems of urb |
| JKIIIS | development. They can define a range of conceptual and technica | | | |
| | paths. To solve specific urban environmental problems they can | | | |
| | context. | | ia integrate t | |
| Personal Competence | | | | |
| | The students can work together in international groups. | | | |
| | | | | |
| Autonomy | Students are able to organize their work flow to prepare themsel | | ributions to th | ne discussions. The |
| | can acquire appropriate knowledge by making enquiries independ | ently. | | |
| Workload in Hours | Independent Study Time 124, Study Time in Lecture 56 | | | |
| Credit points | 6 | | | |
| Course achievement | None | | | |
| Examination | Written elaboration | | | |
| Examination duration and | Written Report plus oral Presentation | | | |
| scale | | | | |
| Assignment for the | Civil Engineering: Specialisation Structural Engineering: Elective C | ompulsory | | |
| Following Curricula | Civil Engineering: Specialisation Geotechnical Engineering: Electiv | e Compulsory | | |
| | Civil Engineering: Specialisation Coastal Engineering: Elective Com | npulsory | | |
| | Civil Engineering: Specialisation Water and Traffic: Elective Compu | ilsory | | |
| | Environmental Engineering: Core Qualification: Elective Compulsor | ry | | |
| | Joint European Master in Environmental Studies - Cities and Sustai | nability: Core Qualification: Cor | mpulsory | |
| | Logistics, Infrastructure and Mobility: Specialisation Infrastructure | and Mobility: Elective Compuls | ory | |
| | Water and Environmental Engineering: Specialisation Environment | : Elective Compulsory | | |
| | Water and Environmental Engineering: Specialisation Cities: Comp | ulsory | | |

| Course L1109: Noise Protect | Course L1109: Noise Protection | | | |
|-----------------------------|--|--|--|--|
| Тур | Lecture | | | |
| Hrs/wk | 2 | | | |
| СР | 2 | | | |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 | | | |
| Lecturer | Prof. Martin Jäschke | | | |
| Language | EN | | | |
| Cycle | SoSe | | | |
| Content | | | | |
| Literature | 1) Müller & Möser (2013): Handbook of Engineering Acoustics (also available in German) | | | |
| | 2) WHO (1999): Guidelines for Community Noise | | | |
| | 3) Environmental Noise Directive 2002/49/EG | | | |
| | 4) ISO 9613-2 (1996): Acoustics, Attenuation of sound during propagation outdoors, Part 2: General method of calculation | | | |

| Course L0874: Urban Infrastructures | | |
|-------------------------------------|---|--|
| Тур | Project-/problem-based Learning | |
| Hrs/wk | 2 | |
| СР | 4 | |
| Workload in Hours | Independent Study Time 92, Study Time in Lecture 28 | |
| Lecturer | Dr. Dorothea Rechtenbach | |
| Language | EN | |
| Cycle | SoSe | |
| Content | Problem Based Learning | |
| | Main topics are: Central vs. Decentral Wastewater Treatment. Compaction of Cities. Car Free Cities. Multifunctional Places in Cities. The Sustainability of Freight Transport in Cities. | |
| Literature | Depends on chosen topic. | |

| Module M0870: Mana | gement of Surface Water | | | |
|-------------------------------------|---|---|----------------------|-----------------------|
| | - | | | |
| Courses | | | | |
| Title | | Тур | Hrs/wk | СР |
| Modelling of Flow in Rivers and Est | uaries (L0810) | Lecture | 3 | 4 |
| Nature-Oriented Hydraulic Enginee | ring / Integrated Flood Protection (L0961) | Project-/problem-based Lea | rning 2 | 2 |
| Module Responsible | Prof. Peter Fröhle | | | |
| Admission Requirements | None | | | |
| Recommended Previous | Fundamentals of Hydromechanics, Hydraulics, | Hydrology and Hydraulic Engineering; | Hydraulic Engineer | ing I and Hydrauli |
| Knowledge | Engineering II | | | |
| Educational Objectives | After taking part successfully, students have reac | hed the following learning results | | |
| Professional Competence | | | | |
| Knowledge | Students are able to define in detail the basic | processes that are related to the mode | lling of flows in hy | draulic engineering |
| | Besides, they can describe the basic aspects of r | numerical modelling and actual numerica | I models for the sir | nulation of flows and |
| | waves. They can also depict the concepts of nature | re oriented hydraulic engineering. | | |
| <i>ci ''</i> | | | | |
| Skills | Students are able to apply hydrodynamic-numeric able to set up flood-risk management concepts ar | | | |
| | able to set up nood-risk management concepts an | to are able to apply basic concepts of ren | | ai problems. |
| Personal Competence | | | | |
| Social Competence | The students are able to deploy their gained kno | wledge in applied problems of the practi | cal nature-based h | ydraulic engineering |
| | Additionaly, they will be able to work in team with | engineers of other disciplines. | | |
| Autonomy | The students will be able to independently extend | I their knowledge and apply it to new prob | olems. | |
| Workload in Hours | Independent Study Time 110, Study Time in Lectu | ure 70 | | |
| Credit points | 6 | | | |
| Course achievement | None | | | |
| Examination | Written exam | | | |
| Examination duration and | The duration of the examination is 150 min. Th | e examination includes tasks with respe | ct to the general u | understanding of th |
| scale | lecture contents and calculations tasks. | | | |
| Assignment for the | Civil Engineering: Specialisation Water and Traffic | : Compulsory | | |
| Following Curricula | Environmental Engineering: Core Qualification: El | ective Compulsory | | |
| | Joint European Master in Environmental Studies - | Cities and Sustainability: Core Qualification | on: Compulsory | |
| | Water and Environmental Engineering: Specialisa | tion Water: Compulsory | | |
| | Water and Environmental Engineering: Specialisa | tion Environment: Compulsory | | |
| | Water and Environmental Engineering: Specialisat | tion Cities: Elective Compulsory | | |

| Course L0810: Modelling of F | low in Rivers and Estuaries |
|------------------------------|--|
| Тур | Lecture |
| Hrs/wk | 3 |
| CP | 4 |
| Workload in Hours | Independent Study Time 78, Study Time in Lecture 42 |
| Lecturer | Prof. Edgar Nehlsen, Prof. Peter Fröhle |
| Language | EN |
| Cycle | SoSe |
| Content | Introduction to numerical flow modelling |
| | Processes affecting tht flow |
| | Examples and applications of numerical models |
| | Procedure of numerical modellingModel concept |
| | Basic equations of hydrodynamics |
| | Saint-Venant equations |
| | Euler Equations |
| | Navier-Stokes equations |
| | Reynolds-averaged Navier-Stokes equations |
| | Shallow water equations |
| | |
| | Solving schemes |
| | Numerical discretization |
| | Solution algorithms |
| | Convergence |
| | |
| Literature | Vorlesungsskript |
| | Literaturempfehlungen |
| | |
| | |
| | Bund der Ingenieure für Wasserwirtschaft, Abfallwirtschaft und Kulturbau (1997): Hydraulische Berechnung von naturnahen Fließgewässern. Düsseldorf: BWK (BWK-Merkblatt). |
| | Chow, Ven-te (1959): Open-channel Hydraulics. New York usw.: McGraw-Hill (McGraw-Hill Civil Engineering Series). |
| | Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische Modelle, DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019a): Merkblatt DWA-M 543-2 Geodaten in der Fließgewässermodellierung Teil 1: Geodaten in der Fließgewässermodellierung. Februar 2019. Hennef: Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (DWA-Regelwerk, 543-1). |
| | Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische Modelle, DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019b): Merkblatt DWA-M 543-2 Geodaten in der Fließgewässermodellierung Teil 2: Bedarfsgerechte Datenerfassung und -aufbereitung. Februar 2019. Hennef: Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (DWA-Regelwerk, 543-2). |
| | Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische Modelle, DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019c): Merkblatt DWA-M 543-3 Geodaten in der Fließgewässermodellierung - Teil 3: Aspekte der Strömungsmodellierung und Fallbeispiele. Februar 2019. Hennef: Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (DWA-Regelwerk, 543-3). |
| | Hervouet, Jean-Michel (2007): Hydrodynamics of free surface flows. Modelling with the finite element method. Chichester: Wiley. Online verfügbar unter http://www.loc.gov/catdir/enhancements/fy0741/2007296953-b.html. |
| | IAHR (2015): Professional Specifications for Physical and Numerical Studies in Environmental Hydraulics. In: Hydrolink (3/2015), S. 90-92. |
| | Olsen, Nils Reidar B. (2012): Numerical Modelling and Hydraulics. 3. Aufl. Department of Hydraulic and Environmental Engineering, The Norwegian University of Science and Technology. |
| | Szymkiewicz, Romuald (2010): Numerical modeling in open channel hydraulics. Dordrecht: Springer (Water science and technology library, 83). |
| | van Waveren, Harold (1999-): Good modelling practice handbook. [Utrecht], Lelystad, Den Haag: STOWA; Rijkswaterstaat-RIZA; SDU, afd. SEO/RIZA [etc. distr.] (Nota, nr. 99.036). |
| | Zielke, Werner (Hg.) (1999): Numerische Modelle von Flüssen, Seen und Küstengewässern. Deutscher Verband für Wasserwirtschaft und Kulturbau. Bonn: Wirtschafts- und VerlGes. Gas und Wasser (Schriftenreihe des Deutschen Verbandes für Wasserwirtschaft und Kulturbau, 127). |

| Course L0961: Nature-Oriented Hydraulic Engineering / Integrated Flood Protection | | | |
|---|---|--|--|
| Тур | Project-/problem-based Learning | | |
| Hrs/wk | 2 | | |
| СР | 2 | | |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 | | |
| Lecturer | Dr. Natasa Manojlovic, Prof. Peter Fröhle | | |
| Language | DE/EN | | |
| Cycle | SoSe | | |
| Content | Regime-Theory and application for the development of environmental guiding priciples of rivers Engineering - biological measures for the stabilization of rivers Risk management in flood protection Design techniques in technical flood protection Methods for the assessment of flood caused damages | | |
| Literature | Vorlesungsumdruck | | |

| Lingineering | | | | |
|------------------------------------|---|--|--------------------|------------------------|
| Module M0871: Hydro | ological Systems | | | |
| Courses | | | | |
| Title | | Тур | Hrs/wk | СР |
| Applied Surface Hydrology (L0289) | | Lecture | 2 | 2 |
| Applied Surface Hydrology (L1412) | | Project-/problem-based Learning | ng 1 | 2 |
| Interaction Water - Environment in | Fluvial Areas (L0295) | Project-/problem-based Learning | ng 1 | 2 |
| Module Responsible | Prof. Peter Fröhle | | | |
| Admission Requirements | None | | | |
| Recommended Previous | Fundamentals of Hydromechanics and Hyd | raulic Engineering: Hydraulic Engineering I and Hy | draulic Engineeri | ng II |
| Knowledge | | | | |
| Educational Objectives | After taking part successfully, students have | e reached the following learning results | | |
| Professional Competence | | | | |
| Knowledge | The students are able to define the basic | concepts of hydrology and water management. Th | ney are able to d | lescribe and quantif |
| | the relevant processes of the hydrological | water cycle. Besides, the students know the main | aspects of rainfa | III-run-off-models and |
| | are able to theoretically derive established | reservoir / storage models and a unit-hydrograph. | | |
| CI-ill- | The shudents are able to use the basis b | | | |
| SKIIIS | | ydrological concepts and approaches and are ab | | |
| | | graph as the basis for rainfall-run-off-models. The | | |
| | | I and hydrodynamic values in nature and are able | | - |
| | assess these measurements. Furthermore, | they are able to apply a hydrological model to bas | ic nyarological pi | robiems. |
| Personal Competence | | | | |
| Social Competence | The students are able to deploy their gaine | ed knowledge in applied problems of the hydrology | and water mana | gement. Additionaly |
| | they will be able to work in team with engin | neers of other disciplines. | | |
| Autonomy | The students will be able to independently | extend their knowledge and apply it to new proble | ms | |
| Workload in Hours | Independent Study Time 124, Study Time i | n Lecture 56 | | |
| Credit points | 6 | | | |
| Course achievement | None | | | |
| Examination | Written exam | | | |
| Examination duration and | The duration of the examination is 90 min. | The examination includes tasks with respect to the | e general underst | tanding of the lectur |
| scale | contents and calculations tasks. | | | |
| Assignment for the | Civil Engineering: Specialisation Computati | onal Engineering: Elective Compulsory | | |
| Following Curricula | Civil Engineering: Specialisation Water and | Traffic: Compulsory | | |
| | Environmental Engineering: Core Qualificat | ion: Elective Compulsory | | |
| | Joint European Master in Environmental Stu | udies - Cities and Sustainability: Core Qualification: | Compulsory | |
| | Water and Environmental Engineering: Spe | cialisation Cities: Elective Compulsory | | |
| | Water and Environmental Engineering: Spe | cialisation Environment: Elective Compulsory | | |
| | Water and Environmental Engineering: Spe | cialisation Water: Elective Compulsory | | |

| Course L0289: Applied Surfa | ce Hydrology |
|-----------------------------|---|
| Тур | Lecture |
| Hrs/wk | 2 |
| CP | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Prof. Peter Fröhle |
| Language | DE/EN |
| Cycle | SoSe |
| | Basics of hydrology: Hydrological cycle Data acquisition Data analyses and statistical assessment Statistics of extremes Regionalization methods for hydrological values Rainfall-run-off modelling on the basis of a unit hydrograph conceps Application of rainfall-run-off models on the basis of Kalypso-Hydrology which is an OpenSource Software Tool. |
| Literature | http://de.wikipedia.org/wiki/Kalypso_(Software) http://kalypso.bjoernsen.de/ http://sourceforge.net/projects/kalypso/ |

| Course L1412: Applied Surface Hydrology | |
|---|---|
| Тур | Project-/problem-based Learning |
| Hrs/wk | 1 |
| СР | 2 |
| Workload in Hours | Independent Study Time 46, Study Time in Lecture 14 |
| Lecturer | Prof. Peter Fröhle |
| Language | DE/EN |
| Cycle | SoSe |
| Content | See interlocking course |
| Literature | See interlocking course |

| Course L0295: Interaction Water - Environment in Fluvial Areas | | |
|--|---|--|
| Тур | Project-/problem-based Learning | |
| Hrs/wk | 1 | |
| СР | 2 | |
| Workload in Hours | Independent Study Time 46, Study Time in Lecture 14 | |
| Lecturer | Prof. Peter Fröhle | |
| Language | DE/EN | |
| Cycle | SoSe | |
| Content | A problem based learning course. The problem will be solved by the students more or less self-contained. The topics will be | |
| | introduced and elaborated over the semester. | |
| Literature | - | |

| Lingineering | | | | | |
|------------------------------------|---|-----------------------------------|---------------------|-------------------|---------------------|
| Module M0874: Waste | ewater Systems | | | | |
| | | | | | |
| Courses | | | | | |
| Title | | Тур | | Hrs/wk | СР |
| Biological Wastewater Treatment (I | L0517) | Lecture | | 2 | 2 |
| Biological Wastewater Treatment (I | L3122) | Recitation | Section (large) | 1 | 1 |
| Advanced Wastewater Treatment (| L0357) | Lecture | | 2 | 2 |
| Advanced Wastewater Treatment (| L0358) | Recitation | Section (large) | 1 | 1 |
| Module Responsible | Dr. Joachim Behrendt | | | | |
| Admission Requirements | None | | | | |
| Recommended Previous | Knowledge of wastewater management an | d the key processes involved in | wastewater treatm | nent. | |
| Knowledge | | | | | |
| Educational Objectives | After taking part successfully, students have | ve reached the following learning | g results | | |
| Professional Competence | | | | | |
| Knowledge | Students are able to outline key areas of the | he full range of treatment syste | ms in waste water | management, as | well as their mutua |
| | dependence for sustainable water protection | on. They can describe relevant e | economic, environn | nental and social | factors. |
| | | | | | |
| Skills | Students are able to pre-design and expla | | eatment processes | and the scope o | f their application |
| | municipal and for some industrial treatmen | nt plants. | | | |
| Personal Competence | | | | | |
| | Social skills are not targeted in this module | 2 | | | |
| Social competence | Social Skills are not targeted in this module | | | | |
| Autonomy | Students are in a position to work on a s | subject and to organize their w | ork flow independ | lently. They can | also present on thi |
| | subject. | | | | |
| Workload in Hours | Independent Study Time 96, Study Time in | Lecture 84 | | | |
| Credit points | 6 | | | | |
| Course achievement | None | | | | |
| Examination | Written exam | | | | |
| Examination duration and | 120 min | | | | |
| scale | | | | | |
| Assignment for the | Civil Engineering: Specialisation Structural | Engineering: Elective Compulso | ry | | |
| | Civil Engineering: Specialisation Geotechni | | | | |
| - | Civil Engineering: Specialisation Coastal En | ngineering: Elective Compulsory | | | |
| | Civil Engineering: Specialisation Water and | | | | |
| | Bioprocess Engineering: Specialisation A - (| | : Elective Compulso | orv | |
| | Environmental Engineering: Specialisation | | | | |
| | International Management and Engineering | | | | Compulsory |
| | International Management and Engineering | | | | |
| | Process Engineering: Specialisation Enviror | | - | | . , |
| | Process Engineering: Specialisation Process | | | | |
| | Water and Environmental Engineering: Spe | | - 2 | | |
| | Water and Environmental Engineering: Spe | | e Compulsory | | |
| | Water and Environmental Engineering: Spe | | e compaisory | | |
| | water and Environmental Engineering. Spe | compuisory | | | |

| Course L0517: Biological Wastewater Treatment | | |
|---|---|--|
| Тур | Lecture | |
| Hrs/wk | 2 | |
| CP | 2 | |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 | |
| Lecturer | Dr. Joachim Behrendt | |
| Language | DE/EN | |
| Cycle | SoSe | |
| Content | Charaterisation of Wastewater | |
| | Metobolism of Microorganisms | |
| | Kinetic of mirobiotic processes | |
| | Calculation of bioreactor for wastewater treatment | |
| | Concepts of Wastewater treatment | |
| | Design of WWTP | |
| | Excursion to a WWTP | |
| | Biofilms | |
| | Biofim Reactors | |
| | Anaerobic Wastewater and sldge treatment | |
| | resources oriented sanitation technology | |
| | Future challenges of wastewater treatment | |
| Literature | Gujer, Willi | |
| | Siedlungswasserwirtschaft : mit 84 Tabellen | |
| 1 | | |

| Engineering | |
|-------------|--|
| | ISBN: 3540343296 (Gb.) URL: http://www.gbv.de/dms/bs/toc/516261924.pdf URL: http://deposit.d-nb.de/cgi-bin/dokserv? |
| | id=2842122&prov=M&dok_var=1&dok_ext=htm |
| | Berlin [u.a.] : Springer, 2007 |
| | TUB_HH_Katalog |
| | Henze, Mogens |
| | Wastewater treatment : biological and chemical processes |
| | ISBN: 3540422285 (Pp.) |
| | Berlin [u.a.] : Springer, 2002 |
| | TUB_HH_Katalog |
| | Imhoff, Karl (Imhoff, Klaus R.;) |
| | Taschenbuch der Stadtentwässerung : mit 10 Tafeln |
| | ISBN: 3486263331 ((Gb.)) |
| | München [u.a.] : Oldenbourg, 1999 |
| | TUB_HH_Katalog |
| | Lange, Jörg (Otterpohl, Ralf; Steger-Hartmann, Thomas;) |
| | Abwasser : Handbuch zu einer zukunftsfähigen Wasserwirtschaft |
| | ISBN: 3980350215 (kart.) URL: http://www.gbv.de/du/services/agi/52567E5D44DA0809C12570220050BF25/00000700334 |
| | Donaueschingen-Pfohren : Mall-Beton-Verl., 2000 |
| | TUB_HH_Katalog |
| | Mudrack, Klaus (Kunst, Sabine;) |
| | Biologie der Abwasserreinigung : 18 Tabellen |
| | ISBN: 382741427X URL: http://www.gbv.de/du/services/agi/94B581161B6EC747C1256E3F005A8143/420000114903 |
| | Heidelberg [u.a.] : Spektrum, Akad. Verl., 2003 |
| | TUB_HH_Katalog |
| | Tchobanoglous, George (Metcalf & Eddy, Inc., ;) |
| | Wastewater engineering : treatment and reuse |
| | ISBN: 0070418780 (alk. paper) ISBN: 0071122508 (ISE (*pbk)) |
| | Boston [u.a.] : McGraw-Hill, 2003 |
| | TUB_HH_Katalog |
| | Henze, Mogens |
| | Activated sludge models ASM1, ASM2, ASM2d and ASM3 |
| | ISBN: 1900222248 |
| | London : IWA Publ., 2002 |
| | TUB_HH_Katalog |
| | Kunz, Peter |
| | Umwelt-Bioverfahrenstechnik |
| | Vieweg, 1992 |
| | Bauhaus-Universität., Arbeitsgruppe Weiterbildendes Studium Wasser und Umwelt (Deutsche Vereinigung für |
| | Wasserwirtschaft, Abwasser und Abfall, ;) |
| | Abwasserbehandlung : Gewässerbelastung, Bemessungsgrundlagen, Mechanische Verfahren, Biologische Verfahren, Reststoffe |
| | aus der Abwasserbehandlung, Kleinkläranlagen |
| | ISBN: 3860682725 URL: http://www.gbv.de/dms/weimar/toc/513989765_toc.pdf URL: |
| | http://www.gbv.de/dms/weimar/abs/513989765_abs.pdf |
| | Weimar : Universitätsverl, 2006 |
| | |
| | TUB_HH_Katalog Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall |
| | |
| | DWA-Regelwerk |
| | Hennef : DWA, 2004 |
| | TUB_HH_Katalog |
| | Wiesmann, Udo (Choi, In Su; Dombrowski, Eva-Maria;) |
| | Fundamentals of biological wastewater treatment |
| | ISBN: 3527312196 (Gb.) URL: http://deposit.ddb.de/cgi-bin/dokserv?id=2774611&prov=M&dok_var=1&dok_ext=htm |
| | Weinheim : WILEY-VCH, 2007 |
| | TUB_HH_Katalog |
| | |

| ourse L3122: Biological Wastewater Treatment | | |
|--|---|--|
| Тур | Recitation Section (large) | |
| Hrs/wk | 1 | |
| CP | 1 | |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 | |
| Lecturer | Dr. Joachim Behrendt | |
| Language | DE/EN | |
| Cycle | SoSe | |
| Content | See interlocking course | |
| Literature | See interlocking course | |

| Course L0357: Advanced Wa | stewater Treatment |
|---------------------------|---|
| Тур | Lecture |
| Hrs/wk | 2 |
| СР | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Dr. Joachim Behrendt |
| Language | EN |
| Cycle | SoSe |
| Content | Survey on advanced wastewater treatment |
| | reuse of reclaimed municipal wastewater |
| | Precipitation |
| | Flocculation |
| | Depth filtration |
| | Membrane Processes |
| | Activated carbon adsorption |
| | Ozonation |
| | "Advanced Oxidation Processes" |
| | Disinfection |
| Literature | Metcalf & Eddy, Wastewater Engineering: Treatment and Reuse, McGraw-Hill, Boston 2003 |
| | Wassertechnologie, H.H. Hahn, Springer-Verlag, Berlin 1987 |
| | Membranverfahren: Grundlagen der Modul- und Anlagenauslegung, T. Melin und R. Rautenbach, Springer-Verlag, Berlin 2007 |
| | Trinkwasserdesinfektion: Grundlagen, Verfahren, Anlagen, Geräte, Mikrobiologie, Chlorung, Ozonung, UV-Bestrahlung, Membranfiltration, Qualitätssicherung, W. Roeske, Oldenbourg-Verlag, München 2006 |
| | Organische Problemstoffe in Abwässern, H. Gulyas, GFEU, Hamburg 2003 |

| Course L0358: Advanced Wa | stewater Treatment |
|---------------------------|---|
| Тур | Recitation Section (large) |
| Hrs/wk | 1 |
| СР | 1 |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 |
| Lecturer | Dr. Joachim Behrendt |
| Language | EN |
| Cycle | SoSe |
| Content | Aggregate organic compounds (sum parameters) |
| | Industrial wastewater |
| | Processes for industrial wastewater treatment |
| | Precipitation |
| | Flocculation |
| | Activated carbon adsorption |
| | Recalcitrant organic compounds |
| | |
| Literature | Metcalf & Eddy, Wastewater Engineering: Treatment and Reuse, McGraw-Hill, Boston 2003 |
| | Wassertechnologie, H.H. Hahn, Springer-Verlag, Berlin 1987 |
| | Membranverfahren: Grundlagen der Modul- und Anlagenauslegung, T. Melin und R. Rautenbach, Springer-Verlag, Berlin 2007 |
| | Trinkwasserdesinfektion: Grundlagen, Verfahren, Anlagen, Geräte, Mikrobiologie, Chlorung, Ozonung, UV-Bestrahlung, Membranfiltration, Qualitätssicherung, W. Roeske, Oldenbourg-Verlag, München 2006 |
| | Organische Problemstoffe in Abwässern, H. Gulyas, GFEU, Hamburg 2003 |

| Module M0875: Nexu | s Engineering - Water, Soil, Food | and Energy | | |
|------------------------------------|---|--|--------------------------|--------------------|
| Courses | | | | |
| Title | | Тур | Hrs/wk | СР |
| Ecological Town Design - Water, Er | ergy, Soil and Food Nexus (L1229) | Seminar | 2 | 2 |
| Water & Wastewater Systems in a | Global Context (L0939) | Lecture | 2 | 4 |
| Module Responsible | Prof. Ralf Otterpohl | | | |
| Admission Requirements | None | | | |
| Recommended Previous Knowledge | Basic knowledge of the global situation with rising poverty, soil degradation, migration to cities, lack of water resources an sanitation | | | |
| Educational Objectives | After taking part successfully, students have rea | ached the following learning results | | |
| Professional Competence | | | | |
| Knowledge | Students can describe the facets of the global water situation. Students can judge the enormous potential of the implementation synergistic systems in Water, Soil, Food and Energy supply. | | | ne implementation |
| Skills | Students are able to design ecological settlements for different geographic and socio-economic conditions for the main climat around the world. | | | |
| Personal Competence | | | | |
| Social Competence | The students are able to develop a specific topi | c in a team and to work out milestones a | according to a given pla | n. |
| Autonomy | Students are in a position to work on a subje subject. | ct and to organize their work flow ind | ependently. They can | also present on th |
| Workload in Hours | Independent Study Time 124, Study Time in Leo | cture 56 | | |
| Credit points | 6 | | | |
| Course achievement | None | | | |
| Examination | Subject theoretical and practical work | | | |
| Examination duration and | During the course of the semester, the students work towards mile stones. The work includes presentations and papers. Detail | | | |
| scale | information can be found at the beginning of th | e smester in the StudIP course module h | nandbook. | |
| Assignment for the | Civil Engineering: Specialisation Water and Traf | fic: Elective Compulsory | | |
| Following Curricula | Bioprocess Engineering: Specialisation A - Gene | ral Bioprocess Engineering: Elective Cor | mpulsory | |
| | Chemical and Bioprocess Engineering: Specialis | ation General Process Engineering: Elec | tive Compulsory | |
| | Environmental Engineering: Core Qualification: | Elective Compulsory | | |
| | Joint European Master in Environmental Studies | - Cities and Sustainability: Core Qualific | ation: Compulsory | |
| | Process Engineering: Specialisation Environmer | tal Process Engineering: Elective Compu | ulsory | |
| | Process Engineering: Specialisation Process Eng | ineering: Elective Compulsory | | |
| | Water and Environmental Engineering: Specialis | sation Water: Elective Compulsory | | |
| | Water and Environmental Engineering: Specialis | sation Environment: Elective Compulsor | y | |
| | Water and Environmental Engineering: Specialis | sation Cities: Elective Compulsory | | |

| Course L1229: Ecological Tov | wn Design - Water, Energy, Soil and Food Nexus |
|------------------------------|--|
| Тур | Seminar |
| Hrs/wk | 2 |
| CP | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Prof. Ralf Otterpohl |
| Language | EN |
| Cycle | SoSe |
| Content | Participants Workshop: Design of the most attractive productive Town Keynote lecture and video The limits of Urbanization / Green Cities The tragedy of the Rural: Soil degradation, agro chemical toxification, migration to cities Global Ecovillage Network: Upsides and Downsides around the World Visit of an Ecovillage Participants Workshop: Resources for thriving rural areas, Short presentations by participants, video competion TUHH Rural Development Toolbox Integrated New Town Development Participants workshop: Design of New Towns: Northern, Arid and Tropical cases Outreach: Participants campaign City with the Rural: Resilience, quality of live and productive biodiversity |
| Literature | Ralf Otterpohl 2013: Gründer-Gruppen als Lebensentwurf: "Synergistische Wertschöpfung in erweiterten Kleinstadt- und Dorfstrukturen", in "Regionales Zukunftsmanagement Band 7: Existenzgründung unter regionalökonomischer Perspektive, Pabst Publisher, Lengerich http://youtu.be/9hmkgn0nBgk (Miracle Water Village, India, Integrated Rainwater Harvesting, Water Efficiency, Reforestation and Sanitation) TEDx New Town Ralf Otterpohl: http://youtu.be/_M0J2u9BrbU |

| Course L0939: Water & Wastewater Systems in a Global Context | | |
|--|---|--|
| Тур | Lecture | |
| Hrs/wk | 2 | |
| СР | 4 | |
| Workload in Hours | Independent Study Time 92, Study Time in Lecture 28 | |
| Lecturer | Prof. Ralf Otterpohl | |
| Language | EN | |
| Cycle | SoSe | |
| Content | Keynote lecture and video Water & Soil: Water availability as a consequence of healthy soils Water and it's utilization, Integrated Urban Water Management Water & Energy, lecture and panel discussion pro and con for a specific big dam project Rainwater Harvesting on Catchment level, Holistic Planned Grazing, Multi-Use-Reforestation Sanitation and Reuse of water, nutrients and soil conditioners, Conventional and Innovative Approaches Why are there excreta in water? Public Health, Awareness Campaigns Rehearsal session, Q&A | |
| Literature | Montgomery, David R. 2007: Dirt: The Erosion of Civilizations, University of California Press Liu, John D.: http://eempc.org/hope-in-a-changing_climate/ (Integrated regeneration of the Loess Plateau, China, and sites in Ethiopia and Rwanda) http://youtu.be/9hmkgn0nBgk (Miracle Water Village, India, Integrated Rainwater Harvesting, Water Efficiency, Reforestation and Sanitation) | |

| Module M0922: City F | lanning |
|-----------------------------|---|
| Courses | |
| Fitle | Typ Hrs/wk CP |
| City Planning (L1066) | Typ Hrs/wk CP Project-/problem-based Learning 4 6 |
| Module Responsible | |
| Admission Requirements | None |
| | for "Principles of Urban Planning": none |
| Knowledge | |
| - | for "Designing Urban Streetscapes": some knowledge of transport planning, e.g. through taking the undergraduate class "Trans |
| | Planning and Traffic Engineering" |
| | |
| Educational Objectives | After taking part successfully, students have reached the following learning results |
| Professional Competence | |
| Knowledge | Students are able to: |
| | use technical terms of urban planning. |
| | describe the main determinants of urban development. |
| | explain and compare different possibilities of how urban development can be influenced. |
| | discuss requirements for public streetscapes. |
| | explain the importance of street design. |
| | |
| | |
| Skills | Students are able to: |
| | read and analyze urban development concepts and designs for streetscapes |
| | appraise such concepts in the context of competing requirements. |
| | design, justify and reflect their own solutions for concrete examples. |
| | |
| Personal Competence | |
| | Students are able to: |
| | |
| | discuss intermediate results with each other. |
| | constructively accept feedback on their own work. |
| | provide constructive feedback to others. |
| | |
| Autonomy | Students are able to: |
| | independently complete a written report including drawings following a broadly pre-defined process. |
| | assess the consequences of their proposed solutions. |
| | independently acquire knowledge and apply this to new issues or problem areas. |
| | |
| | |
| | Independent Study Time 124, Study Time in Lecture 56 |
| Credit points | b |
| Course achievement | |
| | Written elaboration |
| | written assignment, designwork during the semester |
| scale Assignment for the | Civil Engineering: Specialisation Structural Engineering: Elective Compulsory |
| - | |
| Following Curricula | Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory |
| | Civil Engineering: Specialisation Coastar Engineering: Elective Compulsory |
| | Logistics, Infrastructure and Mobility: Specialisation Infrastructure and Mobility: Elective Compulsory |
| | Water and Environmental Engineering: Specialisation Environment: Elective Compulsory |
| | Water and Environmental Engineering: Specialisation Cities: Compulsory |

| Course L1066: City Planning | |
|-----------------------------|---|
| Тур | Project-/problem-based Learning |
| Hrs/wk | 4 |
| CP | 6 |
| Workload in Hours | Independent Study Time 124, Study Time in Lecture 56 |
| Lecturer | Prof. Carsten Gertz |
| Language | DE |
| Cycle | SoSe |
| Content | ", Principles of Urban Planning" deals with the determinants of urban development and their interactions. Topics include: |
| | legal framework, instruments and methods of planning, functional requirements, stakeholders and actors basic design requirements different planning levels and historical contexts. The objective of the course is for students to acquire a basic understanding of urban development problems and approaches for solving them. They will also be able to comprehend the process of urban planning. The course also covers the various functional and aesthetic requirements for designing streetscape as the most important elements of public space. The project work deals with a real life scenario and includes drawing up a development plan, an urban design concept, a building masterplan and a street redesign. |
| Literature | Albers, Gerd; Wekel, Julian (2021) Stadtplanung: Eine illustrierte Einführung. 4. überarbeitete Auflage. Primus Verlag. Darmstadt. Frick, Dieter (2011) Theorie des Städtebaus: Zur baulich-räumlichen Organisation von Stadt. 3. veränderte Auflage. Wasmuth- Verlag. Tübingen |
| | Jonas, Carsten (2009) Die Stadt und ihr Grundriss. Wasmuth-Verlag. Tübingen Kostof, Spiro; Castillo, Greg (1998) Die Anatomie der Stadt. Geschichte städtischer Strukturen. Campus-Verlag. Frankfurt/New York. |

| 2.1.9.1.000.1.19 | | | | |
|-------------------------------|--|-----------------------------|-------------------|-------------------|
| Module M1721: Wate | r and Environment: Theory and Application | | | |
| Courses | | | | |
| Title | Тур | | Hrs/wk | СР |
| Water and Environment (L2754) | Project | t-/problem-based Learning | 3 | 3 |
| Water and Environment (L2753) | Lecture | e | 3 | 3 |
| Module Responsible | Prof. Nima Shokri | | | |
| Admission Requirements | None | | | |
| Recommended Previous | Basic knowledge in water and environmental research, Hydrology | | | |
| Knowledge | | | | |
| Educational Objectives | After taking part successfully, students have reached the following learn | ning results | | |
| Professional Competence | | | | |
| Knowledge | Common research tools and techniques together with the fundamental knowledge relevant to multi-scale and multi-phas challenges present in water and environmental research will be discussed in this module. Both theory and application will b considered. | | | |
| Skills | In addition to the fundamental knowledge, the students will be exposed to several analytical, experimental and numerical tool and techniques relevant to water and environmental research at different scales. This will provide the students with an excellen opportunity to improve their skills on multiple fronts which will be useful in their future career. | | | |
| Personal Competence | | | | |
| Social Competence | Developing teamwork and problem solving skills through Research-Base | ed Teaching approaches w | ill be at the cor | e of this module. |
| Autonomy | The students will be involved in writing individual reports and prese willingness to work independently and responsibly. | entation. This will contrib | oute to the stu | ıdents' ability a |
| Workload in Hours | Independent Study Time 96, Study Time in Lecture 84 | | | |
| Credit points | 6 | | | |
| Course achievement | None | | | |
| Examination | Subject theoretical and practical work | | | |
| Examination duration and | Report and Presentation | | | |
| scale | | | | |
| Assignment for the | Civil Engineering: Specialisation Coastal Engineering: Elective Compulso | ory | | |
| Following Curricula | Civil Engineering: Specialisation Water and Traffic: Elective Compulsory | | | |
| | Environmental Engineering: Specialisation Environment and Climate: Ele | ective Compulsory | | |
| | Water and Environmental Engineering: Specialisation Cities: Elective Co | mpulsory | | |
| | Water and Environmental Engineering: Specialisation Water: Elective Co | ompulsory | | |
| | Water and Environmental Engineering: Specialisation Environment: Con | apulsory | | |

| Course L2754: Water and Environment | |
|-------------------------------------|---|
| Тур | Project-/problem-based Learning |
| Hrs/wk | 3 |
| СР | 3 |
| Workload in Hours | Independent Study Time 48, Study Time in Lecture 42 |
| Lecturer | Dr. Salome Shokri-Kuehni |
| Language | EN |
| Cycle | SoSe |
| Content | See interlocking course |
| Literature | See interlocking course |

| Course L2753: Water and Environment | | |
|-------------------------------------|---|--|
| Тур | Lecture | |
| Hrs/wk | 3 | |
| СР | 3 | |
| Workload in Hours | Independent Study Time 48, Study Time in Lecture 42 | |
| Lecturer | Prof. Nima Shokri | |
| Language | EN | |
| Cycle | SoSe | |
| Content | Research based learning: The students will be engaged in active research focused on water and environmental related challenges. | |
| | The required knowledge and tools will be discussed during the semester. | |
| Literature | NA | |

| Engineering" | | | | |
|-------------------------------------|--|---------------------------------|-------------------------------|-------------------|
| Module M1724: Smar | t Monitoring | | | |
| Courses | | | | |
| Title | | Тур | Hrs/wk | СР |
| Smart Monitoring (L2762) | | Integrated Lecture | 2 | 2 |
| Smart Monitoring (L2763) | | Recitation Section (small) | 2 | 4 |
| Module Responsible | Prof. Kay Smarsly | | | |
| Admission Requirements | | | | |
| | Basic knowledge or interest in object-oriented modeling, progra | amming, and sensor technol | ogies are helpful | . Interest in mo |
| | research and teaching areas, such as Internet of Things, Indust | - | | |
| | skills of scientific working, are required. Basic knowledge in scien | | | |
| Educational Objectives | After taking part successfully, students have reached the following | ng learning results | | |
| Professional Competence | | | | |
| Knowledge | The students will become familiar with the principles and pra | ctices of smart monitoring. | The students wi | I be able to de |
| | decentralized smart systems to be applied for continuous (r | emote) monitoring of syste | ms in the built | and in the nat |
| | environment. In addition, the students will learn to design and to | o implement intelligent senso | or systems using | state-of-the-art |
| | analysis techniques, modern software design concepts, and emb | edded computing methodolo | gies. Besides lect | ures, project wo |
| | also part of this module, which will be conducted throughout th | e semester and will contribu | te to the grade. | In small groups, |
| | students will design smart monitoring systems that integrate a n | umber of "intelligent" sensor | s to be implemen | ted by the stude |
| | Specific focus will be put on the application of machine learning | g techniques. The smart mo | nitoring systems | will be mounte |
| | real-world (built or natural) systems, such as bridges or slopes, o | or on scaled lab structures for | ⁻ validation purpo | ses. The outcom |
| | every group will be documented in a paper. All students of this n | nodule will "automatically" p | articipate with th | eir smart monito |
| | system in the annual "Smart Monitoring" competition. The writte | n papers and oral examination | ons form the final | grades. The mo |
| | will be taught in English. Limited enrollment. | | | |
| Chille | The shudents will as a incident into encoding state of the out on | | | |
| SKIIIS | The students will gain insights into operating state-of-the-art sm | | | |
| | processes relevant to engineering, such as environmental, str | | | |
| | devising monitoring strategies of physical processes as part of | | | |
| | implement the strategies in smart wireless sensor nodes, using | | ogramming. Fina | lly, the students |
| | be able to document the findings of their projects in short report: | 5. | | |
| Personal Competence | | | | |
| Social Competence | The students will be able to work in groups, share parts of the v | vork for their projects, and d | evelop communio | ation skills, tow |
| | achieving the common project goals. | | | |
| | | | | |
| Autonomy | The students will be able to gain a solid basis on approaching | | jineering, as well | as on documer |
| | results, through their involvement in their monitoring group proje | ects. | | |
| | Independent Study Time 124, Study Time in Lecture 56 | | | |
| Credit points Course achievement | | | | |
| | Written elaboration | | | |
| | 10 pages of work with 15-minute oral presentation | | | |
| scale | | | | |
| Assignment for the | Civil Engineering: Specialisation Water and Traffic: Elective Com | oulsory | | |
| Following Curricula | 5 5 1 | , | | |
| | Civil Engineering: Specialisation Coastal Engineering: Elective Co | | | |
| | Civil Engineering: Specialisation Structural Engineering: Elective | Compulsory | | |
| | Computer Science: Specialisation II: Intelligence Engineering: Ele | | | |
| | Environmental Engineering: Specialisation Energy and Resources | 1 3 | | |
| | Environmental Engineering: Specialisation Environment and Clim | | | |
| | Environmental Engineering: Specialisation Water Quality and Wa | | npulsory | |
| | Mechatronics: Technical Complementary Course: Elective Compl | | - | |
| | Mechatronics: Core Qualification: Elective Compulsory | - | | |
| | Theoretical Mechanical Engineering: Specialisation Robotics and | Computer Science: Elective C | Compulsory | |
| | Water and Environmental Engineering: Specialisation Cities: Elec | | - | |
| | Water and Environmental Engineering: Specialisation Environme | | | |
| | water and Environmental Engineering. Specialisation Environment | ne. Elective compaisory | | |

| Course L2762: Smart Monito | ring |
|----------------------------|--|
| Тур | Integrated Lecture |
| Hrs/wk | 2 |
| СР | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Prof. Kay Smarsly |
| Language | EN |
| Cycle | SoSe |
| Content | In this course, principles of smart monitoring will be taught, focusing on modern concepts of data acquisition, data storage, and data analysis. Also, fundamentals of intelligent sensors and embedded computing will be illuminated. Autonomous software and decentralized data processing are further crucial parts of the course, including concepts of the Internet of Things, Industry 4.0 and cyber-physical systems. Furthermore, measuring principles, data acquisition systems, data management and data analysis algorithms will be discussed. Besides the theoretical background, numerous practical examples will be shown to demonstrate how smart monitoring may advantageously be used for assessing the condition of systems in the built or natural environment. |
| Literature | The course contents couples different fields, such as signal processing, sensing technologies, data analytics, environmental engineering, civil engineering, artificial intelligence, database systems, and many more. The basics will be taught in this course. However, specific literature that covers all these topics does not exist. Instead, literature will be referenced in the lectures, all of which are papers that are freely available online. |

| Course L2763: Smart Monito | urse L2763: Smart Monitoring | | |
|----------------------------|--|--|--|
| Тур | Recitation Section (small) | | |
| Hrs/wk | 2 | | |
| СР | 4 | | |
| Workload in Hours | Independent Study Time 92, Study Time in Lecture 28 | | |
| Lecturer | Prof. Kay Smarsly | | |
| Language | EN | | |
| Cycle | SoSe | | |
| Content | The contents of the exercises are based on the lecture contents. In addition to the exercises, project work will be conducted throughout the semester, which will consume the majority of the workload. As part of the project work, students will design smart monitoring systems that will be tested in the laboratory or in the field. As mentioned in the module description, the students will participate in the "Smart Monitoring" competition, hosted annually by the Institute of Digital and Autonomous Construction. Students are encouraged to contribute their own ideas. The tools required to implement the smart monitoring systems will be taught in the group exercises as well as through external sources, such as video tutorials and literature. | | |
| Literature | The course contents couples different fields, such as signal processing, sensing technologies, data analytics, environmental engineering, civil engineering, artificial intelligence, database systems, and many more. The basics will be taught in this course However, specific literature that covers all these topics does not exist. Instead, literature will be referenced in the lectures, all of which are papers that are freely available online. | | |

| | inable energy from wind and water | | | |
|------------------------------------|--|-------------------------------------|---------------------------|-------------------|
| Courses | | | | |
| Title | | Тур | Hrs/wk | СР |
| Offshore Geotechnical Engineering | (L0067) | Lecture | 1 | 1 |
| Hydro Power Use (L0013) | | Lecture | 1 | 1 |
| Wind Turbine Plants (L0011) | | Lecture | 2 | 3 |
| Wind Energy Use - Focus Offshore (| L0012) | Lecture | 1 | 1 |
| Module Responsible | Dr. Marvin Scherzinger | | | |
| Admission Requirements | | | | |
| Recommended Previous | Module: Technical Thermodynamics I, | | | |
| Knowledge | Module: Technical Thermodynamics II, | | | |
| | Module: Fundamentals of Fluid Mechanics | | | |
| Educational Objectives | After taking part successfully, students have reache | d the following learning results | | |
| Professional Competence | | | | |
| | By ending this module students can explain in detail knowledge of wind turbines with a particular focus of wind energy use offshore conditions and can critical comment these aspects in consideration of current developments. Furthermore, they are a to describe fundamentally the use of water power to generate electricity. The students reproduce and explain the basic proced in the implementation of renewable energy projects in countries outside Europe. Through active discussions of various topics within the seminar of the module, students improve their understanding and | | | |
| Skills | application of the theoretical background and are thus able to transfer what they have learned in practice. Students are able to apply the acquired theoretical foundations on exemplary water or wind power systems and evaluate an assess technically the resulting relationships in the context of dimensioning and operation of these energy systems. They can compare critically the special procedure for the implementation of renewable energy projects in countries outside Europe with the in principle applied approach in Europe and can apply this procedure on exemplary theoretical projects. | | | |
| Personal Competence | | | | |
| Social Competence | Students can discuss scientific tasks subjet-specific | y and multidisciplinary within a se | eminar. | |
| Autonomy | Students can independently exploit sources in the lecture and to acquire the particular knowledge abo | | lecture material to clear | r the contents of |
| Workload in Hours | Independent Study Time 110, Study Time in Lecture | 70 | | |
| Credit points | | | | |
| Course achievement | None | | | |
| Examination | Written exam | | | |
| Examination duration and | 180 min | | | |
| scale | | | | |
| Assignment for the | Civil Engineering: Specialisation Structural Engineer | ng: Elective Compulsory | | |
| | Civil Engineering: Specialisation Geotechnical Engine | | | |
| | Civil Engineering: Specialisation Coastal Engineering | : Elective Compulsory | | |
| | International Management and Engineering: Special | | tal Engineering: Elective | Compulsory |
| | International Management and Engineering: Special | | | |
| | Product Development, Materials and Production: Spe | | | |
| | Product Development, Materials and Production: Spe | | | |
| | Product Development, Materials and Production: Spe | | | |
| | Renewable Energies: Core Qualification: Compulsory | | | |
| | | | 004 | |
| | Theoretical Mechanical Engineering: Specialisation E | | | |
| | Process Engineering: Specialisation Environmental P | | puisory | |
| | Water and Environmental Engineering: Specialisatio | | | |
| | Water and Environmental Engineering: Specialisatio Water and Environmental Engineering: Specialisatio | | bry | |
| | | | | |

| urse L0067: Offshore Geot | Lecture | |
|---------------------------|--|--|
| | | |
| Hrs/wk | | |
| СР | | |
| | Independent Study Time 16, Study Time in Lecture 14 | |
| Lecturer | Dr. Jan Dührkop | |
| Language | DE | |
| Cycle | SoSe | |
| Content | Overview and Introduction Offshore Geotechnics Introduction to Soil Mechanics Offshore soil investigation Focus on cyclical effects Geotechnical design of offshore foundations Monopiles Jackets Heavyweight foundations Geotechnical preliminary exploration for the use of lift boats and platforms | |
| Literature | Randolph, M. and Gourvenec, S (2011): Offshore Geotechnical Engineering. Spon Press. Poulos H.G. (1988): Marine Geotechnics. Unwin Hyman, London BSH-Standard Baugrunderkundung für Offshore-Windenergieparks Lesny K. (2010): Foundations for Offshore Wind Turbines. VGE Verlag, Essen. EA-Pfähle (2012): Empfehlungen des Arbeitskreises Pfähle der DGGT. Ernst & Sohn, Berlin. | |

| Course L0013: Hydro Power | Use |
|---------------------------|--|
| Тур | Lecture |
| Hrs/wk | 1 |
| СР | 1 |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 |
| Lecturer | Prof. Stefan Achleitner |
| Language | DE |
| Cycle | SoSe |
| Content | Introduction, importance of water power in the national and global context Physical basics: Bernoulli's equation, usable height of fall, hydrological measures, loss mechanisms, efficiencies Classification of Hydropower: Flow and Storage hydropower, low and high pressure systems Construction of hydroelectric power plants: description of the individual components and their technical system interaction Structural engineering components; representation of dams, weirs, dams, power houses, computer systems, etc. Energy Technical Components: Illustration of the different types of hydraulic machinery, generators and grid connection Hydropower and the Environment Examples from practice |
| Literature | Schröder, W.; Euler, G.; Schneider, K.: Grundlagen des Wasserbaus; Werner, Düsseldorf, 1999, 4. Auflage Quaschning, V.: Regenerative Energiesysteme: Technologie - Berechnung - Simulation; Carl Hanser, München, 2011, 7. Auflage Giesecke, J.; Heimerl, S.; Mosony, E.: Wasserkraftanlagen - Planung, Bau und Betrieb; Springer, Berlin, Heidelberg, 2009, 5. Auflage von König, F.; Jehle, C.: Bau von Wasserkraftanlagen - Praxisbezogene Planungsunterlagen; C. F. Müller, Heidelberg, 2005, 4. Auflage Strobl, T.; Zunic, F.: Wasserbau: Aktuelle Grundlagen - Neue Entwicklungen; Springer, Berlin, Heidelberg, 2006 |
| Course L0011: Wind Turbine | Plants | |
|----------------------------|---|--|
| Тур | cture | |
| Hrs/wk | 2 | |
| СР | 3 | |
| Workload in Hours | Independent Study Time 62, Study Time in Lecture 28 | |
| Lecturer | Dr. Rudolf Zellermann | |
| Language | DE | |
| Cycle | SoSe | |
| Content | Historical development Wind: origins, geographic and temporal distribution, locations Power coefficient, rotor thrust Aerodynamics of the rotor Operating performance Power limitation, partial load, pitch and stall control Plant selection, yield prediction, economy Excursion | |
| Literature | Gasch, R., Windkraftanlagen, 4. Auflage, Teubner-Verlag, 2005 | |

| Course L0012: Wind Energy | Use - Focus Offshore |
|---------------------------|--|
| Тур | Lecture |
| Hrs/wk | 1 |
| CP | 1 |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 |
| Lecturer | Prof. Martin Skiba |
| Language | DE |
| Cycle | SoSe |
| Content | Introduction, importance of offshore wind power generation, Specific requirements for offshore engineering Physical fundamentals for utilization of wind energy Design and operation of offshore wind turbines, presentation of different concepts of offshore wind turbines, representation of the individual system components and their system-technical relationships Foundation engineering, offshore site investigation, presentation of different concepts of offshore foundation structures, planning and fabrication of foundation structures Electrical infrastructure of an offshore wind farm, Inner Park cabling, offshore substation, grid connection Installation of offshore wind farms, installation techniques and auxiliary devices, construction logistics Development and planning of offshore wind farms Operation and optimization of offshore wind farms Day excursion |
| Literature | Gasch, R.; Twele, J.: Windkraftanlagen - Grundlagen, Entwurf, Planung und Betrieb; Vieweg + Teubner, Stuttgart, 2007, 7. Auflage Molly, J. P.: Windenergie - Theorie, Anwendung, Messung; C. F. Müller, Heidel-berg, 1997, 3. Auflage Hau, E.: Windkraftanlagen; Springer, Berlin, Heidelberg, 2008, 4.Auflage Heier, S.: Windkraftanlagen - Systemauslegung, Integration und Regelung; Vieweg + Teubner, Stuttgart, 2009, 5. Auflage Jarass, L.; Obermair, G.M.; Voigt, W.: Windenergie: Zuverlässige Integration in die Energieversorgung; Springer, Berlin, Heidelberg, 2009, 2. Auflage |

| Module M2002: Wast | and Resource Manage | ement | | | |
|------------------------------------|--|------------------------------------|--------------------------------------|----------------|---------------------|
| Courses | | | | | |
| Title | | | Тур | Hrs/wk | СР |
| Waste management (L3261) | | | Project-/problem-based Learning | 3 | 3 |
| International waste concepts (L325 | 9) | | Lecture | 2 | 2 |
| International waste concepts (L326 |)) | | Recitation Section (small) | 1 | 1 |
| Module Responsible | Prof. Kerstin Kuchta | | | | |
| Admission Requirements | None | | | | |
| Recommended Previous | Basics in process engineering | | | | |
| Knowledge | | | | | |
| Educational Objectives | After taking part successfully, stu | udents have reached the follow | ing learning results | | |
| Professional Competence | | | | | |
| Knowledge | The students are able to describ | pe waste as a resource as wel | as advanced technologies for re | cycling and r | ecovery of resource |
| | from waste in detail. This covers | collection, transport, treatmer | t and disposal in national and inte | ernational con | texts. |
| Skills | Students are able to select suitab | hle processes for the treatmen | t with respect to the national or cu | iltural and de | velopmental contex |
| 5/113 | | • | t of different technologies and ma | | |
| | They can evaluate the ecological | i inpuct and the technical cho | t of different teenhologies and me | anagement sy | stems. |
| Personal Competence | | | | | |
| Social Competence | Students can work together as | a team of 2-5 persons, partic | ipate in subject-specific and inte | erdisciplinary | discussions, devel |
| | cooperated solutions and defend | d their own work results in fro | nt of others and promote the scie | entific develo | oment of colleague |
| | Furthermore, they can give and a | accept professional constructiv | e criticisms. | | |
| Autonomy | Students can independently gai | in additional knowledge of the | subject area and apply it in so | lving the giv | en course tasks ar |
| Autonomy | Students can independently gain additional knowledge of the subject area and apply it in solving the given course tasks and projects. | | | | |
| | projects. | | | | |
| Workload in Hours | Independent Study Time 96, Stud | dy Time in Lecture 84 | | | |
| Credit points | 6 | | | | |
| Course achievement | Compulsory Bonus Form | Description | | | |
| | Yes 20 % Written el | laboration | | | |
| Examination | Presentation | | | | |
| Examination duration and | PowerPoint presentation (10-15 r | minutes) | | | |
| scale | | | | | |
| Assignment for the | Civil Engineering: Specialisation | Water and Traffic: Elective Con | npulsory | | |
| Following Curricula | Chemical and Bioprocess Engine | ering: Specialisation General P | rocess Engineering: Elective Comp | oulsory | |
| | Chemical and Bioprocess Engine | ering: Specialisation Bioproces | s Engineering: Elective Compulsor | гy | |
| | Chemical and Bioprocess Engine | ering: Specialisation Chemical | Process Engineering: Elective Con | npulsory | |
| | Chemical and Bioprocess Engine | ering: Specialisation Chemical | and Bio process Engineering: Elec | tive Compuls | ory |
| | Chemical and Bioprocess Engine | ering: Core Qualification: Elect | ve Compulsory | | |
| | Environmental Engineering: Spec | cialisation Energy and Resource | es: Elective Compulsory | | |
| | International Management and E | ngineering: Specialisation II. R | enewable Energy: Elective Compu | lsory | |
| | Process Engineering: Specialisati | ion Environmental Process Eng | ineering: Elective Compulsory | | |
| | Water and Environmental Engine | eering: Specialisation Cities: Ele | ective Compulsory | | |
| | Water and Environmental Engine | eering: Specialisation Environm | ent: Elective Compulsory | | |

| Course L3261: Waste manag | ement | |
|---------------------------|---|--|
| Тур | Project-/problem-based Learning | |
| Hrs/wk | | |
| СР | 3 | |
| Workload in Hours | Independent Study Time 48, Study Time in Lecture 42 | |
| Lecturer | Prof. Rüdiger Siechau | |
| Language | EN | |
| Cycle | SoSe | |
| Content | Introduction into the "Waste Management" consisting of: Thermal Process (incinerator, RDF combustion) Biological processes (Wet-/Dryfermentation) technology, energy, emissions, approval, etc. Group work design of systems/plants for energy recovery from waste The following points are to be processed: Input: waste (fraction collection and transportation, current quantity, material flows, possible amount of development) Plant (design, process diagram, technology, energy production) Output (energy quantity / type, by-products) Costs and revenues Climate and resource protection (CO2 balance, substitution of primary raw materials / fossil fuels) Location and approval (infrastructure, expiration authorization procedure) Focus at the whole concept (advantages, disadvantages, risks and opportunities, discussion) | |
| Literature | Einführung in die Abfallwirtschaft; Martin Kranert, Klaus Cord-Landwehr (Hrsg.); Vieweg + Teubner Verlag; 2010 | |
| | Powerpoint-Folien in Stud IP | |

| Course L3259: International | waste concepts |
|-----------------------------|--|
| Тур | Lecture |
| Hrs/wk | 2 |
| CP | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Prof. Kerstin Kuchta |
| Language | EN |
| Cycle | SoSe |
| Content | Waste avoidance and recycling are the focus of this lecture. Additionally, waste logistics (Collection, transport, export, fees and taxes) as well as international waste shipment solutions are presented. |
| | Other specific wastes, e.g. industrial waste, treatment concepts will be presented and developed by students themselves |
| | Waste composition and production on international level, wast eulogistic, collection and treatment in emerging and developing countries. |
| | Single national projects and studies will be prepared and presented by students |
| Literature | Basel convention |

| Course L3260: International | Course L3260: International waste concepts | |
|-----------------------------|---|--|
| Тур | Recitation Section (small) | |
| Hrs/wk | 1 | |
| CP | 1 | |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 | |
| Lecturer | Prof. Kerstin Kuchta | |
| Language | EN | |
| Cycle | SoSe | |
| Content | See interlocking course | |
| Literature | See interlocking course | |

| Module M0982: Trans | portation Modelling | | |
|----------------------------------|--|---------------|--------------------|
| Courses | | | |
| Title | Тур | Hrs/wk | СР |
| Transportation Modelling (L1180) | Project-/problem-based Learning | 4 | 6 |
| Module Responsible | Prof. Carsten Gertz | | |
| Admission Requirements | None | | |
| Recommended Previous | some knowledge of transport planning, e.g. through taking the undergraduate class "Transport P | lanning and T | raffic Engineering |
| Knowledge | | | |
| Educational Objectives | After taking part successfully, students have reached the following learning results | | |
| Professional Competence | | | |
| Knowledge | Students are able to understand the operation and potential applications of transport models. | | |
| Skills | Students are able to: | | |
| | use travel demand modelling software packages for solving practical problems. design a database structure for travel demand models. assess modelling results. appraise potential applications and limitations of such models. | | |
| | Students are able to independently develop and document solutions. Students are able to: | | |
| | independently organise, manage and solve set tasks. | | |
| | independently prepare written reports. | | |
| Workload in Hours | Independent Study Time 124, Study Time in Lecture 56 | | |
| Credit points | 6 | | |
| Course achievement | None | | |
| Examination | Written elaboration | | |
| Examination duration and | written assignment with presentation during the semester | | |
| scale | | | |
| Assignment for the | Civil Engineering: Specialisation Water and Traffic: Compulsory | | |
| Following Curricula | Logistics, Infrastructure and Mobility: Specialisation Infrastructure and Mobility: Elective Compuls | ory | |
| | Water and Environmental Engineering: Specialisation Cities: Elective Compulsory | | |

| Course L1180: Transportation Modelling | | | |
|--|---|--|--|
| Тур | roject-/problem-based Learning | | |
| Hrs/wk | | | |
| СР | 6 | | |
| Workload in Hours | Independent Study Time 124, Study Time in Lecture 56 | | |
| Lecturer | Prof. Carsten Gertz | | |
| Language | DE | | |
| Cycle | SoSe | | |
| Content | Principles of transport modelling Role of transport modelling in the planning process Fundamentals of mobility behaviour Design and evaluation of transport/mobility surveys mode of operation and data requirements for different stages of modelling Forecasting and scenarios in the transport planning The range of model applications (from transport infrastructure planning over simulation of traffic flows to integrated land-use and transport models as well as the use of models for evaluating locations) Practice-oriented project for assessing consequences of infrastructure projects and changes in land-use | | |
| Literature | Lohse, Dieter und Schnabel, Werner (2011): Grundlagen der Straßenverkehrstechnik und der Verkehrsplanung – Band 2. 3. Auflage. Beuth. Ortúzar, Juan de Dios und Willumsen, Luis G. (2011): Modelling Transport. 4. Auflage. John Wiley & Sons. | | |

| Module M0801: Wate | r Resources and -Supply | | | |
|------------------------------------|---|---|---------------------|---------------------|
| Courses | | | | |
| Title | | Тур | Hrs/wk | СР |
| Chemistry of Drinking Water Treatr | nent (L0311) | Lecture | 2 | 1 |
| Chemistry of Drinking Water Treatr | nent (L0312) | Recitation Section (large) | 1 | 2 |
| Water Resource Management (L04 | 02) | Lecture | 2 | 2 |
| Water Resource Management (L04 | 03) | Recitation Section (small) | 1 | 1 |
| Module Responsible | Prof. Mathias Ernst | | | |
| Admission Requirements | None | | | |
| Recommended Previous | Knowledge of water management and the k | key processes involved in water treatment. | | |
| Knowledge | | | | |
| Educational Objectives | After taking part successfully, students hav | e reached the following learning results | | |
| Professional Competence | | | | |
| Knowledge | Students will be able to outline key areas | of conflict in water management, as well as the | eir mutual depend | lence for sustainal |
| | water supply. They will understand releva | nt economic, environmental and social factors. | Students will be | able to explain a |
| | | er companies. They will be able to explain the av | | |
| | the scope of their application. | | | |
| | | | | |
| Skills | Students will be able to assess comple | ex problems in drinking water production and | l establish soluti | ons involving wa |
| | management and technical measures. The | y will be able to assess the evaluation methods | that can be used f | for this. Students |
| | be able to carry out chemical calculations | s for selected treatment processes and apply g | enerally accepted | l technical rules a |
| | standards to these processes. | | | |
| Demonal Commentance | | | | |
| Personal Competence | Monthian in a diverse second of an addition | | | f |
| Social Competence | Working in a diverse group of specialists, students will be able to develop and document complex solutions for the management | | | |
| | and treatment of drinking water. They will be able to take an appropriate professional position, for example representing us interests. They will be able to develop joint solutions in teams of diverse experts and present these solutions to others. | | | |
| | Interests. They will be able to develop joint | solutions in teams of diverse experts and presen | t these solutions t | o others. |
| Autonomy | Students will be in a position to work on a s | subject independently and present on this subject | | |
| | | | | |
| | Independent Study Time 96, Study Time in | Lecture 84 | | |
| Credit points | | | | |
| Course achievement | | | | |
| Examination | | | | |
| | 60 min (chemistry) + presentation | | | |
| scale | | | | |
| - | Civil Engineering: Specialisation Structural | | | |
| Following Curricula | Civil Engineering: Specialisation Geotechnic | | | |
| | Civil Engineering: Specialisation Water and | | | |
| | Civil Engineering: Specialisation Coastal En | | | |
| | | nnical Complementary Course: Elective Compulso | | |
| | Chemical and Bioprocess Engineering: Tech | nnical Complementary Course: Elective Compulso | ry | |
| | International Management and Engineering | : Specialisation II. Energy and Environmental Eng | ineering: Elective | Compulsory |
| | Process Engineering: Specialisation Environ | mental Process Engineering: Elective Compulsory | / | |
| | Process Engineering: Specialisation Process | Engineering: Elective Compulsory | | |
| | Water and Environmental Engineering: Spe | cialisation Water: Compulsory | | |
| | Water and Environmental Engineering: Spe | cialisation Environment: Elective Compulsory | | |
| | Water and Environmental Engineering, Coo | cialisation Cities: Elective Compulsory | | |

| Course L0311: Chemistry of Drinking Water Treatment | | |
|---|---|--|
| Тур | Lecture | |
| Hrs/wk | 2 | |
| СР | 1 | |
| Workload in Hours | Independent Study Time 2, Study Time in Lecture 28 | |
| Lecturer | Dr. Klaus Johannsen | |
| Language | DE | |
| Cycle | WiSe | |
| Content | The topic of this course is water chemistry with respect to drinking water treatment and water distribution | |
| | Major topics are solubility of gases, carbonic acid system and calcium carbonate, blending, softening, redox processes, materials and legal requirements on drinking water treatment. Focus is put on generally accepted rules of technology (DVGW- and DIN- standards). Special emphasis is put on calculations using realistic analysis data (e.g. calculation of pH or calcium carbonate dissolution potential) in exercises. Students can get a feedback and gain extra points for exam by solving problems for homework. Knowledge of drinking water treatment processes is vital for this lecture. Therefore the most important processes are explained coordinated with the course " Water resources management" in the beginning of the semester. | |
| Literature | MHW (rev. by Crittenden, J. et al.): Water treatment principles and design. John Wiley & Sons, Hoboken, 2005. Stumm, W., Morgan, J.J.: Aquatic chemistry. John Wiley & Sons, New York, 1996. DVGW (Hrsg.): Wasseraufbereitung - Grundlagen und Verfahren. Oldenbourg Industrie Verlag, München, 2004. Jensen, J. N.: A Problem Solving Approach to Aquatic Chemistry. John Wiley & Sons, Inc., New York, 2003. | |

| Course L0312: Chemistry of Drinking Water Treatment | |
|---|---|
| Тур | Recitation Section (large) |
| Hrs/wk | 1 |
| СР | 2 |
| Workload in Hours | Independent Study Time 46, Study Time in Lecture 14 |
| Lecturer | Dr. Klaus Johannsen |
| Language | DE |
| Cycle | WiSe |
| Content | See interlocking course |
| Literature | See interlocking course |

| Course L0402: Water Resour | ce Management |
|----------------------------|--|
| Тур | Lecture |
| Hrs/wk | 2 |
| СР | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Prof. Mathias Ernst |
| Language | DE |
| Cycle | WiSe |
| Content | The lecture provides comprehensive knowledge on interaction of water ressource management and drinking water supply. Content |
| | overview: Current situation of global water resources User and Stakeholder conflicts Wasserressourcenmanagement in urbane Gebieten Rechtliche Aspekte, Organisationsformen Trinkwasserversorgungsunternehmen. Ökobilanzierung, Benchmarking in der Wasserversorgung |
| Literature | Aktuelle UN World Water Development Reports Branchenbild der deutschen Wasserwirtschaft, VKU (2011) Aktuelle Artikel wissenschaftlicher Zeitschriften Ppt der Vorlesung |

| Course L0403: Water Resour | ourse L0403: Water Resource Management | |
|----------------------------|---|--|
| Тур | Recitation Section (small) | |
| Hrs/wk | 1 | |
| СР | 1 | |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 | |
| Lecturer | Prof. Mathias Ernst | |
| Language | DE | |
| Cycle | WiSe | |
| Content | See interlocking course | |
| Literature | See interlocking course | |

| Module M0802: Meml | orane Technology | | | |
|-----------------------------|--|--|--------------------|----------------------|
| Courses | | | | |
| Title | | Tun | Hrs/wk | СР |
| Membrane Technology (L0399) | | Typ Lecture | 2 | 3 |
| Membrane Technology (L0400) | | Recitation Section (small) | 1 | 2 |
| Membrane Technology (L0401) | | Practical Course | 1 | 1 |
| Module Responsible | Prof. Mathias Ernst | | | |
| Admission Requirements | None | | | |
| Recommended Previous | Basic knowledge of water chemistry. Knowledge | e of the core processes involved in water, gas | and steam treatr | nent |
| Knowledge | | | | |
| Educational Objectives | After taking part successfully, students have re- | ached the following learning results | | |
| Professional Competence | | | | |
| • | Students will be able to rank the technical appl | lications of industrially important membrane | processes. They w | vill be able to expl |
| | the different driving forces behind existing m | | | |
| | | | | |
| | membrane filtration and their advantages and membranes in water, other liquid media, gases | | Siain the key une | erences in the use |
| | membranes in water, other inquiti media, gases | and in iiquid/gas mixtures. | | |
| Skills | Students will be able to prepare mathematical | l equations for material transport in porous | and solution-diffu | sion membranes a |
| | calculate key parameters in the membrane se | paration process. They will be able to handle | e technical memb | rane processes us |
| | available boundary data and provide recomm | | | |
| | experiments, students will be able to classif | | | |
| | membrane materials. Students will be able to c | | | |
| | measures to control this. | indicate the formation of the founing layer | in uncrene water | s and apply ceem |
| | | | | |
| Personal Competence | | | | |
| Social Competence | Students will be able to work in diverse teams | on tasks in the field of membrane technolog | y. They will be ab | le to make decision |
| | within their group on laboratory experiments to | be undertaken jointly and present these to c | others. | |
| | | | | |
| Autonomy | Students will be in a position to solve homework on the topic of membrane technology independently. They will be capable o | | | |
| | finding creative solutions to technical questions | 5. | | |
| Workload in Hours | Independent Study Time 124, Study Time in Le | cture 56 | | |
| Credit points | 6 | | | |
| Course achievement | None | | | |
| Examination | Written exam | | | |
| Examination duration and | 90 min | | | |
| scale | | | | |
| Assignment for the | Civil Engineering: Specialisation Water and Traf | ffic: Elective Compulsory | | |
| Following Curricula | Bioprocess Engineering: Specialisation A - Gene | eral Bioprocess Engineering: Elective Compuls | sory | |
| | Bioprocess Engineering: Specialisation B - Indus | strial Bioprocess Engineering: Elective Compu | llsory | |
| | Chemical and Bioprocess Engineering: Specialis | sation General Process Engineering: Elective (| Compulsory | |
| | Chemical and Bioprocess Engineering: Specialis | sation Chemical Process Engineering: Elective | Compulsory | |
| | Chemical and Bioprocess Engineering: Technical Complementary Course: Elective Compulsory | | | |
| | Chemical and Bioprocess Engineering: Technica | al Complementary Course: Elective Compulso | ry | |
| | Environmental Engineering: Specialisation Wate | er Quality and Water Engineering: Elective Co | mpulsory | |
| | Process Engineering: Specialisation Process Eng | gineering: Elective Compulsory | | |
| | Process Engineering: Specialisation Environmer | ntal Process Engineering: Elective Compulsory | / | |
| | Water and Environmental Engineering: Specialis | sation Water: Elective Compulsory | | |
| | | · | | |
| | Water and Environmental Engineering: Speciali | sation Environment: Elective Compulsory | | |

| Course L0399: Membrane Te | chnology |
|---------------------------|--|
| Тур | Lecture |
| Hrs/wk | 2 |
| СР | 3 |
| Workload in Hours | Independent Study Time 62, Study Time in Lecture 28 |
| Lecturer | Prof. Mathias Ernst |
| Language | EN |
| Cycle | WiSe |
| Content | The lecture on membrane technology supply provides students with a broad understanding of existing membrane treatment processes, encompassing pressure driven membrane processes, membrane application in electrodialyis, pervaporation as well as membrane distillation. The lectures main focus is the industrial production of drinking water like particle separation or desalination; however gas separation processes as well as specific wastewater oriented applications such as membrane bioreactor systems will be discussed as well. Initially, basics in low pressure and high pressure membrane applications are presented (microfiltration, ultrafiltration, nanofiltration, reverse osmosis). Students learn about essential water quality parameter, transport equations and key parameter for pore membrane as well as solution diffusion membrane systems. The lecture sets a specific focus on fouling and scaling issues and provides knowledge on methods how to tackle with these phenomena in real water treatment application. A further part of the lecture deals with the character and manufacturing of different membrane materials and the characterization of membrane material by simple methods and advanced analysis. The functions, advantages and drawbacks of different membrane housings and modules are explained. Students learn how an industrial membrane application is designed in the succession of treatment steps like pre-treatment, water conditioning, membrane integration and post-treatment of water. Besides theory, the students will be provided with knowledge on membrane |
| Literature | demo-site examples and insights in industrial practice. T. Melin, R. Rautenbach: Membranverfahren: Grundlagen der Modul- und Anlagenauslegung (2., erweiterte Auflage), Springer-Verlag, Berlin 2004. Marcel Mulder, Basic Principles of Membrane Technology, Kluwer Academic Publishers, Dordrecht, The Netherlands Richard W. Baker, Membrane Technology and Applications, Second Edition, John Wiley & Sons, Ltd., 2004 |

| Course L0400: Membrane Te | ourse L0400: Membrane Technology | | |
|---------------------------|---|--|--|
| Тур | Recitation Section (small) | | |
| Hrs/wk | 1 | | |
| CP | 2 | | |
| Workload in Hours | Independent Study Time 46, Study Time in Lecture 14 | | |
| Lecturer | Prof. Mathias Ernst | | |
| Language | EN | | |
| Cycle | WiSe | | |
| Content | See interlocking course | | |
| Literature | See interlocking course | | |

| Course L0401: Membrane Te | ourse L0401: Membrane Technology | |
|---------------------------|---|--|
| Тур | Practical Course | |
| Hrs/wk | 1 | |
| СР | 1 | |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 | |
| Lecturer | Prof. Mathias Ernst | |
| Language | EN | |
| Cycle | WiSe | |
| Content | See interlocking course | |
| Literature | See interlocking course | |

| | ss Modeling in Water Technolo | 9y | | |
|-----------------------------------|---|---|--------------------|---------------------|
| Courses | | | | |
| Title | | Тур | Hrs/wk | СР |
| Process Modelling of Wastewater T | reatment (L0522) | Project-/problem-based Learning | 2 | 3 |
| Process Modeling in Drinking Wate | r Treatment (L0314) | Project-/problem-based Learning | 2 | 3 |
| Module Responsible | Dr. Klaus Johannsen | | | |
| Admission Requirements | None | | | |
| Recommended Previous | Knowledge of the most important processes i | n drinking water and waste water treatment. | | |
| Knowledge | | | | |
| Educational Objectives | After taking part successfully, students have | reached the following learning results | | |
| Professional Competence | | | | |
| Knowledge | Students are able to explain selected proces | ses of drinking water and waste water treatment i | n detail. The | y are able to expla |
| | basics as well as possibilities and limitations | of dynamic modeling. | | |
| Chille | Students are able to use the most important | fasturas Madalics offers. They are able to transm | co coloctod | processes in drinki |
| SKIIIS | | : features Modelica offers. They are able to transponter nematical model in Modelica with respect to equilib | | |
| | They are able to set up and apply models and | | num, kinetic: | |
| | They are able to set up and apply models and | | | |
| | | | | |
| Personal Competence | | | | |
| | Students are able to solve problems and des | mont colutions in a group with momhers of differen | nt tochnical k | ackground Thou |
| Social Competence | ace Students are able to solve problems and document solutions in a group with members of different technical background. able to give appropriate feedback and can work constructively with feedback concerning their work. | | Jackground. They a | |
| | able to give appropriate recuback and can we | | лк. | |
| | | | | |
| Autonomy | Students are able to define a problem, gain t | a required knowledge and set up a model | | |
| Autonomy | Students are able to define a problem, gain the | le required knowledge and set up a model. | | |
| | | | | |
| Workload in Hours | Independent Study Time 124, Study Time in I | ecture 56 | | |
| Credit points | | | | |
| Course achievement | | | | |
| Examination | Oral exam | | | |
| Examination duration and | | | | |
| scale | | | | |
| | Civil Engineering: Specialisation Water and Tr | affic: Elective Compulsory | | |
| Following Curricula | | cal Complementary Course: Elective Compulsory | | |
| | | cal Complementary Course: Elective Compulsory | | |
| | | ater Quality and Water Engineering: Elective Compu | lsory | |
| | | ental Process Engineering: Elective Compulsory | , | |
| | Process Engineering: Specialisation Process E | | | |
| | Water and Environmental Engineering: Specia | | | |
| | Water and Environmental Engineering: Specia | alisation Environment: Elective Compulsory | | |
| | Water and Environmental Engineering: Specia | alisation Cities: Elective Compulsory | | |

| Course L0522: Process Mode | lling of Wastewater Treatment |
|----------------------------|---|
| Тур | Project-/problem-based Learning |
| Hrs/wk | 2 |
| СР | 3 |
| Workload in Hours | Independent Study Time 62, Study Time in Lecture 28 |
| Lecturer | Dr. Joachim Behrendt |
| Language | DE/EN |
| Cycle | WiSe |
| Content | Mass and energy balances |
| | Tracer modelling |
| | |
| | Activated Sludge Model |
| | Wastewater Treatment Plant Modelling (continously and SBR) |
| | |
| | Sludge Treatment (ADM, aerobic autothermal) |
| | Biofilm Modelling |
| Literature | Henze, Mogens (Seminar on Activated Sludge Modelling, ; Kollekolle Seminar on Activated Sludge Modelling, ;) |
| | Activated sludge modelling : processes in theory and practice ; selected proceedings of the 5th Kollekolle Seminar on Activated |
| | Sludge Modelling, held in Kollekolle, Denmark, 10 - 12 September 2001 |
| | ISBN: 1843394146 |
| | [London] : IWA Publ., 2002 |
| | TUB_HH_Katalog |
| | Henze, Mogens |
| | Activated sludge models ASM1, ASM2, ASM2d and ASM3 ISBN: 1900222248 |
| | London : IWA Publ., 2002 |
| | TUB_HH_Katalog |
| | Henze, Mogens |
| | Wastewater treatment : biological and chemical processes |
| | ISBN: 3540422285 (Pp.) |
| | Berlin [u.a.] : Springer, 2002 |
| | TUB_HH_Katalog |
| | Wiesmann, Udo (Choi, In Su; Dombrowski, Eva-Maria;) |
| | Fundamentals of biological wastewater treatment |
| | ISBN: 3527312196 (Gb.) URL: http://deposit.ddb.de/cgi-bin/dokserv?id=2774611&prov=M&dok_var=1&dok_ext=htm |
| | Weinheim : WILEY-VCH, 2007 |
| | TUB_HH_Katalog |

| Course L0314: Process Mode | ling in Drinking Water Treatment |
|----------------------------|--|
| Тур | Project-/problem-based Learning |
| Hrs/wk | 2 |
| СР | 3 |
| Workload in Hours | Independent Study Time 62, Study Time in Lecture 28 |
| Lecturer | Dr. Klaus Johannsen |
| Language | EN |
| Cycle | WiSe |
| Content | using the programming language Modelica, that is increasingly used in industry. In this course OpenModelica is used, an free access frontend of the programming language Modelica. |
| | In the beginning of the course the use of OpenModelica is explainded by means of simple examples. Together required elements and structure of the model are developed. The implementation in OpenModelica and the application of the model is done individually or in groups respectively. Students get feedback and can gain extra points for the exam. |
| Literature | OpenModelica: https://openmodelica.org/index.php/download/download-windows |
| | OpenModelica - Modelica Tutorial: https://openmodelica.org/index.php/useresresources/userdocumentation |
| | OpenModelica - Users Guide: https://openmodelica.org/index.php/useresresources/userdocumentation |
| | Peter Fritzson: Principles of Object-Oriented Modeling and Simulation with Modelica 2.1, Wiley-IEEE Press, ISBN 0-471-471631. |
| | MHW (rev. by Crittenden, J. et al.): Water treatment principles and design. John Wiley & Sons, Hoboken, 2005. |
| | Stumm, W., Morgan, J.J.: Aquatic chemistry. John Wiley & Sons, New York, 1996. |
| | DVGW (Hrsg.): Wasseraufbereitung - Grundlagen und Verfahren. Oldenbourg Industrie Verlag, München, 2004. |

| Courses | |
|------------------------------------|--|
| ïtle | Typ Hrs/wk CP |
| Operation of Public Transportation | |
| Module Responsible | |
| Admission Requirements | |
| Knowledge | some knowledge of transport planning, e.g. through taking the undergraduate class "Transport Planning and Traffic Engineerin |
| Educational Objectives | After taking part successfully, students have reached the following learning results |
| Professional Competence | |
| Knowledge | Students are able to: |
| | a describe cublic bases of (DT) such as in the bains line of the succes |
| | describe public transport (PT) systems in technical language. |
| | outline the entire PT system including the interdependencies of the different elements. |
| | explain the requirements for a PT system from different perspectives. explain the role of PT in the transport system. |
| | |
| Skills | Students are able to: |
| | systematically develop a public transport system when there are no clear cut correct or incorrect approaches. |
| | cope with imprecise and incomplete data. |
| | develop and appraise alternative solutions. |
| | distinguish or develop appropriate methods of analysis and modes of presentation. |
| | reflect and evaluate their own transport concept, considering competing requirements. |
| | |
| Personal Competence | |
| Social Competence | Students are able to: |
| | carry out and complete a group project, inclusive of an appropriate allocation of tasks. |
| | constructively provide and accept feedback. |
| | present their own results to others. |
| | |
| Autonomy | |
| | independently develop a bus PT concept within a given framework. |
| | determine and justify the focus of their work. arganize and follow their work process recording time and content. |
| | organize and follow their work process regarding time and content. independently author a written report. |
| | independently author a written report. assess the consequences of the solutions they develop. |
| | • assess the consequences of the solutions they develop. |
| Workload in Hours | Independent Study Time 124, Study Time in Lecture 56 |
| Credit points | 6 |
| Course achievement | |
| Examination | Written elaboration |
| Examination duration and | written assignment as groupwork with presentation during the semester |
| scale | |
| Assignment for the | |
| Following Curricula | Water and Environmental Engineering: Specialisation Cities: Elective Compulsory |

| Course L1179: Operation of I | Public Transportation Systems |
|------------------------------|--|
| Тур | Project-/problem-based Learning |
| Hrs/wk | 4 |
| CP | 6 |
| Workload in Hours | Independent Study Time 124, Study Time in Lecture 56 |
| Lecturer | Prof. Carsten Gertz |
| Language | DE |
| Cycle | WiSe |
| Content | The course primarily deals with the planning and operational challenges of public transport systems. A bus-system is the example for studying these problems in depth. The following topics and systemic elements are covered: PT network planning timetabling operational concepts requirements for vehicle technology and operation infrastructural requirements inter- and multimodal connections financing and competition organisational structures The topics are discussed with guests lecturers from the public transport sector and are considered in practice during an excursion. |
| Literature | Verband Deutscher Verkehrsunternehmen / VDV-Förderkreis (Hrsg.) (2010) Nachhaltiger Nahverkehr. Köln. (2 Bände) Wuppertal Institut (2009) Handbuch zur Planung flexibler Bedienungsformen im ÖPNV : ein Beitrag zur Sicherung der Daseinsvorsorge in nachfrageschwachen Räumen. Bundesministerium für Verkehr, Bau und Stadtentwicklung / Bundesinstitut für Bau-, Stadt- und Raumforschung. Bonn. |
| | Forschungsgesellschaft für Straßen- und Verkehrswesen (2009) HVÖ - Hinweise für den Entwurf von Verknüpfungsanlagen des öffentlichen Personennahverkehrs. FGSV Verlag. Köln. |
| | Kirchhoff, Peter (2002) Städtische Verkehrsplanung - Konzepte, Verfahren, Maßnahmen. Vieweg+Teubner Verlag. Wiesbaden. |
| | Kirchhoff, Peter & Tsakarestos, Antonius (2007) Planung des ÖPNV in ländlichen Räumen, Ziele - Entwurf- Realisierung. Vieweg+Teubner Verlag. Wiesbaden |
| | Forschungsgesellschaft für Straßen- und Verkehrswesen (2008) RIN - Richtlinien für integrierte Netzgestaltung. FGSV-Verlag. Köln. |
| | Forschungsgesellschaft für Straßen- und Verkehrswesen (2013) EAÖ - Empfehlungen für die Anlagen des öffentlichen Personennahverkehrs. FGSV-Verlag. Köln. |
| | |

| Courses | | | | |
|---|--|---|--------|----|
| Title | | Тур | Hrs/wk | СР |
| Adaptation to climate change in hy | draulic engineering (L2291) | Project-/problem-based Learning | 4 | 6 |
| Module Responsible | Prof. Peter Fröhle | | | |
| Admission Requirements | None | | | |
| Recommended Previous Knowledge | Hydrology, Hydraulic Engineering Hydromechanic, Hydraulics Fundamentals of Coastal Engineering, Coastal- ar Hydrological Systems | nd Flood Protection | | |
| Educational Objectives | After taking part successfully, students have reached th | e following learning results | | |
| Professional Competence Knowledge Skills | Climate protection and climate adaptation Insights into climate change and its regional char Impacts of climate change on the components of Fundamentals of analysis of climate data Consequences of the impact of the climate change Measures for climate adaptation Assessment, prioritization and communication of Fundamentals of the analysis of hydrometeorolog Critical thinking: analysis of processes and relation Creative thinking: inclusion of restrictions, app methods Consideration of complex tasks | the regional hydrological cycle ge adaptation measures gical and hydrological data ons, assessment of needs for action ategies and adaptation measures | | |
| Personal Competence Social Competence Autonomy | Working in heterogenous groups Working with different scientific / non-scientific d Self reflection Application oriented use of knowledge and skills | sciplines | | |
| | Autonomous work on complex tasks | | | |
| Workload in Hours | Independent Study Time 124, Study Time in Lecture 56 | | | |
| Credit points | 6 | | | |
| Course achievement | None | | | |
| Examination | Written elaboration | | | |
| Examination duration and scale | Preparation of a written report and a presentation of a c | | | |
| Assignment for the | Civil Engineering: Specialisation Coastal Engineering: El | | | |
| Following Curricula | Civil Engineering: Specialisation Geotechnical Engineeri Civil Engineering: Specialisation Structural Engineering: | | | |
| | Civil Engineering: Specialisation Water and Traffic: Elect | | | |
| | Water and Environmental Engineering: Specialisation Ci | | | |
| | Water and Environmental Engineering: Specialisation En | | | |
| | Water and Environmental Engineering: Specialisation W | | | |

| Course L2291: Adaptation to | climate change in hydraulic engineering | | |
|-----------------------------|--|--|--|
| Тур | Project-/problem-based Learning | | |
| Hrs/wk | | | |
| CP | 6 | | |
| Workload in Hours | Independent Study Time 124, Study Time in Lecture 56 | | |
| Lecturer | Prof. Peter Fröhle | | |
| Language | DE | | |
| Cycle | WiSe | | |
| Content | Climate protection and climate adaptation Findings on climate change and its regional characteristics: fundamentals of climate change, climate modelling / climate models Impacts of climate change on the components of the regional hydrological cycle(climate science view) Fundamentals of the analysis of climate data Concequences of the impacts of climate change (ingenieering science view) Measures for climate change adaptation Assessment, prioritization and communication of measures Fundamentals of analysis of hydrometeorological and hydrological data | | |
| Literature | Wird bereitgestellt über die HOOU - eLearning Plattform abhängig von den jeweils schwerpunktmäßig behandelten Fragestellungen wird das Schrifttum (aktuelle Paper) in der Veranstaltung bzw. über StudIP zur Verfügung gestellt. | | |

| Courses | | | | |
|---|--|--|--------|----|
| Title | | Тур | Hrs/wk | СР |
| Environmental Aquatic Chemistry (| 1444) | Lecture | 2 | 3 |
| Solid Matter Process Technology for Biomass (L0052) | | Lecture | 2 | 3 |
| Sustainable landfill design and operation (L3270) | | Integrated Lecture | 3 | 3 |
| Sludge Treatment (L0520) | | Lecture | 2 | 3 |
| Special topics of the Environmenta | engineering 1CP (L3289) | | 1 | 1 |
| Special topics of the Environmenta | engineering 2CP (L3290) | | 2 | 2 |
| Special topics of the Environmenta | engineering 3CP (L3291) | | 3 | 3 |
| Thermal Biomass Utilization (L1767 |) | Lecture | 2 | 2 |
| Thermal Biomass Utilization (L2386 |) | Practical Course | 1 | 1 |
| Module Responsible | Prof. Mathias Ernst | | | |
| Admission Requirements | None | | | |
| Recommended Previous | | | | |
| Knowledge | | | | |
| Educational Objectives | After taking part successfully, students have | e reached the following learning results | | |
| Professional Competence | | | | |
| Knowledge | | | | |
| Skills | | | | |
| Personal Competence | | | | |
| Social Competence | | | | |
| Autonomy | | | | |
| | Depends on choice of courses | | | |
| Credit points | 6 | | | |
| Assignment for the | Environmental Engineering: Core Qualificati | on: Elective Compulsory | | |
| Following Curricula | Water and Environmental Engineering: Spec | cialisation Cities: Elective Compulsory | | |
| _ | Water and Environmental Engineering: Specialisation Environment: Elective Compulsory | | | |
| | | | | |

| Course L1444: Environmenta | I Aquatic Chemistry |
|----------------------------|---|
| Тур | Lecture |
| Hrs/wk | 2 |
| СР | 3 |
| Workload in Hours | Independent Study Time 62, Study Time in Lecture 28 |
| Examination Form | Klausur |
| Examination duration and | 60 min |
| scale | |
| Lecturer | Dr. Klaus Johannsen |
| Language | EN |
| Cycle | SoSe |
| Content | Concentration and activity Gas-water partitioning Acid/base equilibria Alkalinity and acidity Precipitation/dissolution equilibria Redox equilibria Complex formation Sorption |
| Literature | Worch, E.: Hydrochemistry. Basic Concepts and Exercises. De Gruyter, Berlin, 2015 |

| Course L0052: Solid Matter F | Process Technology for Biomass |
|------------------------------|--|
| Тур | Lecture |
| Hrs/wk | 2 |
| CP | 3 |
| Workload in Hours | Independent Study Time 62, Study Time in Lecture 28 |
| Examination Form | Klausur |
| Examination duration and | 60 min |
| scale | |
| Lecturer | Prof. Werner Sitzmann |
| Language | DE |
| Cycle | SoSe |
| Content | The industrial application of unit operations as part of process engineering is explained by actual examples of solid biomass |
| | processes. Size reduction, transportation and dosing, drying and agglomeration of renewable resources are described as important |
| | unit operations when producing solid fuels and bioethanol, producing and refining edible oils, when making Btl - and WPC - |
| | products. Aspects of explosion protection and plant design complete the lecture. |
| Literature | Kaltschmitt M., Hartmann H. (Hrsg.): Energie aus Bioamsse, Springer Verlag, 2001, ISBN 3-540-64853-4 |
| | Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz, Schriftenreihe Nachwachsende Rohstoffe, |
| | Fachagentur Nachwachsende Rohstoffe e.V. www.nachwachsende-rohstoffe.de |
| | Bockisch M.: Nahrungsfette und -öle, Ulmer Verlag, 1993, ISBN 380000158175 |
| | |

| Course L3270: Sustainable la | andfill design and operation |
|------------------------------|--|
| Тур | Integrated Lecture |
| Hrs/wk | 3 |
| СР | 3 |
| Workload in Hours | Independent Study Time 48, Study Time in Lecture 42 |
| Examination Form | Klausur |
| Examination duration and | 60 min |
| scale | |
| Lecturer | Dr. Marco Ritzkowski |
| Language | EN |
| Cycle | SoSe |
| Content | The course introduces the development of modern waste resource management and demonstrates the importance of landfills in the context of recycling processes. Based on international (EU) and national legislation, the current landfill situation is presented and the future significance of landfills will be discussed. A central element of the course deals with the main transformation processes in the landfilled waste, the emission of gases and leachate, the long-term behaviour of landfills as well as aftercare and after-utilisation measures. Further focal points of the course are measures for the sustainable reduction of environmentally and climate-damaging emissions and aspects of landfill technology in an international context. |
| Literature | Waste Management. Bernd Bilitewski; Georg Härdtle; Klaus Marek (Eds.), ISBN: 9783540592105, Springer Verlag Lehrbuchsammlung der TUB, Signatur USH-305 Solid Waste Technology and Management. Thomas Christensen (Ed.), ISBN: 978-1-4051-7517-3, Wiley Verlag Lesesaal 2: US - Umweltschutz, Signatur USH-332 Solid Waste Landfilling - Concepts, Processes, Technologies. Cossu, R. and Stegmann, R. (Eds.), ISBN: 978-0-12-818336-6 PDF (Volltext) über TUB |

| Lingineering | | |
|--------------------------------|---|--|
| Course L0520: Sludge Treatment | | |
| Тур | Lecture | |
| Hrs/wk | 2 | |
| СР | 3 | |
| Workload in Hours | Independent Study Time 62, Study Time in Lecture 28 | |
| Examination Form | Klausur | |
| Examination duration and | 60 min | |
| scale | | |
| Lecturer | Dr. Joachim Behrendt | |
| Language | EN | |
| Cycle | SoSe | |
| Content | Sedimentation characteristic and thickening, | |
| | Centrifugation, | |
| | Flotation, | |
| | Filtration, | |
| | Aerobic sludge stabilisation, | |
| | Sludge Digestion, | |
| | Sludge Disintegration, | |
| | Sludge Dewatering, | |
| | Natural Processes for Sludge Treatment, | |
| | Nutrient Recovery from Sludge, | |
| | Thermal Processes and Incineration. | |
| Literature | Tchobanoglous, George (Metcalf & Eddy, Inc., ;) | |
| | Wastewater engineering : treatment and reuse | |
| | ISBN: 0070418780 (alk. paper) ISBN: 0071122508 (ISE (*pbk)) | |
| | Boston [u.a.] : McGraw-Hill, 2003 | |
| | TUB_HH_Katalog | |
| | Cleverson Vitorio Andreoli, Marcos von Sperling, Fernando Fernandes | |
| | Sludge Treatment and Disposal | |
| | ISBN 9781843391661 | |
| | IWA Publishing, 2007 | |
| L | | |

| Course L3289: Special topics of the Environmental engineering 1CP | | |
|---|---|--|
| Тур | | |
| Hrs/wk | 1 | |
| СР | 1 | |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 | |
| Examination Form | Fachtheoretisch-fachpraktische Arbeit | |
| Examination duration and | wird zu Beginn der Veranstaltung festgelegt | |
| scale | | |
| Lecturer | Dozenten des SD B | |
| Language | DE/EN | |
| Cycle | WiSe/SoSe | |
| Content | The course occurs only if required. The content is defined at short notice. | |
| Literature | Die Literatur wird kurzfristig festgelegt. | |

| Course L3290: Special topics of the Environmental engineering 2CP | | |
|---|---|--|
| Тур | | |
| Hrs/wk | 2 | |
| СР | 2 | |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 | |
| Examination Form | Fachtheoretisch-fachpraktische Arbeit | |
| Examination duration and | wird zu Beginn der Veranstaltung festgelegt | |
| scale | | |
| Lecturer | Dozenten des SD B | |
| Language | DE/EN | |
| Cycle | WiSe/SoSe | |
| Content | The course occurs only if required. The content is defined at short notice. | |
| Literature | Die Literatur wird kurzfristig festgelegt. | |

| Course L3291: Special topics of the Environmental engineering 3CP | | |
|---|---|--|
| Тур | | |
| Hrs/wk | 3 | |
| СР | 3 | |
| Workload in Hours | Independent Study Time 48, Study Time in Lecture 42 | |
| Examination Form | Fachtheoretisch-fachpraktische Arbeit | |
| Examination duration and | wird zu Beginn der Veranstaltung festgelegt | |
| scale | | |
| Lecturer | Dozenten des SD B | |
| Language | DE/EN | |
| Cycle | WiSe/SoSe | |
| Content | The course occurs only if required. The content is defined at short notice. | |
| Literature | Die Literatur wird kurzfristig festgelegt. | |

| Course L1767: Thermal Biom | ass Utilization |
|----------------------------|---|
| Тур | Lecture |
| Hrs/wk | 2 |
| CP | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Examination Form | Klausur |
| Examination duration and | 60 min |
| scale | |
| Lecturer | Prof. Martin Kaltschmitt |
| Language | DE |
| Cycle | WiSe |
| Content | Goal of this course is it to discuss the physical, chemical, and biological as well as the technical, economic, and environmental basics of all options to provide energy from biomass from a German and international point of view. Additionally different system approaches to use biomass for energy, aspects to integrate bioenergy within the energy system, technical and economic development potentials, and the current and expected future use within the energy system are presented. |
| | The course is structured as follows: Biomass as an energy carrier within the energy system; use of biomass in Germany and world-wide, overview on the content of the course Photosynthesis, composition of organic matter, plant production, energy crops, residues, organic waste Biomass provision chains for woody and herbaceous biomass, harvesting and provision, transport, storage, drying Thermo-chemical conversion of solid biofuels Basics of thermo-chemical conversion Direct thermo-chemical conversion through combustion: combustion technologies for small and large scale units, electricity generation technologies, flue gas treatment technologies, ashes and their use Gasification: Gasification technologies, producer gas cleaning technologies, options to use the cleaned producer gas for the provision of heat, electricity and/or fuels Fast and slow pyrolysis: Technologies for the provision of bio-oil and/or for the provision of charcoal, oil cleaning technologies, options to use the pyrolysis oil and charcoal as an energy carrier as well as a raw material Physical-chemical conversion of biomass containing oils and/or fats: Basics, oil seeds and oil fruits, vegetable oil production, production of a biofuel with standardized characteristics (trans-esterification, hydrogenation, co-processing in existing refineries), options to use this fuel, options to use the residues (i.e. meal, glycerine) Bio-chemical conversion Biosics of bio-chemical conversion Biosics of the courses Basics of bio-chemical conversion Biosics is process technologies for the provision of bio methane, use of the digested slurry Ethanol production: Process technologies for feedstock containing sugar, starch or celluloses, use of ethanol as a fuel, use of the stillage |
| Literature | Kaltschmitt, M.; Hartmann, H. (Hrsg.): Energie aus Biomasse; Springer, Berlin, Heidelberg, 2009, 2. Auflage |

| Course L2386: Thermal Biom | ass Utilization |
|----------------------------|---|
| Тур | Practical Course |
| Hrs/wk | 1 |
| СР | 1 |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 |
| Examination Form | Schriftliche Ausarbeitung |
| Examination duration and | Protokolle |
| scale | |
| Lecturer | Prof. Martin Kaltschmitt, Dr. Marvin Scherzinger |
| Language | DE |
| Cycle | WiSe |
| Content | The experiments of the practical lab course illustrate the different aspects of heat generation from biogenic solid fuels. First, different biomasses (e.g. wood, straw or agricultural residues) will be investigated; the focus will be on the calorific value of the biomass. Furthermore, the used biomass will be pelletized, the pellet properties analysed and a combustion test carried out on a pellet combustion system. The gaseous and solid pollutant emissions, especially the particulate matter emissions, are measured and the composition of the particulate matter is investigated in a further experiment. Another focus of the practical course is the consideration of options for the reduction of particulate matter emissions from biomass combustion. In the practical course, a method for particulate matter reduction will be developed and tested. All experiments will be evaluated and the results presented. Within the practical lab course the students discuss different technical-scientific tasks, both subject-specifically and interdisciplinary. They discuss various approaches to solving the problem and advise on the theoretical or practical implementation. |
| Literature | Kaltschmitt, Martin; Hartmann, Hans; Hofbauer, Hermann: Energie aus Biomasse: Grundlagen, Techniken und Verfahren. 3. Auflage. Berlin Heidelberg: Springer Science & Business Media, 2016ISBN 978-3-662-47437-2 Versuchsskript |

| | Module M1720: Emerging Trends in Environmental Engineering | | | |
|---|--|--|--|-----------------------|
| FIGURE FILTZ OF EINER | | Jineering | | |
| Courses | | | | |
| Title | | Тур | Hrs/wk | СР |
| Environmental Research Trends (L2 | 752) | Seminar | 2 | 2 |
| Microplastics in Environment (L275 | 0) | Lecture | 2 | 2 |
| Scientific Communication and Meth | ods (L2751) | Lecture | 1 | 2 |
| Module Responsible | Prof. Nima Shokri | | | |
| Admission Requirements | None | | | |
| Recommended Previous | Basic knowledge on water, soil and environmental research. | | | |
| Knowledge | | | | |
| Educational Objectives | After taking part successfully, students have rea | ched the following learning results | | |
| Professional Competence | | | | |
| Knowledge | The students will be exposed to up-to-date rese | arch topics focused on soil, water and o | climate related challen | iges with a particula |
| | focus on the effects of microplastics in environ | ment. Data analysis, data measuremer | nt, curation and prese | ntation will be othe |
| | skills that the students will develop in this modul | e. | | |
| | | | | |
| | abstract, research paper and proposal will be discussed in this module. Moreover, through Research-Based Learning a the students will be exposed to current research trends in environmental engineering. | | | tion, now to write a |
| | | | ugh Research-Based L | |
| Personal Competence | the students will be exposed to current research | trends in environmental engineering. | - | earning approaches |
| | | trends in environmental engineering. | - | |
| Social Competence | the students will be exposed to current research | trends in environmental engineering. through Research-Based Teaching appr | roaches will be at the c | earning approaches |
| Social Competence | the students will be exposed to current research Developing teamwork and problem solving skills | trends in environmental engineering. through Research-Based Teaching appr dual reports and presentation. This w | roaches will be at the c | earning approaches |
| Social Competence Autonomy | the students will be exposed to current research Developing teamwork and problem solving skills The students will be involved in writing indivi willingness to work independently and responsib | trends in environmental engineering. through Research-Based Teaching appr dual reports and presentation. This w ly. | roaches will be at the c | earning approaches |
| Social Competence Autonomy | the students will be exposed to current research Developing teamwork and problem solving skills The students will be involved in writing indivi willingness to work independently and responsib Independent Study Time 110, Study Time in Lect | trends in environmental engineering. through Research-Based Teaching appr dual reports and presentation. This w ly. | roaches will be at the c | earning approaches |
| Social Competence Autonomy Workload in Hours | the students will be exposed to current research Developing teamwork and problem solving skills The students will be involved in writing indivi willingness to work independently and responsib Independent Study Time 110, Study Time in Lect 6 | trends in environmental engineering. through Research-Based Teaching appr dual reports and presentation. This w ly. | roaches will be at the c | earning approaches |
| Social Competence Autonomy Workload in Hours Credit points Course achievement | the students will be exposed to current research Developing teamwork and problem solving skills The students will be involved in writing indivi willingness to work independently and responsib Independent Study Time 110, Study Time in Lect 6 | trends in environmental engineering. through Research-Based Teaching appr dual reports and presentation. This w ly. | roaches will be at the c | earning approaches |
| Social Competence Autonomy Workload in Hours Credit points Course achievement | the students will be exposed to current research Developing teamwork and problem solving skills The students will be involved in writing indivi willingness to work independently and responsib Independent Study Time 110, Study Time in Lect 6 None | trends in environmental engineering. through Research-Based Teaching appr dual reports and presentation. This w ly. | roaches will be at the c | earning approaches |
| Social Competence Autonomy Workload in Hours Credit points Course achievement Examination | the students will be exposed to current research Developing teamwork and problem solving skills The students will be involved in writing indivi willingness to work independently and responsib Independent Study Time 110, Study Time in Lect 6 None Subject theoretical and practical work | trends in environmental engineering. through Research-Based Teaching appr dual reports and presentation. This w ly. | roaches will be at the c | earning approaches |
| Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale | the students will be exposed to current research Developing teamwork and problem solving skills The students will be involved in writing indivi willingness to work independently and responsib Independent Study Time 110, Study Time in Lect 6 None Subject theoretical and practical work | trends in environmental engineering. through Research-Based Teaching appr dual reports and presentation. This w ly. sure 70 | roaches will be at the c | earning approaches |
| Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the | the students will be exposed to current research Developing teamwork and problem solving skills The students will be involved in writing indivi willingness to work independently and responsib Independent Study Time 110, Study Time in Lect 6 None Subject theoretical and practical work Report and Presentation | trends in environmental engineering. through Research-Based Teaching appr dual reports and presentation. This w ly. ture 70 c: Elective Compulsory | roaches will be at the o | earning approache |
| Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the | the students will be exposed to current research Developing teamwork and problem solving skills The students will be involved in writing indivi willingness to work independently and responsib Independent Study Time 110, Study Time in Lect 6 None Subject theoretical and practical work Report and Presentation Civil Engineering: Specialisation Water and Traffi | trends in environmental engineering. through Research-Based Teaching appr dual reports and presentation. This w ly. ture 70 c: Elective Compulsory ment and Climate: Elective Compulso | roaches will be at the o | earning approache |
| Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the | the students will be exposed to current research Developing teamwork and problem solving skills The students will be involved in writing indivi willingness to work independently and responsib Independent Study Time 110, Study Time in Lect 6 None Subject theoretical and practical work Report and Presentation Civil Engineering: Specialisation Water and Traffi Environmental Engineering: Specialisation Enviro | trends in environmental engineering. through Research-Based Teaching appr dual reports and presentation. This w ly. ture 70 c: Elective Compulsory nment and Climate: Elective Compulsory ation Cities: Elective Compulsory | roaches will be at the o vill contribute to the s | earning approaches |

| Course L2752: Environmental Research Trends | | |
|---|--|--|
| Тур | Seminar | |
| Hrs/wk | 2 | |
| СР | 2 | |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 | |
| Lecturer | Dr. Salome Shokri-Kuehni | |
| Language | EN | |
| Cycle | WiSe | |
| Content | Introduction - course objectives, expectations and format | |
| | Analyzing the Audience, purpose and occasion | |
| | Constructing and delivering effective technical presentations | |
| | How to write an abstract | |
| | How to write a scientific paper | |
| | Developing competitive and persuasive research proposals | |
| | Databases and resources available for water and environmental research | |
| | Individual proposal on water and environmental research | |
| | Individual project on water and environmental research | |
| | Presentation on water and environmental research | |
| Literature | The Craft of Scientific Writing Fourth edition Author: Michael Alley Springer-Verlag New York, Copyright 2018, DOI 10.1007/978-1-4419-8288-9 | |
| | Supplemental materials and web links which will be available to registered students. | |

| Course L2750: Microplastics | in Environment |
|-----------------------------|---|
| Тур | Lecture |
| Hrs/wk | 2 |
| СР | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Prof. Nima Shokri |
| Language | |
| Cycle | WiSe |
| Content | - Introduction, objectives, expectations, format, importance |
| | - Sources of microplastics in environment |
| | - Microplastics sampling; Characterization of microplastics |
| | - Distribution of microplastics in terrestrial environments |
| | - Fate of microplastics in terrestrial environments |
| | - Project discussion |
| | - Effects of microplastics on terrestrial environments |
| | - Health risks of microplastics in environments |
| | - Project presentations by all students |
| Literature | - Microplastics in Terrestrial Environments (2021), Edited by Defu He and Yongming Luo |
| | - Particulate Plastics in Terrestrial and Aquatic Environments (2020), Edited by Nanthi S. Bolan et al. |
| | - Microplastic Pollutants (2017), by Christopher B. Crawford and Brian Quinn |

| Course L2751: Scientific Com | nmunication and Methods |
|------------------------------|--|
| Тур | Lecture |
| Hrs/wk | 1 |
| СР | 2 |
| Workload in Hours | Independent Study Time 46, Study Time in Lecture 14 |
| Lecturer | Prof. Nima Shokri |
| Language | EN |
| Cycle | WiSe |
| Content | Introduction - course objectives, expectations and format |
| | Analyzing the Audience, purpose and occasion |
| | Constructing and delivering effective technical presentations |
| | How to write an abstract |
| | How to create a scientific poster |
| | How to write a scientific paper |
| | Developing competitive and persuasive research proposals |
| | Individual project (report and presentation) related to soil, water and environmental research |
| | |
| Literature | The Craft of Scientific Writing Fourth edition |
| | Author: Michael Alley |
| | Springer-Verlag New York, Copyright 2018, DOI 10.1007/978-1-4419-8288-9 |
| | Supplemental materials and web links which will be available to registered students. |

| Courses | | | | |
|--|--|-------------------------------------|-----------------|------------------|
| Title | | Тур | Hrs/wk | СР |
| | Protection in a Changing Climate (SeaPiaC) (L2926) | Project-/problem-based Learning | 4 | 6 |
| Module Responsible | | | | |
| Admission Requirements | None | | | |
| Recommended Previous | Hydraulic Engineering | | | |
| Knowledge | Hydromechanics, Hydraulics | | | |
| | Fundamentals of Coastal Engineering, Coastal- and Flo | ood Protection | | |
| Educational Objectives | After taking part successfully, students have reached the foll | lowing learning results | | |
| Professional Competence | | | | |
| Knowledge | Climate and Climate Change | | | |
| | General Impacts of Climate Change on Wind Regime a | and Water Cycle | | |
| | Consequences of Climate Change for Coastal Processe | | | |
| | Coastal Protection in Taiwan and Germany | | | |
| | Fundamentals of Climate Adaptation | | | |
| | Nature-based Solutions (NBS) for Coastal Protection | | | |
| Skills | | | | |
| | Critical thinking: analysis of processes and relations, a Creative thinking: development of adaptation strategi | | | |
| | Practical thinking: inclusion of restrictions, application | | ods numerica | l models planni |
| | methods | | ious, numerica | , modelo, planni |
| | Consideration of complex tasks | | | |
| Devenuel Competence | | | | |
| Personal Competence Social Competence | | | | |
| Social competence | Working in heterogenous groups | | | |
| | Working in international groups | | | |
| | Working with different scientific / non-scientific discipl | ines | | |
| | Self reflection | | | |
| Autonomy | | | | |
| | Application oriented use of knowledge and skills | | | |
| | Autonomous work on complex tasks | | | |
| Workload in Hours | Independent Study Time 124, Study Time in Lecture 56 | | | |
| Credit points | | | | |
| Course achievement | None Written elaboration | | | |
| | Preparation of a written report on a complex task with a pr | esentation and subsequent discussi | on The work o | n the complex ta |
| | happens in the course of the lecture. | assentation and subsequent discussi | S.I. THE WORK U | the complex to |
| | Civil Engineering: Specialisation Coastal Engineering: Electiv | e Compulsory | | |
| Following Curricula | | | | |
| - | Civil Engineering: Specialisation Structural Engineering: Elect | tive Compulsory | | |
| | Civil Engineering: Specialisation Water and Traffic: Elective C | Compulsory | | |
| | Environmental Engineering: Specialisation Environment and | Climate: Elective Compulsory | | |
| | Water and Environmental Engineering: Specialisation Cities: | Elective Compulsory | | |
| | Water and Environmental Engineering: Specialisation Environ | | | |
| | Water and Environmental Engineering: Specialisation Water: | Elective Compulsory | | |

| Course L2926: Sustainable N | lature-based Coastal Protection in a Changing Climate (SeaPiaC) |
|-----------------------------|---|
| Тур | Project-/problem-based Learning |
| Hrs/wk | 4 |
| СР | 6 |
| Workload in Hours | Independent Study Time 124, Study Time in Lecture 56 |
| Lecturer | Prof. Peter Fröhle |
| Language | EN |
| Cycle | WiSe |
| Content | Climate and Climate Change General Impacts of Climate Change on Wind Regime and Water Cycle Consequences of Climate Change for Coastal Processes Coastal Protection in Taiwan and Germany Fundamentals of Climate Adaptation Nature-Based Solutions (NBS) for Coastal Protection |
| Literature | Materials provided on eLearning Platform (HOOU Platform) Depending on the main topics of the course in the respective year, the literature (recent papers) will be provided in the course-material or via StudIP. |

| Courses | | | | | |
|---|--|--|---|---|--|
| Гitle | | Тур | | Hrs/wk | СР |
| Naste and Environmental Chemist | | Practical Cou | | 2 | 2 |
| Biological Waste Treatment (L0318 |) | Project-/prob | lem-based Learning | 3 | 4 |
| Module Responsible | Prof. Kerstin Kuchta | | | | |
| Admission Requirements | None | | | | |
| | chemical and biological basics | | | | |
| Knowledge | | | | | |
| | After taking part successfully, students ha | ve reached the following learning r | esults | | |
| Professional Competence | | | | | |
| Knowledge | The module aims possess knowledge conc design and layout of anaerobic and aerobi plants for biological waste treatment plant | c waste treatment plants in detail, | describe different te | | |
| Skills | The students are able to discuss the comp control measurements. The students can and plan additional tests. They are capabl | recherché and evaluate literature | and date connected | | |
| Personal Competence | | | | | |
| - | Students can participate in subject-specif | is and interdisciplinany discussions | davalan cooporata | d colutions a | and defend their a |
| Social competence | work results in front of others and prom accept professional constructive criticism. | ote the scientific development in | | | |
| Autonomy | Students can independently tan knowledge | | | | |
| | are capable, in consultation with supervise steps on this basis. Furthermore, they ca potential social, economic and cultural imp | n define targets for new applicatio | tation, to assess the | ir learning lev | vel and define furt |
| Workload in Hours | are capable, in consultation with supervise steps on this basis. Furthermore, they ca | ors as well as in the interim present n define targets for new applicatio pact. | tation, to assess the | ir learning lev | vel and define furt |
| Workload in Hours Credit points | are capable, in consultation with supervise steps on this basis. Furthermore, they ca potential social, economic and cultural im Independent Study Time 110, Study Time | ors as well as in the interim present n define targets for new applicatio pact. | tation, to assess the | ir learning lev | vel and define furt |
| | are capable, in consultation with supervise steps on this basis. Furthermore, they ca potential social, economic and cultural im Independent Study Time 110, Study Time 6 | ors as well as in the interim present n define targets for new applicatio pact. in Lecture 70 Description | tation, to assess the | ir learning lev | vel and define furt |
| Credit points | are capable, in consultation with supervise steps on this basis. Furthermore, they ca potential social, economic and cultural imp Independent Study Time 110, Study Time 6 Compulsory Bonus Form Yes None Subject theoretic practical work | ors as well as in the interim present n define targets for new applicatio pact. in Lecture 70 Description | tation, to assess the | ir learning lev | vel and define furt |
| Credit points Course achievement Examination Examination duration and | are capable, in consultation with supervise steps on this basis. Furthermore, they ca potential social, economic and cultural imp Independent Study Time 110, Study Time 6 Compulsory Bonus Form Yes None Subject theoretic practical work | ors as well as in the interim present n define targets for new applicatio bact. in Lecture 70 Description cal and | tation, to assess the | ir learning lev | vel and define furt |
| Credit points Course achievement Examination Examination duration and scale | are capable, in consultation with supervise steps on this basis. Furthermore, they ca potential social, economic and cultural imp Independent Study Time 110, Study Time 6 Compulsory Bonus Form Yes None Subject theoretic practical work Presentation Elaboration and Presentation (15-25 minut | ors as well as in the interim present n define targets for new applicatio bact. in Lecture 70 Description Cal and tes in groups) | tation, to assess the | ir learning lev | vel and define furt |
| Credit points Course achievement Examination Examination duration and scale Assignment for the | are capable, in consultation with supervise steps on this basis. Furthermore, they ca potential social, economic and cultural imp Independent Study Time 110, Study Time 6 Compulsory Bonus Form Yes None Subject theoretic practical work Presentation Elaboration and Presentation (15-25 minu Civil Engineering: Specialisation Coastal E | ors as well as in the interim present n define targets for new applicatio oact. in Lecture 70 Description cal and tes in groups) ngineering: Elective Compulsory | ation, to assess the | ir learning lev | vel and define furt |
| Credit points Course achievement Examination Examination duration and scale | are capable, in consultation with supervise steps on this basis. Furthermore, they ca potential social, economic and cultural imp Independent Study Time 110, Study Time 6 Compulsory Bonus Form Yes None Subject theoretic practical work Presentation Elaboration and Presentation (15-25 minu) Civil Engineering: Specialisation Coastal E Civil Engineering: Specialisation Geotechn | ors as well as in the interim present n define targets for new applicatio bact. in Lecture 70 Description cal and tes in groups) ngineering: Elective Compulsory ical Engineering: Elective Compulsory | ation, to assess the | ir learning lev | vel and define furt |
| Credit points Course achievement Examination Examination duration and scale Assignment for the | are capable, in consultation with supervise steps on this basis. Furthermore, they ca potential social, economic and cultural imp Independent Study Time 110, Study Time 6 Compulsory Bonus Form Yes None Subject theoretic practical work Presentation Elaboration and Presentation (15-25 minut Civil Engineering: Specialisation Coastal E Civil Engineering: Specialisation Geotechm Civil Engineering: Specialisation Structura | ors as well as in the interim present n define targets for new application obact. in Lecture 70 Description Cal and tes in groups) ingineering: Elective Compulsory ical Engineering: Elective Compulsory I Engineering: Elective Compulsory | ation, to assess the | ir learning lev | vel and define furt |
| Credit points Course achievement Examination Examination duration and scale Assignment for the | are capable, in consultation with supervise steps on this basis. Furthermore, they ca potential social, economic and cultural imp Independent Study Time 110, Study Time 6 Compulsory Bonus Form Yes None Subject theoretic practical work Presentation Elaboration and Presentation (15-25 minut Civil Engineering: Specialisation Coastal E Civil Engineering: Specialisation Geotechm Civil Engineering: Specialisation Structura Civil Engineering: Specialisation Water and | ors as well as in the interim present n define targets for new application obact. in Lecture 70 Description cal and tes in groups) ingineering: Elective Compulsory ical Engineering: Elective Compulsory d Traffic: Elective Compulsory | ation, to assess their in-or research-orient | ir learning lev | vel and define furt |
| Credit points Course achievement Examination Examination duration and scale Assignment for the | are capable, in consultation with supervise steps on this basis. Furthermore, they ca potential social, economic and cultural imp Independent Study Time 110, Study Time 6 Compulsory Bonus Form Yes None Subject theoretic practical work Presentation Elaboration and Presentation (15-25 minut Civil Engineering: Specialisation Coastal E Civil Engineering: Specialisation Geotechm Civil Engineering: Specialisation Structura Civil Engineering: Specialisation Water and Bioprocess Engineering: Specialisation A - | ors as well as in the interim present n define targets for new application obact. in Lecture 70 Description cal and tes in groups) ingineering: Elective Compulsory ical Engineering: Elective Compulsory d Traffic: Elective Compulsory General Bioprocess Engineering: Elective | ective Compulsory | ir learning lev | vel and define furt |
| Credit points Course achievement Examination Examination duration and scale Assignment for the | are capable, in consultation with supervise steps on this basis. Furthermore, they ca potential social, economic and cultural imp Independent Study Time 110, Study Time 6 Compulsory Bonus Form Yes None Subject theoretic practical work Presentation Elaboration and Presentation (15-25 minut Civil Engineering: Specialisation Coastal E Civil Engineering: Specialisation Geotechm Civil Engineering: Specialisation Structura Civil Engineering: Specialisation Water and Bioprocess Engineering: Specialisation Water and Bioprocess Engineering: Specialisation Structura | ors as well as in the interim present n define targets for new application bact. in Lecture 70 Description cal and tes in groups) ingineering: Elective Compulsory ical Engineering: Elective Compulsory d Traffic: Elective Compulsory General Bioprocess Engineering: Elective Sengineering: Elective Se | etion, to assess their n-or research-orient | ir learning lev red duties in | vel and define furt |
| Credit points Course achievement Examination Examination duration and scale Assignment for the | are capable, in consultation with supervise steps on this basis. Furthermore, they ca potential social, economic and cultural imp Independent Study Time 110, Study Time 6 Compulsory Bonus Form Yes None Subject theoretic practical work Presentation Elaboration and Presentation (15-25 minut Civil Engineering: Specialisation Coastal E Civil Engineering: Specialisation Geotechm Civil Engineering: Specialisation Structura Civil Engineering: Specialisation Water and Bioprocess Engineering: Specialisation A - | ors as well as in the interim present n define targets for new application bact. in Lecture 70 Description cal and tes in groups) ingineering: Elective Compulsory ical Engineering: Elective Compulsory d Traffic: Elective Compulsory d Traffic: Elective Compulsory General Bioprocess Engineering: El ecialisation General Process Engine ecialisation Chemical Process Engine | ering: Elective Comp eering: Elective Comp | ir learning lev red duties in | vel and define furt accordance with |
| Credit points Course achievement Examination Examination duration and scale Assignment for the | are capable, in consultation with supervise steps on this basis. Furthermore, they ca potential social, economic and cultural imp Independent Study Time 110, Study Time 6 Compulsory Bonus Form Yes None Subject theoretic practical work Presentation Elaboration and Presentation (15-25 minut Civil Engineering: Specialisation Coastal E Civil Engineering: Specialisation Geotechn Civil Engineering: Specialisation Structura Civil Engineering: Specialisation Water and Bioprocess Engineering: Specialisation Water and Bioprocess Engineering: Specialisation Structura Chemical and Bioprocess Engineering: Specialisation Specia | ors as well as in the interim present n define targets for new application bact. in Lecture 70 Description cal and tes in groups) ical Engineering: Elective Compulsory ical Engineering: Elective Compulsory d Traffic: Elective Compulsory d Traffic: Elective Compulsory general Bioprocess Engineering: El ecialisation General Process Engine ecialisation Chemical Process Engine ecialisation Chemical and Bioproces | ering: Elective Comp eering: Elective Comp esting: Elective Comp | ulsory ive Compulsor | vel and define furt accordance with |
| Credit points Course achievement Examination Examination duration and scale Assignment for the | are capable, in consultation with supervise steps on this basis. Furthermore, they ca potential social, economic and cultural imp Independent Study Time 110, Study Time 6 Compulsory Bonus Form Yes None Subject theoretic practical work Presentation Elaboration and Presentation (15-25 minut Civil Engineering: Specialisation Coastal E Civil Engineering: Specialisation Geotechn Civil Engineering: Specialisation Structura Civil Engineering: Specialisation Water and Bioprocess Engineering: Specialisation Water and Bioprocess Engineering: Specialisation Structura Chemical and Bioprocess Engineering: Specialisation Specia | ors as well as in the interim present n define targets for new application bact. in Lecture 70 Description cal and tes in groups) ical Engineering: Elective Compulsory ical Engineering: Elective Compulsory d Traffic: Elective Compulsory d Traffic: Elective Compulsory General Bioprocess Engineering: Electilisation General Process Engine ecialisation Chemical Process Engine ecialisation Chemical and Bioprocess ecialisation Bioprocess Engineering: | ering: Elective Compulsory eering: Elective Compusory esting: Elective Compusory ering: Elective Compusory ering: Elective Compusory esting: Elective Compusory | ulsory ive Compulsory | vel and define furt accordance with |
| Credit points Course achievement Examination Examination duration and scale Assignment for the | are capable, in consultation with supervise steps on this basis. Furthermore, they ca potential social, economic and cultural imp Independent Study Time 110, Study Time 6 Compulsory Bonus Form Yes None Subject theoretic practical work Presentation Elaboration and Presentation (15-25 minut Civil Engineering: Specialisation Coastal E Civil Engineering: Specialisation Geotechm Civil Engineering: Specialisation Structura Civil Engineering: Specialisation Water and Bioprocess Engineering: Specialisation Water and Bioprocess Engineering: Specialisation Structura Chemical and Bioprocess Engineering: Spe Chemical and Bioprocess Engineering: Spe Chemical and Bioprocess Engineering: Spe Chemical and Bioprocess Engineering: Spe | ors as well as in the interim present n define targets for new application bact. in Lecture 70 Description cal and tes in groups) ical Engineering: Elective Compulsory ical Engineering: Elective Compulsory d Traffic: Elective Compulsory d Traffic: Elective Compulsory General Bioprocess Engineering: El ecialisation General Process Engine ecialisation Chemical and Bioprocess ecialisation Bioprocess Engineering: ecialisation Chemical and Bioprocess ecialisation Chemical and Bioprocess | ering: Elective Compulsory eering: Elective Compusory esting: Elective Compusory ering: Elective Compusory ering: Elective Compusory esting: Elective Compusory | ulsory ive Compulsory | vel and define furt accordance with |
| Credit points Course achievement Examination Examination duration and scale Assignment for the | are capable, in consultation with supervise steps on this basis. Furthermore, they ca potential social, economic and cultural imp Independent Study Time 110, Study Time 6 Compulsory Bonus Form Yes None Subject theoretic practical work Presentation Elaboration and Presentation (15-25 minut Civil Engineering: Specialisation Coastal E Civil Engineering: Specialisation Geotechn Civil Engineering: Specialisation Water and Bioprocess Engineering: Specialisation Water and Bioprocess Engineering: Specialisation Water and Chemical and Bioprocess Engineering: Spe Chemical and Bioprocess Engineering: Spe | ors as well as in the interim present n define targets for new application bact. in Lecture 70 Description cal and tes in groups) ical Engineering: Elective Compulsory ical Engineering: Elective Compulsory d Traffic: Elective Compulsory d Traffic: Elective Compulsory General Bioprocess Engineering: Electiation General Process Engine ecclalisation Chemical Process Engine ecclalisation Chemical and Bioprocess ecclalisation Chemical and Bioprocess | ering: Elective Compulsory ering: Elective Compusion ering: Elective Compusion is Engineering: Elect | ir learning lev red duties in usory pulsory ive Compulso y ive Compulso | vel and define furt accordance with |
| Credit points Course achievement Examination Examination duration and scale Assignment for the | are capable, in consultation with supervise steps on this basis. Furthermore, they ca potential social, economic and cultural imp Independent Study Time 110, Study Time 6 Compulsory Bonus Form Yes None Subject theoretic practical work Presentation Elaboration and Presentation (15-25 minut Civil Engineering: Specialisation Coastal E Civil Engineering: Specialisation Geotechn Civil Engineering: Specialisation Water and Bioprocess Engineering: Specialisation Water and Bioprocess Engineering: Specialisation A - Chemical and Bioprocess Engineering: Spe Chemical and Bioprocess Engineering: Spe Environmental Engineering: Core Qualification | ors as well as in the interim present n define targets for new application obact. in Lecture 70 Description cal and tes in groups) ical Engineering: Elective Compulsory ical Engineering: Elective Compulsory d Traffic: Elective Compulsory d Traffic: Elective Compulsory General Bioprocess Engineering: El ecialisation General Process Engine ecialisation Chemical and Bioproces ecialisation Chemical and Bioproces | eation, to assess their on-or research-orient pry lective Compulsory ering: Elective Compu- eering: Elective Compu- eering: Elective Compulsor is Engineering: Elect is Engineering: Elect is Engineering: Elect is Engineering: Elective is Engineering: Elective is Engineering: Elective is Engineering: Elective is Engineering: Elective is Engineering: Elective is Engineering: Elective Compulsor | ir learning lev red duties in usory pulsory ive Compulso y ive Compulso | vel and define furt accordance with |
| Credit points Course achievement Examination Examination duration and scale Assignment for the | are capable, in consultation with supervise steps on this basis. Furthermore, they ca potential social, economic and cultural imp Independent Study Time 110, Study Time 6 Compulsory Bonus Form Yes None Subject theoretic practical work Presentation Elaboration and Presentation (15-25 minut Civil Engineering: Specialisation Coastal E Civil Engineering: Specialisation Geotechn Civil Engineering: Specialisation Mater and Bioprocess Engineering: Specialisation Water and Bioprocess Engineering: Specialisation A - Chemical and Bioprocess Engineering: Spe Chemical and Bioprocess Engineering: Spe Environmental Engineering: Core Qualifica International Management and Engineering | ors as well as in the interim present n define targets for new application bact. in Lecture 70 Description cal and tes in groups) ical Engineering: Elective Compulsory ical Engineering: Elective Compulsory d Traffic: Elective Compulsory General Bioprocess Engineering: Electialisation General Process Engineering: ecialisation Chemical Process Engineering: ecialisation Chemical and Bioprocess ecialisation Chemical and Bioprocess ecialisation Chemical and Bioprocess tion: Compulsory g: Specialisation II. Renewable Ener nmental Process Engineering: Elect | ective Compulsory ering: Elective Compulsory ering: Elective Compulsory ering: Elective Compulsory ering: Elective Compulsor is Engineering: Elect is Elective Compulsory est Engineering: Elective is Engineering: Elective Compulsory | ir learning lev red duties in usory pulsory ive Compulso y ive Compulso | vel and define furt accordance with |

| Course L0328: Waste and En | vironmental Chemistry |
|----------------------------|--|
| Тур | Practical Course |
| Hrs/wk | 2 |
| СР | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Prof. Kerstin Kuchta |
| Language | EN |
| Cycle | WiSe |
| Content | The participants are divided into groups. Each group prepares a transcript on the experiment performed, which is then used as basis for discussing the results and to evaluate the performance of the group and the individual student. In some experiments the test procedure and the results are presented in seminar form, accompanied by discussion and results evaluation. Experiments ar e.g. Screening and particle size determination Fos/Tac AAS Chalorific value |
| Literature | Scripte |

| Course L0318: Biological Was | ste Treatment | |
|------------------------------|---|--|
| Тур | ject-/problem-based Learning | |
| Hrs/wk | | |
| СР | 4 | |
| Workload in Hours | Independent Study Time 78, Study Time in Lecture 42 | |
| Lecturer | Prof. Kerstin Kuchta | |
| Language | EN | |
| Cycle | WiSe | |
| Content | Introduction biological basics determination process specific material characterization aerobic degradation (Composting, stabilization) anaerobic degradation (Biogas production, fermentation) Technical layout and process design Flue gas treatment Plant design practical phase | |
| Literature | | |

| Module M2009: Study | / Work Specialisation Cities |
|---|---|
| Courses | |
| Title | Typ Hrs/wk CP |
| Module Responsible | Dozenten des SD B |
| Admission Requirements | None |
| Recommended Previous | |
| Knowledge | Basics of Urban Planning |
| | Urban Infrastructures (Water, Energy, Heat) Environmental Technologies (Solid Waste Disposal, Air Quality Control, Wastewater Treatement, etc.) |
| | • Environmental recimologies (Solid Waste Disposal, All Quality Control, Wastewater Treatement, etc.) |
| | |
| | After taking part successfully, students have reached the following learning results |
| Professional Competence | |
| Knowledge | The students are able to demonstrate their detailed knowledge in the field of Water and Environmental Engineering. They ca exemplify the state of technology and application and discuss critically in the context of actual problems and general conditions science and society. |
| | The students can develop solving strategies and approaches for fundamental and practical problems in the field of Water ar Environmental Engineering. They may apply theory based procedures and integrate safety-related, ecological, ethical, ar |
| | economic view points of science and society. |
| | Scientific work techniques that are used can be described and critically reviewed. |
| Skills | The students are able to independently select methods or planning approaches for the project work and to justify their choic They can explain how these methods or approaches relate to solutions in the field of work and how the context of application h to be adjusted. General findings and further developments may essentially be outlined. |
| Personal Competence | |
| Social Competence | The students are able to condense the relevance and the structure of the project work, the work steps and the sub-problems for the presentation and discussion in front of a bigger group. They can lead the discussion and give a feedback on the project to the colleagues. |
| Autonomy | The students are capable of independently planning and documenting the work steps and procedures while considering the give deadlines. This includes the ability to accurately procure the newest scientific information. Furthermore, they can obtain feedbac from experts with regard to the progress of the work, and to accomplish results on the state of the art in science and technology. |
| Workload in Hours | Independent Study Time 360, Study Time in Lecture 0 |
| Credit points | 12 |
| Course achievement | None |
| Examination | Study work |
| Examination duration and scale | |
| Assignment for the Following Curricula | Water and Environmental Engineering: Specialisation Cities: Compulsory |

| | e Treatment and Recycling | | | | |
|------------------------------------|--|---------------------------------|----------------|-------------------|--|
| Courses | | | | | |
| Fitle | Ту | /p | Hrs/wk | СР | |
| Planning of waste treatment plants | (L3267) Pro | oject-/problem-based Learning | 3 | 3 | |
| Recycling technologies and therma | I waste treatment (L3265) Leo | cture | 2 | 2 | |
| Recycling technologies and therma | I waste treatment (L3266) Rec | citation Section (small) | 1 | 1 | |
| Module Responsible | Prof. Kerstin Kuchta | | | | |
| Admission Requirements | None | | | | |
| Recommended Previous | Basics of thermo dynamics | | | | |
| Knowledge | Basics of fluid dynamics | | | | |
| | fluid dynamics chemistry | | | | |
| | | | | | |
| Educational Objectives | After taking part successfully, students have reached the following le | earning results | | | |
| Professional Competence | | | | | |
| Knowledge | The students can name, describe current issue and problems in the | e field of waste treatment (m | echanical, che | emical and therm | |
| | and contemplate them in the context of their field. | | | | |
| | The industrial application of unit operations as part of process engin | eering is explained by actual | examples of v | vaste technologi | |
| | Compostion, particle sizes, transportation and dosing of wastes are of | | | laste teennologi | |
| | | | perations | | |
| | Students will be able to design and design waste treatment technol | ogy equipment. | | | |
| Skills | The students are able to select suitable processes for the treatment | t of wastes or raw material w | ith respect to | their characteris | |
| | and the process aims. They can evaluate the efforts and costs for pr | | | | |
| | | | | | |
| Personal Competence | | | | | |
| Social Competence | Students can | | | | |
| | respectfully work together as a team and discuss technical taget | sks | | | |
| | participate in subject-specific and interdisciplinary discussions | | | | |
| | develop cooperated solutions | | | | |
| | promote the scientific development and accept professional | constructive criticism. | | | |
| | | | | | |
| Autonomy | Students can independently tap knowledge of the subject area and transform it to new questions. They are capable, consultation with supervisors, to assess their learning level and define further steps on this basis. Furthermore, they can define | | | | |
| | | | | | |
| | targets for new application-or research-oriented duties in accordance | e with the potential social, ec | onomic and ci | ultural impact. | |
| Workload in Hours | Independent Study Time 96, Study Time in Lecture 84 | | | | |
| Credit points | 6 | | | | |
| Course achievement | None | | | | |
| Examination | Written exam | | | | |
| Examination duration and | 120 min | | | | |
| scale | | | | | |
| • | Civil Engineering: Specialisation Water and Traffic: Elective Compuls | - | | | |
| Following Curricula | Bioprocess Engineering: Specialisation A - General Bioprocess Engine | 5 1 5 | | | |
| | Chemical and Bioprocess Engineering: Specialisation General Proces | 5 5 1 | | | |
| | Chemical and Bioprocess Engineering: Specialisation Bioprocess Eng | 5 5 1 . | | | |
| | Chemical and Bioprocess Engineering: Specialisation Chemical Proce | | | | |
| | Chemical and Bioprocess Engineering: Specialisation Chemical and E | | | - | |
| | Chemical and Bioprocess Engineering: Specialisation Chemical and E | | ive Compulsor | У | |
| | Environmental Engineering: Specialisation Energy and Resources: El | | loon | | |
| | International Management and Engineering: Specialisation II. Renew | | sory | | |
| | Renewable Energies: Specialisation Bioenergy Systems: Elective Cor | | | | |
| | Process Engineering: Specialisation Chemical Process Engineering: E | | | | |
| | Process Engineering, Specialization Process Engineering, Elective Co | | | | |
| | Process Engineering: Specialisation Process Engineering: Elective Co | | | | |
| | Process Engineering: Specialisation Process Engineering: Elective Co Process Engineering: Specialisation Environmental Process Engineer Water and Environmental Engineering: Specialisation Environment: (| ring: Elective Compulsory | | | |

| ourse L3267: Planning of waste treatment plants | | | |
|---|---|--|--|
| Тур | Project-/problem-based Learning | | |
| Hrs/wk | 3 | | |
| СР | 3 | | |
| Workload in Hours | Independent Study Time 48, Study Time in Lecture 42 | | |
| Lecturer | Prof. Rüdiger Siechau | | |
| Language | EN | | |
| Cycle | WiSe | | |
| Content | The focus is on getting to know the organization and practice of waste management companies. Topics such as planning, financing and logistics will be discussed and there will be an excursion (waste incineration plant, vehicle fleet and collection systems / containers). Project based learning: You will be given a task to work on independently in groups of 4 to 6 students. All tools and data needed for the project work will be discussed in the lecture "Recycling Technologies and Thermal Waste Treatment". Course documents can be downloaded from StudIP. Communication during the project work also takes place via StudIP. | | |
| Literature | Einführung in die Abfallwirtschaft; Martin Kranert, Klaus Cord-Landwehr (Hrsg.); Vieweg + Teubner Verlag; 2010 PowerPoint Präsentationen in Stud IP | | |

| Course L3265: Recycling tech | hnologies and thermal waste treatment |
|------------------------------|---|
| Тур | Lecture |
| Hrs/wk | 2 |
| СР | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Prof. Kerstin Kuchta |
| Language | EN |
| Cycle | WiSe |
| Content | Introduction, actual state-of-the-art of waste incineration, aims. legal background, reaction principals basics of incineration processes: waste composition, calorific value, calculation of air demand and flue gas composition Incineration techniques: grate firing, ash transfer, boiler Flue gas cleaning: Volume, composition, legal frame work and emission limits, dry treatment, scrubber, de-nox techniques, dioxin elimination, Mercury elimination Ash treatment: Mass, quality, treatment concepts, recycling, disposal |
| Literature | Thomé-Kozmiensky, K. J. (Hrsg.): Thermische Abfallbehandlung Bande 1-7. EF-Verlag für Energie- und Umwelttechnik, Berlin, 196 - 2013. |

| Course L3266: Recycling technologies and thermal waste treatment | | |
|--|---|--|
| Тур | Recitation Section (small) | |
| Hrs/wk | 1 | |
| СР | 1 | |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 | |
| Lecturer | Prof. Kerstin Kuchta | |
| Language | EN | |
| Cycle | WiSe | |
| Content | See interlocking course | |
| Literature | See interlocking course | |

| Courses Title Typ Hrs/wk CP Methods in Climate Informed Engineering (L3347) Lecture 3 3 Topics in Climate Informed Engineering (L3348) Lecture 3 3 Module Responsible Prof. Nima Shokri Admission Requirements None Recommended Previous Students are expected to have a foundational understanding of environmental science, basic engineering principl interest in sustainability. Recommended knowledge includes climate science, data analysis, and familiarity with engineering processes. Analytical and critical thinking and creative problem-solving skills are also beneficial Educational Objectives After taking part successfully, students have reached the following learning results Professional Competence Knowledge This module explores next-generation climate models and high-resolution data, emphasizing their impact on environ engineering products and processes. It covers how various engineering disciplines can benefit from climate information based learning activities, expert taks, and presentations will expose students to state-of-the-art modeling, measure analysis in climate-informed engineering. Skills Climate data analysis, engineering adaptation strategies, problem-solving, research-based learning, and inter collaboration. Personal Competence Social Competence Collaboration, interdisciplinary teamwork, communication skills, problem-solving, ethical responsibilil | | | | |
|---|--|--|--|--|
| Title Typ Hrs/wk CP Methods in Climate Informed Engineering (L3347) Lecture 3 3 Topics in Climate Informed Engineering (L3348) Lecture 3 3 Module Responsible Prof. Nima Shokri Lecture 3 3 Admission Requirements None Recommended Previous Students are expected to have a foundational understanding of environmental science, basic engineering principi interest in sustainability. Recommended knowledge includes climate science, data analysis, and familiarity with engineer processes. Analytical and critical thinking and creative problem-solving skills are also beneficial Image: Students are expected to have a foundational understanding of environmental science, basic engineering principi for processes. Analytical and critical thinking and creative problem-solving skills are also beneficial Educational Objectives After taking part successfully, students have reached the following learning results Image: Students and processes. It covers how various engineering disciplines can benefit from climate information based learning activities, expert talks, and presentations will expose students to state-of-the-art modeling, measure analysis in climate-informed engineering. Skills Climate data analysis, engineering adaptation strategies, problem-solving, research-based learning, and inter collaboration. Personal Competence Social Competence Collaboration, interdisciplinary teamwork, communication skills, problem-solving, ethical responsibility, and decisior cl | | | | |
| Methods in Climate Informed Engineering (L3347) Lecture 3 3 Topics in Climate Informed Engineering (L3348) Prof. Nima Shokri Admission Requirements None Recommended Previous Students are expected to have a foundational understanding of environmental science, basic engineering principlininterest in sustainability. Recommended knowledge includes climate science, data analysis, and familiarity with engineer processes. Analytical and critical thinking and creative problem-solving skills are also beneficial Educational Objectives After taking part successfully, students have reached the following learning results Professional Competence Knowledge Knowledge This module explores next-generation climate models and high-resolution data, emphasizing their impact on environi engineering products and processes. It covers how various engineering disciplines can benefit from climate information based learning activities, expert talks, and presentations will expose students to state-of-the-art modeling, measure analysis in climate-informed engineering. Skills Climate data analysis, engineering adaptation strategies, problem-solving, research-based learning, and inter collaboration. Personal Competence Collaboration, interdisciplinary teamwork, communication skills, problem-solving, ethical responsibility, and decision climate-informed engineering. Autonomy Time management, self-directed learning, critical thinking, accountability, initiative, and the ability to conduct in research and make informed decisions in climate | | | | |
| Topics in Climate Informed Engineering (13348) Lecture 3 3 Module Responsible Prof. Nima Shokri International Shokri International Shokri Admission Requirements None International Status and Creative problem-solving skills are also beneficial International Objective Recommended Dipectives After taking part successfully, students have reached the following learning results International Status and Protesses. It covers how various engineering disciplines can benefit from climate information based learning activities, expert talks, and presentations will expose students to state-of-the-art modeling, measure analysis in climate-informed engineering. Skills Skills Climate data analysis, engineering adaptation strategies, problem-solving, ethical responsibility, and decision climate-resilient engineering. Internation skills, problem-solving, ethical responsibility, and decision climate-resilient engineering. Autonomy Time management, self-directed learning, critical thinking, accountability, initiative, and the ability to conduct in research and make informed decisions in climate-informed engineering. Workload in Houra Independent Study Time 96, Study Time in Lecture 84 Gredit points | | | | |
| Module Responsible Prof. Nima Shokri Admission Requirements None Recommended Previous Students are expected to have a foundational understanding of environmental science, basic engineering principl interest in sustainability. Recommended knowledge includes climate science, data analysis, and familiarity with engineer processes. Analytical and critical thinking and creative problem-solving skills are also beneficial Educational Objectives After taking part successfully, students have reached the following learning results Professional Competence <i>Knowledge</i> This module explores next-generation climate models and high-resolution data, emphasizing their impact on environ engineering products and processes. It covers how various engineering disciplines can benefit from climate information based learning activities, expert talks, and presentations will expose students to state-of-the-art modeling, measure analysis in climate-informed engineering. Skills Climate data analysis, engineering adaptation strategies, problem-solving, research-based learning, and inter collaboration. Personal Competence Social Competence Collaboration, interdisciplinary teamwork, communication skills, problem-solving, ethical responsibility, and decision climate-resilient engineering. Workload in Hours Independent Study Time 96, Study Time in Lecture 84 Credit points 6 | | | | |
| Admission Requirements None Recommended Previous Students are expected to have a foundational understanding of environmental science, basic engineering principli interest in sustainability. Recommended knowledge includes climate science, data analysis, and familiarity with engineer processes. Analytical and critical thinking and creative problem-solving skills are also beneficial Educational Objectives After taking part successfully, students have reached the following learning results Professional Competence Knowledge This module explores next-generation climate models and high-resolution data, emphasizing their impact on environ engineering products and processes. It covers how various engineering disciplines can benefit from climate information based learning activities, expert talks, and presentations will expose students to state-of-the-art modeling, measure analysis in climate-informed engineering. Skills Climate data analysis, engineering adaptation strategies, problem-solving, research-based learning, and inter collaboration. Personal Competence Collaboration, interdisciplinary teamwork, communication skills, problem-solving, ethical responsibility, and decision climate-resilient engineering. Autonomy Time management, self-directed learning, critical thinking, accountability, initiative, and the ability to conduct in research and make informed decisions in climate-informed engineering. Workload in Hours Independent Study Time 96, Study Time in Lecture 84 | | | | |
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| Analysis in climate-informed engineering. Skills Climate data analysis, engineering adaptation strategies, problem-solving, research-based learning, and inter collaboration. Personal Competence Collaboration, interdisciplinary teamwork, communication skills, problem-solving, ethical responsibility, and decision climate-resilient engineering. Autonomy Time management, self-directed learning, critical thinking, accountability, initiative, and the ability to conduct in research and make informed decisions in climate-informed engineering. Workload in Hours Independent Study Time 96, Study Time in Lecture 84 Credit points 6 | . Research | | | |
| Skills Climate data analysis, engineering adaptation strategies, problem-solving, research-based learning, and inter collaboration. Personal Competence Collaboration, interdisciplinary teamwork, communication skills, problem-solving, ethical responsibility, and decision climate-resilient engineering. Autonomy Time management, self-directed learning, critical thinking, accountability, initiative, and the ability to conduct in research and make informed decisions in climate-informed engineering. Workload in Hours Independent Study Time 96, Study Time in Lecture 84 Credit points 6 | ement, and | | | |
| Personal Competence collaboration. Social Competence Collaboration, interdisciplinary teamwork, communication skills, problem-solving, ethical responsibility, and decision climate-resilient engineering. Autonomy Time management, self-directed learning, critical thinking, accountability, initiative, and the ability to conduct in research and make informed decisions in climate-informed engineering. Workload in Hours Independent Study Time 96, Study Time in Lecture 84 Credit points 6 | | | | |
| Personal Competence collaboration. Social Competence Collaboration, interdisciplinary teamwork, communication skills, problem-solving, ethical responsibility, and decision climate-resilient engineering. Autonomy Time management, self-directed learning, critical thinking, accountability, initiative, and the ability to conduct in research and make informed decisions in climate-informed engineering. Workload in Hours Independent Study Time 96, Study Time in Lecture 84 Credit points 6 | discinlinar | | | |
| Personal Competence Collaboration, interdisciplinary teamwork, communication skills, problem-solving, ethical responsibility, and decision climate-resilient engineering. Autonomy Time management, self-directed learning, critical thinking, accountability, initiative, and the ability to conduct in research and make informed decisions in climate-informed engineering. Workload in Hours Independent Study Time 96, Study Time in Lecture 84 Credit points 6 | alscipilliar | | | |
| Social Competence Collaboration, interdisciplinary teamwork, communication skills, problem-solving, ethical responsibility, and decision climate-resilient engineering. Autonomy Time management, self-directed learning, critical thinking, accountability, initiative, and the ability to conduct in research and make informed decisions in climate-informed engineering. Workload in Hours Independent Study Time 96, Study Time in Lecture 84 Credit points 6 | | | | |
| Autonomy Cimate-resilient engineering. Autonomy Time management, self-directed learning, critical thinking, accountability, initiative, and the ability to conduct in research and make informed decisions in climate-informed engineering. Workload in Hours Independent Study Time 96, Study Time in Lecture 84 Credit points 6 | | | | |
| Autonomy Time management, self-directed learning, critical thinking, accountability, initiative, and the ability to conduct in research and make informed decisions in climate-informed engineering. Workload in Hours Independent Study Time 96, Study Time in Lecture 84 Credit points 6 | Collaboration, interdisciplinary teamwork, communication skills, problem-solving, ethical responsibility, and decision-making in | | | |
| workload in Hours Independent Study Time 96, Study Time in Lecture 84 Credit points 6 | | | | |
| workload in Hours Independent Study Time 96, Study Time in Lecture 84 Credit points 6 | Time management self-directed learning critical thinking accountability initiative and the ability to conduct independent | | | |
| Credit points 6 | | | | |
| Credit points 6 | | | | |
| | | | | |
| Course achievement None | | | | |
| | | | | |
| Examination Subject theoretical and practical work | | | | |
| Examination duration and Report and Presentation | | | | |
| scale | | | | |
| Assignment for the Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory | | | | |
| Following Curricula Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory | | | | |
| Civil Engineering: Specialisation Structural Engineering: Elective Compulsory | | | | |
| Civil Engineering: Specialisation Water and Traffic: Elective Compulsory | | | | |
| Civil Engineering: Specialisation Computational Engineering: Elective Compulsory | | | | |
| Data Science: Specialisation III. Applications: Elective Compulsory | | | | |
| Environmental Engineering: Core Qualification: Elective Compulsory Process Engineering: Specialisation Process Engineering: Elective Compulsory | | | | |
| Water and Environmental Engineering: Specialisation Process Engineering: Elective Compulsory | | | | |
| Water and Environmental Engineering: Specialisation Environment: Elective Compulsory Water and Environmental Engineering: Specialisation Environment: Elective Compulsory | | | | |
| Water and Environmental Engineering: Specialisation Water: Elective Compulsory | | | | |

| Course L3347: Methods in Climate Informed Engineering | | | |
|---|---|--|--|
| Тур | Lecture | | |
| Hrs/wk | 3 | | |
| СР | 3 | | |
| Workload in Hours | Independent Study Time 48, Study Time in Lecture 42 | | |
| Lecturer | Prof. Nima Shokri, Prof. Cathy Hohenegger, Prof. Irina Smirnova | | |
| Language | EN | | |
| Cycle | WiSe | | |
| Content | Students will learn techniques for incorporating climate data and environmental factors into engineering design. It covers climate modelling and the use of sensors and devices to measure climate-related parameters and engineering processes. Students will have the opportunity to conduct their own measurements, analyze the collected data, and write a report on their findings. This hands-on experience will be assessed and contribute to their final grade. | | |
| Literature | | | |

| Course L3348: Topics in Climate Informed Engineering | | | |
|--|--|--|--|
| Тур | Lecture | | |
| Hrs/wk | 3 | | |
| СР | 3 | | |
| Workload in Hours | Independent Study Time 48, Study Time in Lecture 42 | | |
| Lecturer | Prof. Irina Smirnova, Prof. Cathy Hohenegger, Prof. Nima Shokri | | |
| Language | EN | | |
| Cycle | WiSe | | |
| Content | Exploring specific applications of climate data in various engineering disciplines. Invited speakers will present their research and discuss the relevance of climate-informed engineering to their work. Additionally, there will be a segment on effective communication, covering how to give impactful presentations and write research papers. Students will also give presentations on their own class projects related to climate-informed engineering, applying the concepts they've learned. This hands-on experience will be assessed and contribute to their final grade. | | |
| Literature | | | |

| Engineering" | | | | |
|--------------------------|--|---------------------------------------|----------------------|---------------------|
| Module M2156: Wate | r Protection | | | |
| Courses | | | | |
| Title | | Тур | Hrs/wk | СР |
| Water Protection (L3459) | | Integrated Lecture | 6 | 6 |
| Module Responsible | Prof. Simon Michael Papalexiou | | | |
| Admission Requirements | | | | |
| Recommended Previous | | | | |
| Knowledge | Basic knowledge in water management; | | | |
| | Good knowledge in urban drainage; | | | |
| | Good knowledge of wastewater treatment techniq | | | |
| | Good knowledge of pollutants (e.g. COD, BOD, TS, | N, P) and their properties; | | |
| Educational Objectives | After taking part successfully, students have reached the | following learning results | | |
| Professional Competence | | | | |
| | The students can describe the basic principles of the reg | ulatory framework related to the | international and Eu | ropean water sector |
| | They can explain limnological processes, substance cy | | | |
| | problems related to water protection, such as ecosyste | m service and wastewater treat | ment with a special | focus on innovative |
| | solutions, remediation measures as well as conceptual ap | oproaches. | | |
| Chille | Students can accurately assess current problems and sit | tuations in a country specific or l | acal context They a | an suggest concrete |
| JKIIIS | actions to contribute to the planning of tomorrow's ur | | - | |
| | administrative and legislative solutions to solve these pro- | | ney can suggest a | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| Personal Competence | | | | |
| Social Competence | The students can work together in international groups. | | | |
| | | | | |
| | | | | |
| | | | | |
| Autonomy | Students are able to organize their work flow to prepare | presentations and discussions. | They can acquire ap | propriate knowledge |
| | by making enquiries independently. | | - J | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| Workload in Hours | Independent Study Time 96, Study Time in Lecture 84 | | | |
| Credit points | | | | |
| Course achievement | Compulsory Bonus Form Descri | ption | | |
| | Yes 20 % Presentation 10-mi | inütige Präsentation von Arbeitser | gebnissen | |
| Examination | Written exam | | | |
| Examination duration and | 150 minutes | | | |
| scale | | | | |
| Assignment for the | Civil Engineering: Specialisation Coastal Engineering: Ele | ctive Compulsory | | |
| Following Curricula | Civil Engineering: Specialisation Geotechnical Engineerin | g: Elective Compulsory | | |
| | Civil Engineering: Specialisation Structural Engineering: E | Elective Compulsory | | |
| | Civil Engineering: Specialisation Water and Traffic: Elective | ve Compulsory | | |
| | Environmental Engineering: Specialisation Water Quality | and Water Engineering: Elective | Compulsory | |
| | International Management and Engineering: Specialisation | on II. Civil Engineering: Elective Co | mpulsory | |
| | Water and Environmental Engineering: Specialisation Citi | | | |
| | Water and Environmental Engineering: Specialisation Env | | | |
| | Water and Environmental Engineering: Specialisation Wa | ter: Elective Compulsory | | |

| Course L3459: Water Protection | | | |
|--------------------------------|---|--|--|
| Тур | ntegrated Lecture | | |
| Hrs/wk | 6 | | |
| СР | 6 | | |
| Workload in Hours | Independent Study Time 96, Study Time in Lecture 84 | | |
| Lecturer | Prof. Simon Michael Papalexiou | | |
| Language | EN | | |
| Cycle | WiSe | | |
| Content | | | |
| Literature | | | |

| | rtainty Modelling | | | | | |
|--|--|---|---|---|---|---|
| ourses | | | | | | |
| itle | | | Ту | p | Hrs/wk | СР |
| ncertainty Modelling for Engineer | rs (L3458) | | Inte | egrated Lecture | 6 | 6 |
| Module Responsible | Prof. Simon Michael Pa | ipalexiou | | | | |
| Admission Requirements | None | | | | | |
| Recommended Previous Knowledge | 1. General familiar | rity with engineering bability and statistics | concepts. s, and mathematical skills | | | |
| | - | skills for handling da ng engineering probl | ata. lems using statistical and | probabilistic methods | 5. | |
| Educational Objectives | After taking part succe | essfully, students hav | ve reached the following lo | earning results | | |
| Professional Competence | | | | | | |
| | introduces probability probability distribution uncertainty in enginee decision-making and p and disutility and learn | as a measure of un as, extreme value the ering problems. The predictive modeling. In how to apply Bayes | n in uncertainty, probabil ncertainty, covering frequ neory, joint probability dis course also covers linea Additionally, students wil sian Decision Theory to op able to apply probabilistic | uency-based method stributions, and stoch r and nonlinear regr I gain insight into ris timize engineering so | s. Students will explo nastic optimization to ession methods, esse sk assessment as a fu olutions under uncerta | ore Bayes' Theore model and quan ential for data-driv unction of probabi ainty. |
| JAINS | problems. They will ga inference to real-world enabling them to analy | ain expertise in fitti d engineering chall yze complex engine | ng probability distribution enges. Students will also ering datasets and improv ethods and optimization t | s, performing extrem develop skills in lin ve risk predictions. Th | ne value analysis, an near and nonlinear r nrough hands-on com | d applying Bayes regression modeli putational exercis |
| Personal Competence | | | | | | |
| Social competence | effectively with peers, | | k collaboratively on eng | | | |
| 4.6000 | uncertainty quantifica challenges. | | engineering analyses a | re both rigorous an | d applicable to real- | -world infrastruct |
| Autonomy | uncertainty quantifica challenges. Students will learn to i distributions, regressio | independently analy on methods, and sto natural and human-n | | re both rigorous an g uncertainties, selec arious applications. T | d applicable to real- cting and applying ap They will also gain th | world infrastruct |
| | uncertainty quantifica challenges. Students will learn to i distributions, regressic risks associated with n | independently analy on methods, and sto natural and human-n iter mitigation. | engineering analyses a vze and model engineerin ochastic techniques for va nade hazards, ensuring th | re both rigorous an g uncertainties, selec arious applications. T | d applicable to real- cting and applying ap They will also gain th | world infrastruct |
| Workload in Hours | uncertainty quantifica challenges. Students will learn to i distributions, regressio risks associated with n assessment, and disas Independent Study Tim | independently analy on methods, and sto natural and human-n iter mitigation. | engineering analyses a vze and model engineerin ochastic techniques for va nade hazards, ensuring th | re both rigorous an g uncertainties, selec arious applications. T | d applicable to real- cting and applying ap They will also gain th | world infrastruct |
| | uncertainty quantifica challenges. Students will learn to i distributions, regressic risks associated with n assessment, and disas Independent Study Tim 6 | independently analy on methods, and sto natural and human-n iter mitigation. | engineering analyses a vze and model engineerin ochastic techniques for va nade hazards, ensuring th | re both rigorous an g uncertainties, selec arious applications. T | d applicable to real- cting and applying ap They will also gain th | world infrastruct |
| Workload in Hours Credit points | uncertainty quantifica challenges. Students will learn to i distributions, regressic risks associated with n assessment, and disas Independent Study Tim 6 | independently analy on methods, and sto natural and human-n ter mitigation. ne 96, Study Time in | engineering analyses a rze and model engineerin ochastic techniques for va nade hazards, ensuring th Lecture 84 Description | re both rigorous an g uncertainties, selec arious applications. T | d applicable to real- cting and applying ap They will also gain th ed engineering decisio | world infrastruct |
| Workload in Hours Credit points | uncertainty quantification challenges. Students will learn to it distributions, regression risks associated with m assessment, and disas Independent Study Tim 6 Compulsory Bonus Yes 20 % | independently analy on methods, and sto natural and human-n- ter mitigation. ne 96, Study Time in Form | engineering analyses a rze and model engineerin ochastic techniques for va nade hazards, ensuring th Lecture 84 Description | re both rigorous an g uncertainties, selec arious applications. T ney can make informe | d applicable to real- cting and applying ap They will also gain th ed engineering decisio | world infrastruct |
| Workload in Hours Credit points Course achievement | uncertainty quantifica challenges. Students will learn to i distributions, regressio risks associated with n assessment, and disas Independent Study Tim 6 Compulsory Bonus Yes 20 % Written exam | independently analy on methods, and sto natural and human-n- ter mitigation. ne 96, Study Time in Form | engineering analyses a rze and model engineerin ochastic techniques for va nade hazards, ensuring th Lecture 84 Description | re both rigorous an g uncertainties, selec arious applications. T ney can make informe | d applicable to real- cting and applying ap They will also gain th ed engineering decisio | world infrastruct |
| Workload in Hours Credit points Course achievement Examination | uncertainty quantifica challenges. Students will learn to i distributions, regressio risks associated with n assessment, and disas Independent Study Tim 6 Compulsory Bonus Yes 20 % Written exam | independently analy on methods, and sto natural and human-n- ter mitigation. ne 96, Study Time in Form | engineering analyses a rze and model engineerin ochastic techniques for va nade hazards, ensuring th Lecture 84 Description | re both rigorous an g uncertainties, selec arious applications. T ney can make informe | d applicable to real- cting and applying ap They will also gain th ed engineering decisio | world infrastruct |
| Workload in Hours Credit points Course achievement Examination Examination duration and | uncertainty quantifica challenges. Students will learn to i distributions, regressio risks associated with n assessment, and disas Independent Study Tim 6 Compulsory Bonus Yes 20 % Written exam 150 min | independently analy on methods, and sto natural and human-m iter mitigation. ne 96, Study Time in Presentation | engineering analyses a rze and model engineerin ochastic techniques for va nade hazards, ensuring th Lecture 84 Description | re both rigorous an g uncertainties, selec arious applications. T ney can make informe entation von Arbeitse | d applicable to real- cting and applying ap They will also gain th ed engineering decisio | world infrastruct |
| Workload in Hours Credit points Course achievement Examination Examination duration and scale | uncertainty quantification challenges. Students will learn to it distributions, regression risks associated with m assessment, and disast Independent Study Tim 6 Compulsory Bonus Yes 20 % Written exam 150 min Civil Engineering: Spec Civil Engineering: Spec | independently analy on methods, and sto natural and human-n iter mitigation. ne 96, Study Time in Form Presentation Cialisation Coastal Er cialisation Geotechni | engineering analyses a rze and model engineerin ochastic techniques for va nade hazards, ensuring th Lecture 84 Description 10-minütige Präs | re both rigorous an g uncertainties, selec arious applications. T eey can make informe entation von Arbeitse ulsory Compulsory | d applicable to real- cting and applying ap They will also gain th ed engineering decisio | world infrastruct |
| Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the | uncertainty quantification challenges. Students will learn to it distributions, regression risks associated with m assessment, and disass Independent Study Tim 6 Compulsory Bonus Yes 20 % Written exam 150 min Civil Engineering: Spec Civil Engineering: Spec | independently analy on methods, and sto natural and human-n- ter mitigation. ne 96, Study Time in Presentation Presentation | engineering analyses an rze and model engineerin ochastic techniques for va nade hazards, ensuring th Lecture 84 Description 10-minütige Präs ngineering: Elective Comp cal Engineering: Elective Comp | re both rigorous an g uncertainties, selec arious applications. T ney can make informe entation von Arbeitse ulsory Compulsory npulsory | d applicable to real- cting and applying ap They will also gain th ed engineering decisio | world infrastruct |
| Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the | uncertainty quantifica challenges. Students will learn to i distributions, regressio risks associated with n assessment, and disas Independent Study Tim 6 Compulsory Bonus Yes 20 % Written exam 150 min Civil Engineering: Spec Civil Engineering: Spec Civil Engineering: Spec | independently analy on methods, and sto natural and human-n- ter mitigation. ne 96, Study Time in Presentation Cialisation Coastal Er cialisation Geotechni cialisation Structural cialisation Computat | engineering analyses an rze and model engineerin ochastic techniques for va nade hazards, ensuring th Lecture 84 Description 10-minütige Präs ngineering: Elective Comp cal Engineering: Elective Comp ional Engineering: Elective | re both rigorous an g uncertainties, selec arious applications. T ney can make informe entation von Arbeitse ulsory Compulsory e Compulsory | d applicable to real- cting and applying ap They will also gain th ed engineering decision | world infrastruct |
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| Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the | uncertainty quantifica challenges. Students will learn to i distributions, regressio risks associated with n assessment, and disas Independent Study Tim 6 Compulsory Bonus Yes 20 % Written exam 150 min Civil Engineering: Spec Civil Engineering: Spec Civil Engineering: Spec Civil Engineering: Spec Civil Engineering: Spec Civil Engineering: Spec | independently analy on methods, and sto natural and human-n- iter mitigation. ne 96, Study Time in Form Presentation Cialisation Coastal Er cialisation Geotechni cialisation Structural cialisation Computat cialisation Water and cialisation Coastal Er | engineering analyses an rze and model engineerin ochastic techniques for va nade hazards, ensuring th o Lecture 84 Description 10-minütige Präs ngineering: Elective Comp cal Engineering: Elective Com ional Engineering: Elective I Traffic: Elective Compuls | re both rigorous an g uncertainties, selec arious applications. T ney can make informe entation von Arbeitse ulsory Compulsory npulsory e Compulsory ory ulsory | d applicable to real- cting and applying ap They will also gain th ed engineering decision | world infrastruct |
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| Course L3458: Uncertainty M | Iodelling for Engineers |
|-----------------------------|---|
| Тур | Integrated Lecture |
| Hrs/wk | 6 |
| СР | 6 |
| Workload in Hours | Independent Study Time 96, Study Time in Lecture 84 |
| Lecturer | Prof. Simon Michael Papalexiou |
| Language | EN |
| Cycle | SoSe |
| Content | Engineering decisions are rarely made with complete certainty—uncertainty affects material properties, environmental conditions, structural performance, and risk assessments. This course provides students with theoretical foundations and practical tools to quantify uncertainty, assess risks, and enhance decision-making in civil, structural, geotechnical, and environmental engineering applications. Students will begin with fundamental probability concepts, learning how Bayes' Theorem, probability distributions, and extreme value theory help evaluate engineering uncertainties. They will explore linear and nonlinear regression methods for analyzing complex datasets, as well as joint probability distributions and stochastic optimization to improve predictive modeling and reliability assessments. The course also introduces Bayesian Decision Theory, offering a structured approach to decision-making under uncertainty. With a focus on real-world engineering problems, students will apply probabilistic models, extreme value analysis, and stochastic techniques to assess risks in infrastructure design, system reliability, and disaster resilience. Hands-on computational exercises will reinforce key concepts, preparing students to work with data-driven models and uncertainty quantification techniques used in engineering practice. This course is ideal for students interested in engineering risk assessment, reliability analysis, and data-driven modeling. By the end of the course, students will have developed critical analytical and problem-solving skills, equipping them for careers in structural safety, geotechnical engineering, environmental risk management, and beyond. |
| Literature | |
Specialization Environment

| Module M0581: Wate | * Drotostion | | | |
|-----------------------------------|---|--|-----------------------|----------------------|
| Module M0561: Wale | refotection | | | |
| Courses | | | | |
| Title | | Тур | Hrs/wk | СР |
| Water Protection and Wastewater I | - | Lecture | 3 | 3 |
| Water Protection and Wastewater I | - | Project Seminar | 3 | 3 |
| Module Responsible | | | | |
| Admission Requirements | None | | | |
| Recommended Previous | Basic knowledge in water management; | | | |
| Knowledge | Good knowledge in urban drainage; | | | |
| | Good knowledge of wastewater treatment | nt techniques; | | |
| | Good knowledge of pollutants (e.g. COD, | BOD, TS, N, P) and their properties; | | |
| Educational Objectives | After taking part successfully, students have re | ached the following learning results | | |
| Professional Competence | | | | |
| Knowledge | The students can describe the basic principles | of the regulatory framework related to the | international and Eu | ropean water sector. |
| | They can explain limnological processes, sub | | - | |
| | problems related to water protection, such as | • | ment with a special | focus on innovative |
| | solutions, remediation measures as well as con | ceptual approaches. | | |
| Skills | Students can accurately assess current proble | ms and situations in a country-specific or | local context. They c | an suggest concrete |
| | actions to contribute to the planning of tome | | they can suggest ap | propriate technical, |
| | administrative and legislative solutions to solve | e these problems. | | |
| | | | | |
| | | | | |
| | | | | |
| Personal Competence | | | | |
| Social Competence | The students can work together in internationa | l groups. | | |
| | | | | |
| | | | | |
| | | | | |
| Autonomy | Students are able to organize their work flow | to prepare presentations and discussions. | They can acquire ap | propriate knowledge |
| | by making enquiries independently. | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| Workload in Hours | Independent Study Time 96, Study Time in Lec | ture 84 | | |
| Credit points | | | | |
| Course achievement | None | | | |
| Examination | Presentation | | | |
| Examination duration and | Term paper plus presentation | | | |
| scale | | | | |
| Assignment for the | 5 5 1 5 | • • • | | |
| Following Curricula | Civil Engineering: Specialisation Geotechnical E | • • • • | | |
| | Civil Engineering: Specialisation Coastal Engine Civil Engineering: Specialisation Water and Tra | • • • | | |
| | Environmental Engineering: Specialisation Water and Tra | | Compulsorv | |
| | International Management and Engineering: Sp | . , | | |
| | Water and Environmental Engineering: Speciali | | | |
| | Water and Environmental Engineering: Speciali | sation Water: Elective Compulsory | | |
| | Water and Environmental Engineering: Speciali | sation Environment: Compulsory | | |

| Course L0226: Water Protection and Wastewater Management | | |
|--|---|--|
| Тур | Lecture | |
| Hrs/wk | 3 | |
| CP | 3 | |
| Workload in Hours | Independent Study Time 48, Study Time in Lecture 42 | |
| Lecturer | Prof. Ralf Otterpohl | |
| Language | EN | |
| Cycle | WiSe | |
| Content | The lecture focusses on: | |
| | Regulatory Framework (e.g. WFD) Main instruments for the water management and protection In depth knowledge of relevant measures of water pollution control Urban drainage, treatment options in different regions on the world Rainwater management, improved management of heavy rainfalls, downpours, rainwater harvesting, rainwater infiltration Case Studies and Field Trips | |
| Literature | The literature listed below is available in the library of the TUHH. Water and wastewater technology Hammer, M. J. 1., & . (2012). (7. ed., internat. ed.). Boston [u.a.]: Pearson Education International. Water and wastewater engineering : design principles and practice: Davis, M. L. 1. (2011) New York, NY: McGraw-Hill. Biological wastewater treatment: (2011). C. P. Leslie Grady, Jr. (3. ed.). London, Boca Raton, Fla. [u.a.]: IWA Publ. | |

| Course L2008: Water Protection and Wastewater Management | |
|--|---|
| Тур | Project Seminar |
| Hrs/wk | 3 |
| СР | 3 |
| Workload in Hours | Independent Study Time 48, Study Time in Lecture 42 |
| Lecturer | Prof. Ralf Otterpohl |
| Language | EN |
| Cycle | WiSe |
| Content | |
| Literature | |

| | e Treatment and Recycling | | | |
|------------------------------------|--|---------------------------------------|----------------|-------------------|
| Courses | | | | |
| Title | | Тур | Hrs/wk | СР |
| Planning of waste treatment plants | (L3267) | Project-/problem-based Learning | 3 | 3 |
| Recycling technologies and therma | | Lecture | 2 | 2 |
| Recycling technologies and therma | | Recitation Section (small) | 1 | 1 |
| Module Responsible | Prof. Kerstin Kuchta | | | |
| Admission Requirements | None | | | |
| Recommended Previous | Basics of thermo dynamics | | | |
| Knowledge | Basics of fluid dynamics | | | |
| | fluid dynamics chemistry | | | |
| | | | | |
| Educational Objectives | After taking part successfully, students have reached the foll | owing learning results | | |
| Professional Competence | | | | |
| Knowledge | The students can name, describe current issue and problem | ns in the field of waste treatment (n | nechanical, cl | nemical and thern |
| | and contemplate them in the context of their field. | | | |
| | The industrial application of unit operations as part of proces | s engineering is explained by actual | examples of | waste technologi |
| | Composition, particle sizes, transportation and dosing of wast | | | nable teenholog. |
| | | | | |
| | Students will be able to design and design waste treatment | technology equipment. | | |
| Skills | The students are able to select suitable processes for the tre | eatment of wastes or raw material w | ith respect to | their characteris |
| | and the process aims. They can evaluate the efforts and cost | | | |
| | | · | | |
| Personal Competence | | | | |
| Social Competence | Students can | | | |
| | respectfully work together as a team and discuss tech | nical tasks | | |
| | participate in subject-specific and interdisciplinary disc | | | |
| | develop cooperated solutions | | | |
| | promote the scientific development and accept profes | ssional constructive criticism. | | |
| | | | | |
| Autonomy | Students can independently tap knowledge of the subje | | | |
| | consultation with supervisors, to assess their learning level | | | |
| | targets for new application-or research-oriented duties in acc | cordance with the potential social, e | conomic and o | cultural impact. |
| Workload in Hours | Independent Study Time 96, Study Time in Lecture 84 | | | |
| Credit points | 6 | | | |
| Course achievement | None | | | |
| Examination | Written exam | | | |
| Examination duration and | 120 min | | | |
| scale | | | | |
| Assignment for the | Civil Engineering: Specialisation Water and Traffic: Elective C | ompulsory | | |
| Following Curricula | Bioprocess Engineering: Specialisation A - General Bioproces | s Engineering: Elective Compulsory | | |
| | Chemical and Bioprocess Engineering: Specialisation Genera | Process Engineering: Elective Com | oulsory | |
| | Chemical and Bioprocess Engineering: Specialisation Bioproc | ess Engineering: Elective Compulso | ry | |
| | Chemical and Bioprocess Engineering: Specialisation Chemic | al Process Engineering: Elective Cor | npulsory | |
| | Chemical and Bioprocess Engineering: Specialisation Chemic | al and Bio process Engineering: Elec | tive Compuls | ory |
| | Environmental Engineering: Specialisation Energy and Resou | | | |
| | International Management and Engineering: Specialisation II. | | llsory | |
| | Renewable Energies: Specialisation Bioenergy Systems: Elec | | | |
| | Process Engineering: Specialisation Chemical Process Engine | 3 1 3 | | |
| | Process Engineering: Specialisation Process Engineering: Electronic Spec | | | |
| | Process Engineering: Specialisation Environmental Process E | | | |
| | Water and Environmental Engineering: Specialisation Environ | | | |
| | Water and Environmental Engineering: Specialisation Cities: | Elective Compulsory | | |

| Course L3267: Planning of waste treatment plants | | |
|--|---|--|
| Тур | Project-/problem-based Learning | |
| Hrs/wk | 3 | |
| CP | 3 | |
| Workload in Hours | Independent Study Time 48, Study Time in Lecture 42 | |
| Lecturer | Prof. Rüdiger Siechau | |
| Language | EN | |
| Cycle | WiSe | |
| Content | The focus is on getting to know the organization and practice of waste management companies. Topics such as planning, financing and logistics will be discussed and there will be an excursion (waste incineration plant, vehicle fleet and collection systems / containers). Project based learning: You will be given a task to work on independently in groups of 4 to 6 students. All tools and data needed for the project work will be discussed in the lecture "Recycling Technologies and Thermal Waste Treatment". Course documents can be downloaded from StudIP. Communication during the project work also takes place via StudIP. | |
| Literature | Einführung in die Abfallwirtschaft; Martin Kranert, Klaus Cord-Landwehr (Hrsg.); Vieweg + Teubner Verlag; 2010 PowerPoint Präsentationen in Stud IP | |

| Course L3265: Recycling technologies and thermal waste treatment | | |
|--|---|--|
| Тур | Lecture | |
| Hrs/wk | 2 | |
| СР | 2 | |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 | |
| Lecturer | Prof. Kerstin Kuchta | |
| Language | EN | |
| Cycle | WiSe | |
| Content | Introduction, actual state-of-the-art of waste incineration, aims. legal background, reaction principals basics of incineration processes: waste composition, calorific value, calculation of air demand and flue gas composition Incineration techniques: grate firing, ash transfer, boiler Flue gas cleaning: Volume, composition, legal frame work and emission limits, dry treatment, scrubber, de-nox techniques, dioxin elimination, Mercury elimination Ash treatment: Mass, quality, treatment concepts, recycling, disposal | |
| Literature | Thomé-Kozmiensky, K. J. (Hrsg.): Thermische Abfallbehandlung Bande 1-7. EF-Verlag für Energie- und Umwelttechnik, Berlin, 196 - 2013. | |

| Course L3266: Recycling technologies and thermal waste treatment | |
|--|---|
| Тур | Recitation Section (small) |
| Hrs/wk | 1 |
| СР | 1 |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 |
| Lecturer | Prof. Kerstin Kuchta |
| Language | EN |
| Cycle | WiSe |
| Content | See interlocking course |
| Literature | See interlocking course |

| Linginieering | | | | |
|--------------------------------|--|---|--|-------------------------|
| Module M0513: Syste | m Aspects of Renewable Energies | | | |
| Courses | | | | |
| | | True | Une (colo | CD |
| Title | as: Now Materials for Energy Production and Storage (10021) | Typ Lecture | Hrs/wk | CP 2 |
| Energy Trading (L0019) | ge: New Materials for Energy Production and Storage (L0021) | Lecture | 2 | 1 |
| Energy Trading (L0020) | | Recitation Section (small) | 1 | 1 |
| Deep Geothermal Energy (L0025) | | Lecture | 2 | 2 |
| Module Responsible | Prof. Martin Kaltschmitt | | | |
| Admission Requirements | None | | | |
| Recommended Previous | Module: Technical Thermodynamics I | | | |
| Knowledge | Module: Technical Thermodynamics II | | | |
| | Module: rechnical merhodynamics in | | | |
| Educational Objectives | After taking part successfully, students have reached the f | ollowing learning results | | |
| Professional Competence | | | | |
| Knowledge | Students are able to describe the processes in energy trad | ing and the design of energy man | rkets and can critic | ally evaluate them ir |
| | relation to current subject specific problems. Further | more, they are able to expla | in the basics of | thermodynamics of |
| | electrochemical energy conversion in fuel cells and can e | stablish and explain the relation | ship to different ty | pes of fuel cells and |
| | their respective structure. Students can compare this tech | nology with other energy storage | e options. In additio | on, students can give |
| | an overview of the procedure and the energetic involveme | nt of deep geothermal energy. | | |
| | | | | |
| Skills | Students can apply the learned knowledge of storage syste | ems for excessive energy to expl | ain for various ener | rgy systems different |
| | approaches to ensure a secure energy supply. In particu | llar, they can plan and calculate | e domestic, comm | ercial and industrial |
| | heating equipment using energy storage systems in an e | nergy-efficient way and can ass | ess them in relation | on to complex power |
| | systems. In this context, students can assess the potent | ial and limits of geothermal po | wer plants and ex | plain their operating |
| | mode. | | | |
| | Furthermore, the students are able to explain the procedu | res and strategies for marketing | of energy and appl | lv it in the context of |
| | other modules on renewable energy projects. In this cont | | | |
| | markets and energy trades. | · · · · · · · · · · · · · · · · · · · | · · · , · · · · | j |
| | | | | |
| Personal Competence | | | | |
| Social Competence | Students are able to discuss issues in the thematic fields in | i the renewable energy sector ad | idressed within the | module. |
| Autonomy | Students can independently exploit sources , acquire the | e particular knowledge about the | e subject area and | transform it to new |
| | questions. | | | |
| Werkland in Heure | Independent Study Time 06, Study Time in Lecture 04 | | | |
| Credit points | Independent Study Time 96, Study Time in Lecture 84 | | | |
| Course achievement | | | | |
| | Written exam | | | |
| Examination duration and | | | | |
| scale | | | | |
| | Bioprocess Engineering: Specialisation A - General Bioproc | ess Engineering: Elective Compu | lsory | |
| • | Aircraft Systems Engineering: Core Qualification: Elective (| | - | |
| i showing curricula | | | | |
| i onowing curricula | International Management and Engineering: Specialisation | II. Renewable Energy: Elective C | ompulsory | |
| . chowing current | International Management and Engineering: Specialisation International Management and Engineering: Specialisation | 3, | 1 | Compulsory |
| . c.coming curricula | 5 | II. Energy and Environmental En | gineering: Elective | |
| | International Management and Engineering: Specialisation | II. Energy and Environmental En | gineering: Elective | |
| . c.ioning curitula | International Management and Engineering: Specialisation International Management and Engineering: Specialisation | II. Energy and Environmental En | gineering: Elective | |
| . c.ioning curitula | International Management and Engineering: Specialisation International Management and Engineering: Specialisation Aeronautics: Core Qualification: Elective Compulsory | II. Energy and Environmental En II. Process Engineering and Biote | gineering: Elective | |
| . c.ioning curricula | International Management and Engineering: Specialisation International Management and Engineering: Specialisation Aeronautics: Core Qualification: Elective Compulsory Renewable Energies: Core Qualification: Compulsory | II. Energy and Environmental En II. Process Engineering and Biote Systems: Elective Compulsory | gineering: Elective echnology: Elective | |
| . c.ioning curitula | International Management and Engineering: Specialisation International Management and Engineering: Specialisation Aeronautics: Core Qualification: Elective Compulsory Renewable Energies: Core Qualification: Compulsory Theoretical Mechanical Engineering: Specialisation Energy | II. Energy and Environmental En II. Process Engineering and Biote Systems: Elective Compulsory Engineering: Elective Compulsor | gineering: Elective echnology: Elective | |
| . c.ioning curitula | International Management and Engineering: Specialisation International Management and Engineering: Specialisation Aeronautics: Core Qualification: Elective Compulsory Renewable Energies: Core Qualification: Compulsory Theoretical Mechanical Engineering: Specialisation Energy Process Engineering: Specialisation Environmental Process | II. Energy and Environmental En II. Process Engineering and Biote Systems: Elective Compulsory Engineering: Elective Compulsor lective Compulsory | gineering: Elective echnology: Elective | |

| Course L0021: Fuel Cells, Batteries, and Gas Storage: New Materials for Energy Production and Storage | |
|---|--|
| Тур | Lecture |
| Hrs/wk | 2 |
| CP | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Prof. Michael Fröba |
| Language | DE |
| Cycle | SoSe |
| Content | Introduction to electrochemical energy conversion Function and structure of electrolyte Low-temperature fuel cell Types Thermodynamics of the PEM fuel cell Cooling and humidification strategy High-temperature fuel cell The MCFC The SOFC Integration Strategies and partial reforming Fuels Supply of fuel Reforming of natural gas and biogas Reforming of liquid hydrocarbons Energetic Integration and control of fuel cell systems |
| Literature | • Hamann, C.; Vielstich, W.: Elektrochemie 3. Aufl.; Weinheim: Wiley - VCH, 2003 |

| Course L0019: Energy Tradin | Ig |
|-----------------------------|---|
| Тур | Lecture |
| Hrs/wk | 1 |
| СР | 1 |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 |
| Lecturer | Robert Gersdorf |
| Language | DE |
| Cycle | SoSe |
| Content | Basic concepts and tradable products in energy markets Primary energy markets Electricity Markets European Emissions Trading Scheme Influence of renewable energy Real options Risk management Within the exercise the various tasks are actively discussed and applied to various cases of application. |
| Literature | |

| Course L0020: Energy Tradir | ourse L0020: Energy Trading | |
|-----------------------------|---|--|
| Тур | Recitation Section (small) | |
| Hrs/wk | 1 | |
| СР | 1 | |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 | |
| Lecturer | Robert Gersdorf | |
| Language | DE | |
| Cycle | SoSe | |
| Content | See interlocking course | |
| Literature | See interlocking course | |

| Course L0025: Deep Geother | mal Energy |
|----------------------------|---|
| Тур | Lecture |
| Hrs/wk | 2 |
| СР | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Dr. Ben Norden |
| Language | DE |
| Cycle | SoSe |
| Content | Introduction to the deep geothermal use Geological Basics I Geological Basics II Geology and thermal aspects Rock Physical Aspects Geochemical aspects Geochemical aspects Exploration of deep geothermal reservoirs Drilling technologies, piping and expansion Borehole Geophysics Underground system characterization and reservoir engineering Microbiology and Upper-day system components Adapted investment concepts, cost and environmental aspect |
| Literature | Dipippo, R.: Geothermal Power Plants: Principles, Applications, Case Studies and Environmental Impact. Butterworth Heinemann; 3rd revised edition. (29. Mai 2012) www.geo-energy.org Edenhofer et al. (eds): Renewable Energy Sources and Climate Change Mitigation; Special Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, 2012. Kaltschmitt et al. (eds): Erneuerbare Energien: Systemtechnik, Wirtschaftlichkeit, Umweltaspekte. Springer, 5. Aufl. 2013. Kaltschmitt et al. (eds): Energie aus Erdwärme. Spektrum Akademischer Verlag; Auflage: 1999 (3. September 2001) Huenges, E. (ed.): Geothermal Energy Systems: Exploration, Development, and Utilization. Wiley-VCH Verlag GmbH & Co. KGaA; Auflage: 1. Auflage (19. April 2010) |

| | It is to have to sha | | | |
|--|--|--|---------------|---------------------|
| Module M0827: Mode | ling in Water Management | | | |
| Courses | | | | |
| Title | ow (L0E42) | Тур | Hrs/wk | СР |
| Groundwater Modeling using Modfl Groundwater Modeling using Modfl | | Lecture Recitation Section (small) | 1 2 | 1 2 |
| Modeling of Water Supply Network | | Project-/problem-based Learning | 2 | 3 |
| Module Responsible | Dr. Klaus Johannsen | | | |
| Admission Requirements | None | | | |
| Recommended Previous | Groundwater | | | |
| Knowledge | groundwater hydraulics and transport o | f substances | | |
| | Pipe Systems | | | |
| | Knowledge on urban water infrastruct special structures | tures, in particular drinking water systemsand | urban drainag | e systems including |
| | Hydraulics of drinking water supply syst | tems and sewer systems | | |
| | Basic knowledge on water management | | | |
| Educational Objectives | After taking part successfully, students have re | eached the following learning results | | |
| Professional Competence | | | | |
| Knowledge | The students are able to describe the modelling of groundwater flow and transport as well as urban water infrastructures. They can carry out systems analyses and can detect technical and conceptual weak points within the systems in case studies. Besides they are able to analyse interdependencies of hydraulic and toxic phenomena in soil and water. | | | |
| Skills | The students are able to construct and apply scientific groundwater models indipendently. They can work on different scenarios and can compare or assess different solutions for existing problems by application of selected software products. The students are able to use different software solutions (e.g. EPANET, EPA-SWMM). | | | |
| Personal Competence | | | | |
| Social Competence | Wird nicht vermittelt. | | | |
| Autonomy | Wird nicht vermittelt. | | | |
| Workload in Hours | Independent Study Time 110, Study Time in L | ecture 70 | | |
| Credit points | 6 | | | |
| Course achievement | None | | | |
| Examination | Oral exam | | | |
| Examination duration and | 30 min | | | |
| scale | | | | |
| - | Civil Engineering: Specialisation Structural Eng | | | |
| Following Curricula | 5 5 1 | | | |
| | Civil Engineering: Specialisation Coastal Engin | | | |
| | Civil Engineering: Specialisation Water and Tra | | | |
| | Civil Engineering: Specialisation Computationa | | | |
| | Water and Environmental Engineering: Special | | | |
| | Water and Environmental Engineering: Special | | | |
| | Water and Environmental Engineering: Special | lisation Water: Elective Compulsory | | |

| Course L0543: Groundwater | Course L0543: Groundwater Modeling using Modflow | | |
|---------------------------|--|--|--|
| Тур | Lecture | | |
| Hrs/wk | 1 | | |
| СР | 1 | | |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 | | |
| Lecturer | Sonja Götz | | |
| Language | DE/EN | | |
| Cycle | SoSe | | |
| Content | Introduction and application of the groundwater model MODFLOW (PMWIN); theoretical backround of the modell, students do work | | |
| | with the model PMWIN for practical case studies. | | |
| Literature | MODFLOW-Handbuch | | |
| | Chiang, Wen Hsien: PMWIN | | |
| | | | |

| Course L0544: Groundwater | ourse L0544: Groundwater Modeling using Modflow | | |
|---------------------------|---|--|--|
| Тур | Recitation Section (small) | | |
| Hrs/wk | 2 | | |
| СР | 2 | | |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 | | |
| Lecturer | Sonja Götz | | |
| Language | DE/EN | | |
| Cycle | SoSe | | |
| Content | See interlocking course | | |
| Literature | See interlocking course | | |

| Course L0875: Modeling of W | ourse L0875: Modeling of Water Supply Network | | |
|-----------------------------|--|--|--|
| Тур | Project-/problem-based Learning | | |
| Hrs/wk | 2 | | |
| СР | 3 | | |
| Workload in Hours | Independent Study Time 62, Study Time in Lecture 28 | | |
| Lecturer | Dr. Klaus Johannsen | | |
| Language | DE | | |
| Cycle | SoSe | | |
| Content | | | |
| Literature | Mutschmann/Stimmelmayr: Taschenbuch der Wasserversorgung, 16. Auflage. Springer Vieweg - Verlag. Wiesbaden 2014. | | |

| Module M0828: Urbar | n Environmental Management | | | |
|-------------------------------|---|----------------------------------|-----------------|--------------------|
| Courses | | | | |
| Title | Ту | /p | Hrs/wk | СР |
| Noise Protection (L1109) | - | cture | 2 | 2 |
| Urban Infrastructures (L0874) | Pro | oject-/problem-based Learning | 2 | 4 |
| Module Responsible | Dr. Dorothea Rechtenbach | | | |
| Admission Requirements | None | | | |
| Recommended Previous | e Knowledge en Urban planning | | | |
| Knowledge | Knowledge on Urban planning Knowledge on measures for slimate protection | | | |
| | Knowledge on measures for climate protection General knowledge of scientific writing/working | | | |
| | | | | |
| Educational Objectives | After taking part successfully, students have reached the following I | earning results | | |
| Professional Competence | | | | |
| Knowledge | Students can describe urban development corridors as well as curre | ent and future urban environr | nental probler | ns. They are able |
| | explain the causes of environmental problems (like noise). | | | |
| | Students can specify applications for various technical innovations | and explain why these contril | oute to the im | provement of urba |
| | life. They can, for example, derive and discuss measures for effective | ve noise abatement. | | |
| Skille | Students are able to develop specific solutions for correcting | existing or future environ | mont-related | problems of urb |
| SKIIIS | development. They can define a range of conceptual and technical | ÷ | | |
| | paths. To solve specific urban environmental problems they can so | | | |
| | context. | | ia incegnate e | |
| Personal Competence | | | | |
| | The students can work together in international groups. | | | |
| | | <i>.</i> | | |
| Autonomy | Students are able to organize their work flow to prepare themselve | | ributions to th | e discussions. The |
| | can acquire appropriate knowledge by making enquiries independer | ntly. | | |
| Workload in Hours | Independent Study Time 124, Study Time in Lecture 56 | | | |
| Credit points | 6 | | | |
| Course achievement | None | | | |
| Examination | Written elaboration | | | |
| Examination duration and | Written Report plus oral Presentation | | | |
| scale | | | | |
| Assignment for the | Civil Engineering: Specialisation Structural Engineering: Elective Cor | mpulsory | | |
| Following Curricula | Civil Engineering: Specialisation Geotechnical Engineering: Elective | Compulsory | | |
| | Civil Engineering: Specialisation Coastal Engineering: Elective Comp | oulsory | | |
| | Civil Engineering: Specialisation Water and Traffic: Elective Compuls | sory | | |
| | Environmental Engineering: Core Qualification: Elective Compulsory | | | |
| | Joint European Master in Environmental Studies - Cities and Sustaina | ability: Core Qualification: Cor | npulsory | |
| | Logistics, Infrastructure and Mobility: Specialisation Infrastructure and | nd Mobility: Elective Compuls | ory | |
| | Water and Environmental Engineering: Specialisation Environment: | Elective Compulsory | | |
| | Water and Environmental Engineering: Specialisation Cities: Compu | lsory | | |

| Course L1109: Noise Protection | | |
|--------------------------------|--|--|
| Тур | Lecture | |
| Hrs/wk | 2 | |
| СР | 2 | |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 | |
| Lecturer | Prof. Martin Jäschke | |
| Language | EN | |
| Cycle | SoSe | |
| Content | | |
| Literature | 1) Müller & Möser (2013): Handbook of Engineering Acoustics (also available in German) | |
| | 2) WHO (1999): Guidelines for Community Noise | |
| | 3) Environmental Noise Directive 2002/49/EG | |
| | 4) ISO 9613-2 (1996): Acoustics, Attenuation of sound during propagation outdoors, Part 2: General method of calculation | |

| Course L0874: Urban Infrastructures | | |
|-------------------------------------|---|--|
| Тур | Project-/problem-based Learning | |
| Hrs/wk | 2 | |
| СР | 4 | |
| Workload in Hours | Independent Study Time 92, Study Time in Lecture 28 | |
| Lecturer | Dr. Dorothea Rechtenbach | |
| Language | EN | |
| Cycle | SoSe | |
| Content | Problem Based Learning | |
| | Aain topics are: Central vs. Decentral Wastewater Treatment. Compaction of Cities. Car Free Cities. Multifunctional Places in Cities. The Sustainability of Freight Transport in Cities. | |
| Literature | Depends on chosen topic. | |

| Medule M0070: Mana | noment of Curfree Water | | | |
|--------------------------------------|--|---|--------------------|-----------------------|
| Module M0070: Malia | gement of Surface Water | | | |
| Courses | | | | |
| Title | | Тур | Hrs/wk | СР |
| Modelling of Flow in Rivers and Este | uaries (L0810) | Lecture | 3 | 4 |
| Nature-Oriented Hydraulic Enginee | ring / Integrated Flood Protection (L0961) | Project-/problem-based Learni | ng 2 | 2 |
| Module Responsible | Prof. Peter Fröhle | | | |
| Admission Requirements | None | | | |
| Recommended Previous | Fundamentals of Hydromechanics, Hydraulics, Hy | drology and Hydraulic Engineering; Hy | draulic Engineer | ing I and Hydraulic |
| Knowledge | Engineering II | | | |
| Educational Objectives | After taking part successfully, students have reache | d the following learning results | | |
| Professional Competence | | | | |
| Knowledge | Students are able to define in detail the basic pr | ocesses that are related to the modelli | ng of flows in hy | draulic engineering. |
| | Besides, they can describe the basic aspects of nur | merical modelling and actual numerical n | nodels for the sin | nulation of flows and |
| | waves. They can also depict the concepts of nature | oriented hydraulic engineering. | | |
| Chille | Students are able to apply bydrodynamic nymerical | models to practical budraulis engineering | tooks Furtherm | are the students are |
| SKIIIS | Students are able to apply hydrodynamic-numerical able to set up flood-risk management concepts and | | - | |
| | able to set up nood-lisk management concepts and | | | ai problems. |
| Personal Competence | | | | |
| Social Competence | The students are able to deploy their gained knowl | edge in applied problems of the practica | I nature-based h | ydraulic engineering. |
| | Additionaly, they will be able to work in team with e | ngineers of other disciplines. | | |
| Autonomy | The students will be able to independently extend the | neir knowledge and apply it to new proble | ms. | |
| Workload in Hours | Independent Study Time 110, Study Time in Lecture | : 70 | | |
| Credit points | 6 | | | |
| Course achievement | None | | | |
| Examination | Written exam | | | |
| Examination duration and | The duration of the examination is 150 min. The | examination includes tasks with respect | to the general u | understanding of the |
| scale | lecture contents and calculations tasks. | | | |
| Assignment for the | Civil Engineering: Specialisation Water and Traffic: C | Compulsory | | |
| Following Curricula | Environmental Engineering: Core Qualification: Elect | tive Compulsory | | |
| | Joint European Master in Environmental Studies - Cit | ies and Sustainability: Core Qualification: | Compulsory | |
| | Water and Environmental Engineering: Specialisatio | n Water: Compulsory | | |
| | Water and Environmental Engineering: Specialisatio | n Environment: Compulsory | | |
| | Water and Environmental Engineering: Specialisatio | n Cities: Elective Compulsory | | |

| Course L0810: Modelling of F | low in Rivers and Estuaries |
|------------------------------|--|
| Тур | Lecture |
| Hrs/wk | 3 |
| CP | 4 |
| Workload in Hours | Independent Study Time 78, Study Time in Lecture 42 |
| Lecturer | Prof. Edgar Nehlsen, Prof. Peter Fröhle |
| Language | EN |
| Cycle | SoSe |
| Content | Introduction to numerical flow modelling |
| | Processes affecting tht flow |
| | Examples and applications of numerical models |
| | Procedure of numerical modelling |
| | Model concept |
| | Basic equations of hydrodynamics |
| | |
| | Saint-Venant equations Euler Equations |
| | Navier-Stokes equations |
| | Reynolds-averaged Navier-Stokes equations |
| | Shallow water equations |
| | |
| | Solving schemes |
| | |
| | Numerical discretization |
| | Solution algorithms |
| | Convergence |
| | |
| Literature | Vorlesungsskript |
| | Literaturempfehlungen |
| | Literaturempfehlungen |
| | |
| | Bund der Ingenieure für Wasserwirtschaft, Abfallwirtschaft und Kulturbau (1997): Hydraulische Berechnung von naturnahen |
| | Fließgewässern. Düsseldorf: BWK (BWK-Merkblatt). |
| | Chow, Ven-te (1959): Open-channel Hydraulics. New York usw.: McGraw-Hill (McGraw-Hill Civil Engineering Series). |
| | |
| | Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische Modelle, DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019a): Merkblatt DWA-M 543-2 Geodaten in der |
| | Fließgewässermodellierung Teil 1: Geodaten in der Fließgewässermodellierung. Februar 2019. Hennef: Deutsche Vereinigung für |
| | Wasserwirtschaft, Abwasser und Abfall (DWA-Regelwerk, 543-1). |
| | |
| | Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische Modelle, DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019b): Merkblatt DWA-M 543-2 Geodaten in der |
| | Fließgewässermodellierung Teil 2: Bedarfsgerechte Datenerfassung und -aufbereitung. Februar 2019. Hennef: Deutsche |
| | Vereinigung für Wasserwirtschaft, Abwasser und Abfall (DWA-Regelwerk, 543-2). |
| | |
| | Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische Modelle, DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019c): Merkblatt DWA-M 543-3 Geodaten in der |
| | Fließgewässermodellierung - Teil 3: Aspekte der Strömungsmodellierung und Fallbeispiele. Februar 2019. Hennef: Deutsche |
| | Vereinigung für Wasserwirtschaft, Abwasser und Abfall (DWA-Regelwerk, 543-3). |
| | |
| | Hervouet, Jean-Michel (2007): Hydrodynamics of free surface flows. Modelling with the finite element method. Chichester: Wiley. Online verfügbar unter http://www.loc.gov/catdir/enhancements/fy0741/2007296953-b.html. |
| | onine vertagbar ander n.e |
| | IAHR (2015): Professional Specifications for Physical and Numerical Studies in Environmental Hydraulics. In: Hydrolink (3/2015), S. |
| | 90-92. |
| | Olsen, Nils Reidar B. (2012): Numerical Modelling and Hydraulics. 3. Aufl. Department of Hydraulic and Environmental Engineering, |
| | The Norwegian University of Science and Technology. |
| | Szymkiewicz, Romuald (2010): Numerical modeling in open channel hydraulics. Dordrecht: Springer (Water science and |
| | technology library, 83). |
| | |
| | van Waveren, Harold (1999-): Good modelling practice handbook. [Utrecht], Lelystad, Den Haag: STOWA; Rijkswaterstaat-RIZA; |
| | SDU, afd. SEO/RIZA [etc. distr.] (Nota, nr. 99.036). |
| | Zielke, Werner (Hg.) (1999): Numerische Modelle von Flüssen, Seen und Küstengewässern. Deutscher Verband für |
| | Wasserwirtschaft und Kulturbau. Bonn: Wirtschafts- und VerlGes. Gas und Wasser (Schriftenreihe des Deutschen Verbandes für |
| | Wasserwirtschaft und Kulturbau, 127). |

| Course L0961: Nature-Orient | Course L0961: Nature-Oriented Hydraulic Engineering / Integrated Flood Protection | | |
|-----------------------------|---|--|--|
| Тур | Project-/problem-based Learning | | |
| Hrs/wk | 2 | | |
| СР | 2 | | |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 | | |
| Lecturer | Dr. Natasa Manojlovic, Prof. Peter Fröhle | | |
| Language | DE/EN | | |
| Cycle | SoSe | | |
| Content | Regime-Theory and application for the development of environmental guiding priciples of rivers Engineering - biological measures for the stabilization of rivers Risk management in flood protection Design techniques in technical flood protection Methods for the assessment of flood caused damages | | |
| Literature | Vorlesungsumdruck | | |

| Lingineering | | | | |
|------------------------------------|--|--|--------------------|------------------------|
| Module M0874: Waste | ewater Systems | | | |
| | | | | |
| Courses | | | | |
| Title | | Тур | Hrs/wk | СР |
| Biological Wastewater Treatment (I | | Lecture | 2 | 2 |
| Biological Wastewater Treatment (I | | Recitation Section (large) | 1 | 1 |
| Advanced Wastewater Treatment (| | Lecture | 2 | 2 |
| Advanced Wastewater Treatment (| | Recitation Section (large) | 1 | 1 |
| Module Responsible | - | | | |
| | | | | |
| Recommended Previous | Knowledge of wastewater management and | d the key processes involved in wastewater treat | ment. | |
| Knowledge | | | | |
| Educational Objectives | After taking part successfully, students have | e reached the following learning results | | |
| Professional Competence | | | | |
| Knowledge | Students are able to outline key areas of th | e full range of treatment systems in waste wate | r management, as | well as their mutua |
| | dependence for sustainable water protectio | n. They can describe relevant economic, environ | mental and social | factors. |
| Chille | Students are able to pre design and evolution | in the swellable wastewater treatment processe | and the scene of | f their application is |
| SKIIIS | | in the available wastewater treatment processe | s and the scope o | or their application i |
| | municipal and for some industrial treatment | t plants. | | |
| Personal Competence | | | | |
| Social Competence | Social skills are not targeted in this module. | | | |
| | | | | |
| Autonomy | | ubject and to organize their work flow indepen | dently. They can | also present on this |
| | subject. | | | |
| Workload in Hours | Independent Study Time 96, Study Time in | Lecture 84 | | |
| Credit points | 6 | | | |
| Course achievement | None | | | |
| Examination | Written exam | | | |
| Examination duration and | 120 min | | | |
| scale | | | | |
| Assignment for the | Civil Engineering: Specialisation Structural E | Engineering: Elective Compulsory | | |
| - | Civil Engineering: Specialisation Geotechnic | | | |
| - | Civil Engineering: Specialisation Coastal Eng | | | |
| | Civil Engineering: Specialisation Water and | Traffic: Compulsory | | |
| | Bioprocess Engineering: Specialisation A - G | General Bioprocess Engineering: Elective Compute | sory | |
| | | Nater Quality and Water Engineering: Elective Co | | |
| | International Management and Engineering | : Specialisation II. Process Engineering and Biote | chnology: Elective | Compulsory |
| | International Management and Engineering | : Specialisation II. Energy and Environmental Eng | ineering: Elective | Compulsory |
| | Process Engineering: Specialisation Environ | mental Process Engineering: Elective Compulsor | / | |
| | Process Engineering: Specialisation Process | Engineering: Elective Compulsory | | |
| | Water and Environmental Engineering: Spec | cialisation Water: Compulsory | | |
| | | | | |
| | Water and Environmental Engineering: Spec | cialisation Environment: Elective Compulsory | | |

| Course L0517: Biological Wastewater Treatment | | |
|---|---|--|
| Тур | Lecture | |
| Hrs/wk | 2 | |
| CP | 2 | |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 | |
| Lecturer | Dr. Joachim Behrendt | |
| Language | DE/EN | |
| Cycle | SoSe | |
| Content | Charaterisation of Wastewater | |
| | Metobolism of Microorganisms | |
| | Kinetic of mirobiotic processes | |
| | Calculation of bioreactor for wastewater treatment | |
| | Concepts of Wastewater treatment | |
| | Design of WWTP | |
| | Excursion to a WWTP | |
| | Biofilms | |
| | Biofim Reactors | |
| | Anaerobic Wastewater and sldge treatment | |
| | resources oriented sanitation technology | |
| | Future challenges of wastewater treatment | |
| Literature | Gujer, Willi | |
| | Siedlungswasserwirtschaft : mit 84 Tabellen | |
| 1 | I | |

| ISBN: 3540343296 (Gb.) URL: http://www.gbv.de/dms/bs/toc/516261924.pdf URL: http://deposit.d-nb.de/cgi-bin/de id=2842122&prov=M&dok_var=1&dok_ext=htm Berlin [u.a.] : Springer, 2007 TUB_HH_Katalog Henze, Mogens Wastewater treatment : biological and chemical processes ISBN: 3540422285 (Pp.) Berlin [u.a.] : Springer, 2002 TUB_HH_Katalog | kserv? |
|---|---------|
| Berlin [u.a.] : Springer, 2007 TUB_HH_Katalog Henze, Mogens Wastewater treatment : biological and chemical processes ISBN: 3540422285 (Pp.) Berlin [u.a.] : Springer, 2002 | |
| TUB_HH_Katalog Henze, Mogens Wastewater treatment : biological and chemical processes ISBN: 3540422285 (Pp.) Berlin [u.a.] : Springer, 2002 | |
| Henze, Mogens Wastewater treatment : biological and chemical processes ISBN: 3540422285 (Pp.) Berlin [u.a.] : Springer, 2002 | |
| Wastewater treatment : biological and chemical processes ISBN: 3540422285 (Pp.) Berlin [u.a.] : Springer, 2002 | |
| ISBN: 3540422285 (Pp.) Berlin [u.a.] : Springer, 2002 | |
| Berlin [u.a.] : Springer, 2002 | |
| | |
| TUB HH Katalog | |
| 105_m_kalalog | |
| Imhoff, Karl (Imhoff, Klaus R.;) | |
| Taschenbuch der Stadtentwässerung : mit 10 Tafeln | |
| ISBN: 3486263331 ((Gb.)) | |
| München [u.a.] : Oldenbourg, 1999 | |
| TUB_HH_Katalog | |
| Lange, Jörg (Otterpohl, Ralf; Steger-Hartmann, Thomas;) | |
| Abwasser : Handbuch zu einer zukunftsfähigen Wasserwirtschaft | |
| ISBN: 3980350215 (kart.) URL: http://www.gbv.de/du/services/agi/52567E5D44DA0809C12570220050BF25/000000700334 | |
| Donaueschingen-Pfohren : Mall-Beton-Verl., 2000 | |
| TUB_HH_Katalog | |
| Mudrack, Klaus (Kunst, Sabine;) | |
| Biologie der Abwasserreinigung : 18 Tabellen | |
| ISBN: 382741427X URL: http://www.gbv.de/du/services/agi/94B581161B6EC747C1256E3F005A8143/420000114903 | |
| Heidelberg [u.a.] : Spektrum, Akad. Verl., 2003 | |
| TUB_HH_Katalog | |
| Tchobanoglous, George (Metcalf & Eddy, Inc., ;) | |
| Wastewater engineering : treatment and reuse | |
| ISBN: 0070418780 (alk. paper) ISBN: 0071122508 (ISE (*pbk)) | |
| Boston [u.a.] : McGraw-Hill, 2003 | |
| TUB_HH_Katalog | |
| Henze, Mogens | |
| Activated sludge models ASM1, ASM2, ASM2d and ASM3 | |
| ISBN: 1900222248 | |
| London : IWA Publ., 2002 | |
| TUB_HH_Katalog | |
| Kunz, Peter | |
| Umwelt-Bioverfahrenstechnik | |
| Vieweg, 1992 | |
| Bauhaus-Universität., Arbeitsgruppe Weiterbildendes Studium Wasser und Umwelt (Deutsche Vereinigu | ng für |
| Wasserwirtschaft, Abwasser und Abfall, ;) | 5 |
| Abwasserbehandlung : Gewässerbelastung, Bemessungsgrundlagen, Mechanische Verfahren, Biologische Verfahren, Re | tstoffe |
| aus der Abwasserbehandlung, Kleinkläranlagen | |
| ISBN: 3860682725 URL: http://www.gbv.de/dms/weimar/toc/513989765_toc.pdf | URL: |
| http://www.gbv.de/dms/weimar/abs/513989765_abs.pdf | |
| Weimar : Universitätsverl, 2006 | |
| TUB_HH_Katalog | |
| Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall | |
| DWA-Regelwerk | |
| Hennef : DWA, 2004 | |
| TUB_HH_Katalog | |
| Wiesmann, Udo (Choi, In Su; Dombrowski, Eva-Maria;) | |
| Fundamentals of biological wastewater treatment | |
| ISBN: 3527312196 (Gb.) URL: http://deposit.ddb.de/cgi-bin/dokserv?id=2774611&prov=M&dok_var=1&dok_ext=htm | |
| Weinheim : WILEY-VCH, 2007 | |
| | |
| TUB_HH_Katalog | |

| Course L3122: Biological Wa | ourse L3122: Biological Wastewater Treatment | | |
|-----------------------------|---|--|--|
| Тур | Recitation Section (large) | | |
| Hrs/wk | 1 | | |
| CP | 1 | | |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 | | |
| Lecturer | Dr. Joachim Behrendt | | |
| Language | DE/EN | | |
| Cycle | SoSe | | |
| Content | See interlocking course | | |
| Literature | See interlocking course | | |

| Course L0357: Advanced Wa | stewater Treatment |
|---------------------------|---|
| Тур | Lecture |
| Hrs/wk | 2 |
| СР | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Dr. Joachim Behrendt |
| Language | EN |
| Cycle | SoSe |
| Content | Survey on advanced wastewater treatment |
| | reuse of reclaimed municipal wastewater |
| | Precipitation |
| | Flocculation |
| | Depth filtration |
| | Membrane Processes |
| | Activated carbon adsorption |
| | Ozonation |
| | "Advanced Oxidation Processes" |
| | Disinfection |
| Literature | Metcalf & Eddy, Wastewater Engineering: Treatment and Reuse, McGraw-Hill, Boston 2003 |
| | Wassertechnologie, H.H. Hahn, Springer-Verlag, Berlin 1987 |
| | Membranverfahren: Grundlagen der Modul- und Anlagenauslegung, T. Melin und R. Rautenbach, Springer-Verlag, Berlin 2007 |
| | Trinkwasserdesinfektion: Grundlagen, Verfahren, Anlagen, Geräte, Mikrobiologie, Chlorung, Ozonung, UV-Bestrahlung, Membranfiltration, Qualitätssicherung, W. Roeske, Oldenbourg-Verlag, München 2006 |
| | Organische Problemstoffe in Abwässern, H. Gulyas, GFEU, Hamburg 2003 |

| Course L0358: Advanced Wa | stewater Treatment |
|---------------------------|---|
| Тур | Recitation Section (large) |
| Hrs/wk | 1 |
| СР | 1 |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 |
| Lecturer | Dr. Joachim Behrendt |
| Language | EN |
| Cycle | SoSe |
| Content | Aggregate organic compounds (sum parameters) |
| | Industrial wastewater |
| | Processes for industrial wastewater treatment |
| | Precipitation |
| | Flocculation |
| | Activated carbon adsorption |
| | Recalcitrant organic compounds |
| | |
| Literature | Metcalf & Eddy, Wastewater Engineering: Treatment and Reuse, McGraw-Hill, Boston 2003 |
| | Wassertechnologie, H.H. Hahn, Springer-Verlag, Berlin 1987 |
| | Membranverfahren: Grundlagen der Modul- und Anlagenauslegung, T. Melin und R. Rautenbach, Springer-Verlag, Berlin 2007 |
| | Trinkwasserdesinfektion: Grundlagen, Verfahren, Anlagen, Geräte, Mikrobiologie, Chlorung, Ozonung, UV-Bestrahlung, Membranfiltration, Qualitätssicherung, W. Roeske, Oldenbourg-Verlag, München 2006 |
| | Organische Problemstoffe in Abwässern, H. Gulyas, GFEU, Hamburg 2003 |

| Module M0875: Nexu | s Engineering - Water, Soil, Food | and Energy | | |
|--|---|--|-------------------|----|
| Courses | | | | |
| Title | | Тур | Hrs/wk | СР |
| Ecological Town Design - Water, Er | ergy, Soil and Food Nexus (L1229) | Seminar | 2 | 2 |
| Water & Wastewater Systems in a Global Context (L0939) Lecture 2 4 | | | 4 | |
| Module Responsible | Prof. Ralf Otterpohl | | | |
| Admission Requirements | None | | | |
| Recommended Previous Knowledge | Basic knowledge of the global situation with rising poverty, soil degradation, migration to cities, lack of water resources ar | | | |
| Educational Objectives | After taking part successfully, students have rea | ached the following learning results | | |
| Professional Competence | | | | |
| Knowledge | Students can describe the facets of the global water situation. Students can judge the enormous potential of the implementation synergistic systems in Water, Soil, Food and Energy supply. | | | |
| Skills | Students are able to design ecological settlements for different geographic and socio-economic conditions for the main climate around the world. | | | |
| Personal Competence | | | | |
| Social Competence | The students are able to develop a specific topic in a team and to work out milestones according to a given plan. | | | |
| Autonomy | Students are in a position to work on a subject and to organize their work flow independently. They can also present on thi subject. | | | |
| Workload in Hours | Independent Study Time 124, Study Time in Lecture 56 | | | |
| Credit points | 6 | | | |
| Course achievement | | | | |
| Examination | Subject theoretical and practical work | | | |
| Examination duration and | During the course of the semester, the students work towards mile stones. The work includes presentations and papers. Detaile | | | |
| scale | information can be found at the beginning of the | e smester in the StudIP course module h | nandbook. | |
| Assignment for the | Civil Engineering: Specialisation Water and Traf | fic: Elective Compulsory | | |
| Following Curricula | Bioprocess Engineering: Specialisation A - Gene | ral Bioprocess Engineering: Elective Cor | npulsory | |
| | Chemical and Bioprocess Engineering: Specialis | ation General Process Engineering: Elec | tive Compulsory | |
| | Environmental Engineering: Core Qualification: | Elective Compulsory | | |
| | Joint European Master in Environmental Studies | - Cities and Sustainability: Core Qualific | ation: Compulsory | |
| | Process Engineering: Specialisation Environmen | tal Process Engineering: Elective Compu | ulsory | |
| | Process Engineering: Specialisation Process Eng | ineering: Elective Compulsory | | |
| | Water and Environmental Engineering: Specialis | sation Water: Elective Compulsory | | |
| | Water and Environmental Engineering: Specialis | sation Environment: Elective Compulsor | y | |
| | Water and Environmental Engineering: Specialis | sation Cities: Elective Compulsory | | |

| Course L1229: Ecological Tov | wn Design - Water, Energy, Soil and Food Nexus |
|------------------------------|--|
| Тур | Seminar |
| Hrs/wk | 2 |
| CP | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Prof. Ralf Otterpohl |
| Language | EN |
| Cycle | SoSe |
| Content | Participants Workshop: Design of the most attractive productive Town Keynote lecture and video The limits of Urbanization / Green Cities The tragedy of the Rural: Soil degradation, agro chemical toxification, migration to cities Global Ecovillage Network: Upsides and Downsides around the World Visit of an Ecovillage Participants Workshop: Resources for thriving rural areas, Short presentations by participants, video competion TUHH Rural Development Toolbox Integrated New Town Development Participants workshop: Design of New Towns: Northern, Arid and Tropical cases Outreach: Participants campaign City with the Rural: Resilience, quality of live and productive biodiversity |
| Literature | Ralf Otterpohl 2013: Gründer-Gruppen als Lebensentwurf: "Synergistische Wertschöpfung in erweiterten Kleinstadt- und Dorfstrukturen", in "Regionales Zukunftsmanagement Band 7: Existenzgründung unter regionalökonomischer Perspektive, Pabst Publisher, Lengerich http://youtu.be/9hmkgn0nBgk (Miracle Water Village, India, Integrated Rainwater Harvesting, Water Efficiency, Reforestation and Sanitation) TEDx New Town Ralf Otterpohl: http://youtu.be/_M0J2u9BrbU |

| Course L0939: Water & Wastewater Systems in a Global Context | | | |
|--|---|--|--|
| Тур | Lecture | | |
| Hrs/wk | 2 | | |
| СР | 4 | | |
| Workload in Hours | Independent Study Time 92, Study Time in Lecture 28 | | |
| Lecturer | Prof. Ralf Otterpohl | | |
| Language | EN | | |
| Cycle | SoSe | | |
| Content | Keynote lecture and video Water & Soil: Water availability as a consequence of healthy soils Water and it's utilization, Integrated Urban Water Management Water & Energy, lecture and panel discussion pro and con for a specific big dam project Rainwater Harvesting on Catchment level, Holistic Planned Grazing, Multi-Use-Reforestation Sanitation and Reuse of water, nutrients and soil conditioners, Conventional and Innovative Approaches Why are there excreta in water? Public Health, Awareness Campaigns Rehearsal session, Q&A | | |
| Literature | Montgomery, David R. 2007: Dirt: The Erosion of Civilizations, University of California Press Liu, John D.: http://eempc.org/hope-in-a-changing_climate/ (Integrated regeneration of the Loess Plateau, China, and sites in Ethiopia and Rwanda) http://youtu.be/9hmkgn0nBgk (Miracle Water Village, India, Integrated Rainwater Harvesting, Water Efficiency, Reforestation and Sanitation) | | |

| Engineering | |
|--------------------------|--|
| Module M0922: City F | lanning |
| Courses | |
| Title | Tura Handwik CD |
| City Planning (L1066) | Typ Hrs/wk CP Project-/problem-based Learning 4 6 |
| Module Responsible | |
| Admission Requirements | |
| | for "Principles of Urban Planning": none |
| Knowledge | |
| | for "Designing Urban Streetscapes": some knowledge of transport planning, e.g. through taking the undergraduate class ",Trans Planning and Traffic Engineering" |
| | The many did traine Engineering |
| | |
| | After taking part successfully, students have reached the following learning results |
| Professional Competence | |
| Knowleage | Students are able to: |
| | use technical terms of urban planning. |
| | describe the main determinants of urban development. |
| | explain and compare different possibilities of how urban development can be influenced. |
| | discuss requirements for public streetscapes. |
| | explain the importance of street design. |
| | |
| Skills | Students are able to: |
| | read and analyze urban development concepts and designs for streetscapes |
| | appraise such concepts in the context of competing requirements. |
| | design, justify and reflect their own solutions for concrete examples. |
| | |
| Personal Competence | |
| | Students are able to: |
| boelar competence | |
| | discuss intermediate results with each other. |
| | constructively accept feedback on their own work. |
| | provide constructive feedback to others. |
| | |
| Autonomy | Students are able to: |
| | independently complete a written report including drawings following a broadly pre-defined process. |
| | assess the consequences of their proposed solutions. |
| | independently acquire knowledge and apply this to new issues or problem areas. |
| | |
| Workload in Hours | Independent Study Time 124, Study Time in Lecture 56 |
| Credit points | |
| Course achievement | None |
| Examination | |
| Examination duration and | written assignment, designwork during the semester |
| scale | |
| Assignment for the | Civil Engineering: Specialisation Structural Engineering: Elective Compulsory |
| Following Curricula | Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory |
| | Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory |
| | Civil Engineering: Specialisation Water and Traffic: Elective Compulsory |
| | Logistics, Infrastructure and Mobility: Specialisation Infrastructure and Mobility: Elective Compulsory |
| | Water and Environmental Engineering: Specialisation Environment: Elective Compulsory |
| | Water and Environmental Engineering: Specialisation Cities: Compulsory |

| Course L1066: City Planning | |
|-----------------------------|---|
| Тур | Project-/problem-based Learning |
| Hrs/wk | 4 |
| CP | 6 |
| Workload in Hours | Independent Study Time 124, Study Time in Lecture 56 |
| Lecturer | Prof. Carsten Gertz |
| Language | DE |
| Cycle | SoSe |
| Content | ", Principles of Urban Planning" deals with the determinants of urban development and their interactions. Topics include: |
| | legal framework, instruments and methods of planning, functional requirements, stakeholders and actors basic design requirements different planning levels and historical contexts. The objective of the course is for students to acquire a basic understanding of urban development problems and approaches for solving them. They will also be able to comprehend the process of urban planning. The course also covers the various functional and aesthetic requirements for designing streetscape as the most important elements of public space. The project work deals with a real life scenario and includes drawing up a development plan, an urban design concept, a building masterplan and a street redesign. |
| Literature | Albers, Gerd; Wekel, Julian (2021) Stadtplanung: Eine illustrierte Einführung. 4. überarbeitete Auflage. Primus Verlag. Darmstadt. Frick, Dieter (2011) Theorie des Städtebaus: Zur baulich-räumlichen Organisation von Stadt. 3. veränderte Auflage. Wasmuth- Verlag. Tübingen |
| | Jonas, Carsten (2009) Die Stadt und ihr Grundriss. Wasmuth-Verlag. Tübingen Kostof, Spiro; Castillo, Greg (1998) Die Anatomie der Stadt. Geschichte städtischer Strukturen. Campus-Verlag. Frankfurt/New York. |

| Engineering" | | | | |
|--------------------------|--|--|--------------------|------------------|
| Module M1724: Smar | t Monitoring | | | |
| Courses | | | | |
| Title | | Тур | Hrs/wk | СР |
| Smart Monitoring (L2762) | | Integrated Lecture | 2 | 2 |
| Smart Monitoring (L2763) | | Recitation Section (small) | 2 | 4 |
| Module Responsible | Prof. Kay Smarsly | | | |
| Admission Requirements | | | | |
| | | ramming and sensor technol | ogies are beloful | Interest in mo |
| Knowledge | Basic knowledge or interest in object-oriented modeling, programming, and sensor technologies are helpful. Interest in mode research and teaching areas, such as Internet of Things, Industry 4.0 and cyber-physical systems, as well as the will to deep | | | |
| Knowledge | skills of scientific working, are required. Basic knowledge in scie | | | |
| Educational Objectives | After taking part successfully, students have reached the followi | ing learning results | | |
| Professional Competence | | | | |
| | The students will become familiar with the principles and pra | actices of smart monitoring. | The students wil | l be able to de |
| | decentralized smart systems to be applied for continuous (| | | |
| | environment. In addition, the students will learn to design and t | | | |
| | analysis techniques, modern software design concepts, and enl | | | |
| | also part of this module, which will be conducted throughout th | | - | |
| | students will design smart monitoring systems that integrate a r | | • | • |
| | Specific focus will be put on the application of machine learning | | | |
| | real-world (built or natural) systems, such as bridges or slopes, | • | • • | |
| | every group will be documented in a paper. All students of this | | | |
| | system in the annual "Smart Monitoring" competition. The writte | | | |
| | | en papers and oral examination | ons form the final | grades. The mo |
| | will be taught in English. Limited enrollment. | | | |
| Skills | The students will gain insights into operating state-of-the-art sn | mart sensor systems, used fo | r monitoring a wig | de range of phys |
| | processes relevant to engineering, such as environmental, st | | | |
| | devising monitoring strategies of physical processes as part of | | | |
| | implement the strategies in smart wireless sensor nodes, using | | | |
| | be able to document the findings of their projects in short report | | 5 5 | |
| Personal Competence | | | | |
| | | work for their projects and d | | ation skills tow |
| Social competence | The students will be able to work in groups, share parts of the | work for their projects, and d | evelop communic | ation skins, tow |
| | achieving the common project goals. | | | |
| Autonomy | The students will be able to gain a solid basis on approaching | and solving problems in eng | gineering, as well | as on documer |
| - | results, through their involvement in their monitoring group proj | | | |
| Workload in Hours | Independent Study Time 124, Study Time in Lecture 56 | | | |
| Credit points | | | | |
| Course achievement | None | | | |
| Examination | Written elaboration | | | |
| Examination duration and | 10 pages of work with 15-minute oral presentation | | | |
| scale | | | | |
| Assignment for the | Civil Engineering: Specialisation Water and Traffic: Elective Com | npulsory | | |
| Following Curricula | Civil Engineering: Specialisation Geotechnical Engineering: Elect | tive Compulsory | | |
| | Civil Engineering: Specialisation Coastal Engineering: Elective Co | ompulsory | | |
| | Civil Engineering: Specialisation Structural Engineering: Elective | e Compulsory | | |
| | Computer Science: Specialisation II: Intelligence Engineering: Ele | ective Compulsory | | |
| | 1 | | | |
| | Environmental Engineering: Specialisation Energy and Resource | es: Elective Compulsory | | |
| | Environmental Engineering: Specialisation Energy and Resource Environmental Engineering: Specialisation Environment and Clin | | | |
| | | mate: Elective Compulsory | npulsory | |
| | Environmental Engineering: Specialisation Environment and Clin | nate: Elective Compulsory ater Engineering: Elective Cor | npulsory | |
| | Environmental Engineering: Specialisation Environment and Clin Environmental Engineering: Specialisation Water Quality and Wa Mechatronics: Technical Complementary Course: Elective Comp | nate: Elective Compulsory ater Engineering: Elective Cor | npulsory | |
| | Environmental Engineering: Specialisation Environment and Clin Environmental Engineering: Specialisation Water Quality and Wa | nate: Elective Compulsory ater Engineering: Elective Cor ulsory | | |
| | Environmental Engineering: Specialisation Environment and Clin Environmental Engineering: Specialisation Water Quality and Wa Mechatronics: Technical Complementary Course: Elective Compl Mechatronics: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Robotics and | nate: Elective Compulsory ater Engineering: Elective Cor ulsory I Computer Science: Elective (| | |
| | Environmental Engineering: Specialisation Environment and Clin Environmental Engineering: Specialisation Water Quality and Wa Mechatronics: Technical Complementary Course: Elective Compl Mechatronics: Core Qualification: Elective Compulsory | nate: Elective Compulsory ater Engineering: Elective Cor iulsory d Computer Science: Elective (ctive Compulsory | | |

| Course L2762: Smart Monito | ring |
|----------------------------|--|
| Тур | Integrated Lecture |
| Hrs/wk | 2 |
| СР | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Prof. Kay Smarsly |
| Language | EN |
| Cycle | SoSe |
| Content | In this course, principles of smart monitoring will be taught, focusing on modern concepts of data acquisition, data storage, and data analysis. Also, fundamentals of intelligent sensors and embedded computing will be illuminated. Autonomous software and decentralized data processing are further crucial parts of the course, including concepts of the Internet of Things, Industry 4.0 and cyber-physical systems. Furthermore, measuring principles, data acquisition systems, data management and data analysis algorithms will be discussed. Besides the theoretical background, numerous practical examples will be shown to demonstrate how smart monitoring may advantageously be used for assessing the condition of systems in the built or natural environment. |
| Literature | The course contents couples different fields, such as signal processing, sensing technologies, data analytics, environmental engineering, civil engineering, artificial intelligence, database systems, and many more. The basics will be taught in this course. However, specific literature that covers all these topics does not exist. Instead, literature will be referenced in the lectures, all of which are papers that are freely available online. |

| Course L2763: Smart Monito | ring |
|----------------------------|--|
| Тур | Recitation Section (small) |
| Hrs/wk | 2 |
| CP | 4 |
| Workload in Hours | Independent Study Time 92, Study Time in Lecture 28 |
| Lecturer | Prof. Kay Smarsly |
| Language | EN |
| Cycle | SoSe |
| | The contents of the exercises are based on the lecture contents. In addition to the exercises, project work will be conducted throughout the semester, which will consume the majority of the workload. As part of the project work, students will design smart monitoring systems that will be tested in the laboratory or in the field. As mentioned in the module description, the students will participate in the "Smart Monitoring" competition, hosted annually by the Institute of Digital and Autonomous Construction. Students are encouraged to contribute their own ideas. The tools required to implement the smart monitoring systems will be taught in the group exercises as well as through external sources, such as video tutorials and literature. |
| Literature | engineering, civil engineering, artificial intelligence, database systems, and many more. The basics will be taught in this course. However, specific literature that covers all these topics does not exist. Instead, literature will be referenced in the lectures, all of which are papers that are freely available online. |

| Module M1721: Wate | r and Environment: Theory and Application | | | |
|-------------------------------|--|-----------------------------|---------------------------|--------------------|
| Courses | | | | |
| Title | Тур | | Hrs/wk | СР |
| Water and Environment (L2754) | Project | -/problem-based Learning | 3 | 3 |
| Water and Environment (L2753) | Lecture | 3 | 3 | 3 |
| Module Responsible | Prof. Nima Shokri | | | |
| Admission Requirements | None | | | |
| Recommended Previous | Basic knowledge in water and environmental research, Hydrology | | | |
| Knowledge | | | | |
| Educational Objectives | After taking part successfully, students have reached the following learn | ning results | | |
| Professional Competence | | | | |
| Knowledge | Common research tools and techniques together with the fundamental knowledge relevant to multi-scale and multi-phase challenges present in water and environmental research will be discussed in this module. Both theory and application will be considered. | | | |
| Skills | In addition to the fundamental knowledge, the students will be exposed to several analytical, experimental and numerical tools and techniques relevant to water and environmental research at different scales. This will provide the students with an excellent opportunity to improve their skills on multiple fronts which will be useful in their future career. | | | |
| Personal Competence | | | | |
| Social Competence | Developing teamwork and problem solving skills through Research-Base | d Teaching approaches w | <i>i</i> ll be at the cor | re of this module. |
| Autonomy | The students will be involved in writing individual reports and prese willingness to work independently and responsibly. | entation. This will contrib | oute to the stu | ıdents' ability an |
| Workload in Hours | Independent Study Time 96, Study Time in Lecture 84 | | | |
| Credit points | 6 | | | |
| Course achievement | | | | |
| Examination | Subject theoretical and practical work | | | |
| Examination duration and | | | | |
| scale | | | | |
| Assignment for the | Civil Engineering: Specialisation Coastal Engineering: Elective Compulso | iry | | |
| - | Civil Engineering: Specialisation Water and Traffic: Elective Compulsory | - | | |
| - | Environmental Engineering: Specialisation Environment and Climate: Ele | ective Compulsory | | |
| | Water and Environmental Engineering: Specialisation Cities: Elective Co | mpulsory | | |
| | Water and Environmental Engineering: Specialisation Water: Elective Co | mpulsory | | |
| | Water and Environmental Engineering: Specialisation Environment: Com | | | |

| Course L2754: Water and En | Course L2754: Water and Environment | |
|----------------------------|---|--|
| Тур | Project-/problem-based Learning | |
| Hrs/wk | 3 | |
| СР | 3 | |
| Workload in Hours | Independent Study Time 48, Study Time in Lecture 42 | |
| Lecturer | Dr. Salome Shokri-Kuehni | |
| Language | EN | |
| Cycle | SoSe | |
| Content | See interlocking course | |
| Literature | See interlocking course | |

| Course L2753: Water and Environment | | |
|-------------------------------------|---|--|
| Тур | Lecture | |
| Hrs/wk | 3 | |
| СР | 3 | |
| Workload in Hours | Independent Study Time 48, Study Time in Lecture 42 | |
| Lecturer | Prof. Nima Shokri | |
| Language | EN | |
| Cycle | SoSe | |
| Content | Research based learning: The students will be engaged in active research focused on water and environmental related challenges. | |
| | The required knowledge and tools will be discussed during the semester. | |
| Literature | NA | |

| Module M0858: Coast | al Hydraulic Engineering I | | | | |
|------------------------------------|---|------------------------|------------------------------------|-----------------|---------------------|
| | ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,, | | | | |
| Courses | | | | | |
| Title | | | Тур | Hrs/wk | СР |
| Basics of Coastal Engineering (L08 | | | Lecture | 3 | 4 |
| Basics of Coastal Engineering (L14 | 13) | | Project-/problem-based Learning | 1 | 2 |
| Module Responsible | Prof. Peter Fröhle | | | | |
| Admission Requirements | None | | | | |
| Recommended Previous | Basics of hydraulic engineering, hydrology an | d hydromechanics | | | |
| Knowledge | | | | | |
| Educational Objectives | After taking part successfully, students have | reached the following | ng learning results | | |
| Professional Competence | | | | | |
| Knowledge | The students are able to define and explain t | he basic concepts o | f coastal engineering and port e | ngineering. Th | ney are able to app |
| | the concepts to selected practical problems | of coastal engineer | ing. Students can define and de | termine the b | asics for design ar |
| | dimensioning of coastal engineering construct | tions. | | | |
| Cl://l- | The shudents are excluded a surfly beside desi | | | | |
| SKIIIS | The students are capable to apply basic design | jn approacnes to se | lected and pre-defined design ta | asks in coastai | engineering. |
| Personal Competence | | | | | |
| Social Competence | The students are able to deploy their gained | l knowledge in appl | ied problems such as the desig | n of coastal p | rotection structure |
| | Additionaly, they will be able to work in team | with engineers of o | ther disciplines, for instance des | signing of coas | stal breakwaters. |
| | | | | | |
| Autonomy | The students will be able to independently ex | tend their knowledg | ge and applyit to new problems. | | |
| Workload in Hours | Independent Study Time 124, Study Time in I | _ecture 56 | | | |
| Credit points | 6 | | | | |
| Course achievement | None | | | | |
| Examination | Written exam | | | | |
| Examination duration and | The duration of the examination is 2 hours | . The examination | includes tasks with respect to | the general u | nderstanding of th |
| scale | lecture contents and calculations tasks. | | | | |
| Assignment for the | Civil Engineering: Specialisation Coastal Engi | neering: Compulsor | / | | |
| Following Curricula | Civil Engineering: Specialisation Geotechnical | Engineering: Comp | oulsory | | |
| | Civil Engineering: Specialisation Structural En | gineering: Elective | Compulsory | | |
| | Environmental Engineering: Specialisation En | vironment and Clim | ate: Elective Compulsory | | |
| | Environmental Engineering: Specialisation Wa | ater Quality and Wa | ter Engineering: Elective Compu | llsory | |
| | International Management and Engineering: S | Specialisation II. Civ | il Engineering: Elective Compuls | ory | |
| | Water and Environmental Engineering: Specia | alisation Environme | nt: Elective Compulsory | | |
| | Water and Environmental Engineering: Specia | alisation Water: Elec | tive Compulsory | | |

| Course L0807: Basics of Coastal Engineering | | |
|---|---|--|
| Тур | Lecture | |
| Hrs/wk | 3 | |
| СР | 4 | |
| Workload in Hours | Independent Study Time 78, Study Time in Lecture 42 | |
| Lecturer | Prof. Peter Fröhle | |
| Language | EN | |
| Cycle | SoSe | |
| Content | Basics of planning and design | |
| | • Water levels | |
| | • Currents | |
| | • Waves | |
| | ∘ Ice | |
| | Planning and Design in Coastal Engineering | |
| | Functional and constructional design | |
| | Determination of design parameters | |
| | Design-approaches | |
| | Filter | |
| | Rubble mound constructions | |
| | Piles Vertical constructions | |
| | Vertical constructions | |
| | | |
| Literature | Coastal Engineering Manual, CEM | |
| | Vorlesungsumdruck | |
| | | |
| | | |
| L | | |

| Course L1413: Basics of Coas | Course L1413: Basics of Coastal Engineering | | |
|------------------------------|---|--|--|
| Тур | Project-/problem-based Learning | | |
| Hrs/wk | 1 | | |
| СР | 2 | | |
| Workload in Hours | Independent Study Time 46, Study Time in Lecture 14 | | |
| Lecturer | Prof. Peter Fröhle | | |
| Language | EN | | |
| Cycle | SoSe | | |
| Content | See interlocking course | | |
| Literature | See interlocking course | | |

| Module M1980: Field | measurements for environmental studies | | | |
|----------------------------------|--|------------------------|--------|----|
| Courses | | | | |
| Title | Тур | | Hrs/wk | СР |
| Field measurements for environme | ntal studies: Application (L3231) Project-/ | problem-based Learning | 3 | 4 |
| ield measurements for environme | ntal studies: Theory (L3230) Lecture | | 1 | 2 |
| Module Responsible | Prof. Nima Shokri | | | |
| Admission Requirements | None | | | |
| Recommended Previous | | | | |
| Knowledge | | | | |
| Educational Objectives | After taking part successfully, students have reached the following learning | ng results | | |
| Professional Competence | | | | |
| Knowledge | | | | |
| Skills | | | | |
| Personal Competence | | | | |
| Social Competence | | | | |
| Autonomy | | | | |
| Workload in Hours | Independent Study Time 124, Study Time in Lecture 56 | | | |
| Credit points | 6 | | | |
| Course achievement | None | | | |
| Examination | Subject theoretical and practical work | | | |
| Examination duration and | Report & Präsentation | | | |
| scale | | | | |
| Assignment for the | Environmental Engineering: Specialisation Environment and Climate: Elec | tive Compulsory | | |
| Following Curricula | Environmental Engineering: Specialisation Environment and Climate: Elec | tive Compulsory | | |
| | Water and Environmental Engineering: Specialisation Environment: Electi | ve Compulsory | | |
| | Water and Environmental Engineering: Specialisation Environment: Electi | ve Compulsory | | |

| Course L3231: Field measure | Course L3231: Field measurements for environmental studies: Application | |
|-----------------------------|---|--|
| Тур | Project-/problem-based Learning | |
| Hrs/wk | 3 | |
| СР | 4 | |
| Workload in Hours | Independent Study Time 78, Study Time in Lecture 42 | |
| Lecturer | Dr. Milad Aminzadeh | |
| Language | EN | |
| Cycle | SoSe | |
| Content | | |
| Literature | | |

| Course L3230: Field measure | Course L3230: Field measurements for environmental studies: Theory | |
|-----------------------------|--|--|
| Тур | Lecture | |
| Hrs/wk | 1 | |
| СР | 2 | |
| Workload in Hours | Independent Study Time 46, Study Time in Lecture 14 | |
| Lecturer | Prof. Nima Shokri | |
| Language | EN | |
| Cycle | SoSe | |
| Content | | |
| Literature | | |

| Module M1878: Susta | inable energy from wind and water | | | |
|--|--|---|-------------------------|--------------------------|
| Courses | | | | |
| Title Offshore Geotechnical Engineering Hydro Power Use (L0013) Wind Turbine Plants (L0011) | | Typ Lecture Lecture Lecture | Hrs/wk 1 1 2 | CP 1 1 3 |
| Wind Energy Use - Focus Offshore | | Lecture | 1 | 1 |
| | Dr. Marvin Scherzinger | | | |
| Admission Requirements | | | | |
| Recommended Previous Knowledge | Module: Technical Thermodynamics I, Module: Technical Thermodynamics II, | | | |
| | Module: Fundamentals of Fluid Mechanics | | | |
| Educational Objectives | After taking part successfully, students have reached | the following learning results | | |
| Professional Competence | | | | |
| ĸnowiedge | By ending this module students can explain in detail knowledge of wind turbines with a particular focus of wind energy use i offshore conditions and can critical comment these aspects in consideration of current developments. Furthermore, they are able to describe fundamentally the use of water power to generate electricity. The students reproduce and explain the basic procedur in the implementation of renewable energy projects in countries outside Europe. Through active discussions of various topics within the seminar of the module, students improve their understanding and th | | | |
| Skills | application of the theoretical background and are thus able to transfer what they have learned in practice. Students are able to apply the acquired theoretical foundations on exemplary water or wind power systems and evaluate and assess technically the resulting relationships in the context of dimensioning and operation of these energy systems. They can in compare critically the special procedure for the implementation of renewable energy projects in countries outside Europe with the in principle applied approach in Europe and can apply this procedure on exemplary theoretical projects. | | | |
| Personal Competence | | | | |
| Social Competence | Students can discuss scientific tasks subjet-specificly | y and multidisciplinary within a se | minar. | |
| Autonomy | Students can independently exploit sources in the lecture and to acquire the particular knowledge about | | ecture material to clea | the contents of t |
| Workload in Hours | Independent Study Time 110, Study Time in Lecture | 70 | | |
| Credit points | 6 | | | |
| Course achievement | None | | | |
| Examination | Written exam | | | |
| Examination duration and | 180 min | | | |
| scale | | | | |
| Assignment for the | Civil Engineering: Specialisation Structural Engineering | ng: Elective Compulsory | | |
| Following Curricula | Civil Engineering: Specialisation Geotechnical Engine | ering: Elective Compulsory | | |
| | Civil Engineering: Specialisation Coastal Engineering: | | | |
| | International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory | | | |
| | International Management and Engineering: Specialis | •• | | |
| | Product Development, Materials and Production: Spe | | | |
| | Product Development, Materials and Production: Spe | | | |
| | Product Development, Materials and Production: Spe- | | npulsory | |
| | Renewable Energies: Core Qualification: Compulsory | | | |
| | Theoretical Mechanical Engineering: Specialisation En | | | |
| | Process Engineering: Specialisation Environmental Pr | | buisory | |
| | Water and Environmental Engineering: Specialisation | | | |
| | Water and Environmental Engineering: Specialisation | | ry | |
| | Water and Environmental Engineering: Specialisation | water: Elective Compulsory | | |

| Course L0067: Offshore Geot | echnical Engineering |
|-----------------------------|--|
| Тур | Lecture |
| Hrs/wk | 1 |
| СР | 1 |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 |
| Lecturer | Dr. Jan Dührkop |
| Language | DE |
| Cycle | SoSe |
| Content | Overview and Introduction Offshore Geotechnics Introduction to Soil Mechanics Offshore soil investigation Focus on cyclical effects Geotechnical design of offshore foundations Monopiles Jackets Heavyweight foundations Geotechnical preliminary exploration for the use of lift boats and platforms |
| Literature | Randolph, M. and Gourvenec, S (2011): Offshore Geotechnical Engineering. Spon Press. Poulos H.G. (1988): Marine Geotechnics. Unwin Hyman, London BSH-Standard Baugrunderkundung für Offshore-Windenergieparks Lesny K. (2010): Foundations for Offshore Wind Turbines. VGE Verlag, Essen. EA-Pfähle (2012): Empfehlungen des Arbeitskreises Pfähle der DGGT. Ernst & Sohn, Berlin. |

| Course L0013: Hydro Power | Use |
|---------------------------|--|
| Тур | Lecture |
| Hrs/wk | 1 |
| СР | 1 |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 |
| Lecturer | Prof. Stefan Achleitner |
| Language | DE |
| Cycle | SoSe |
| Content | Introduction, importance of water power in the national and global context Physical basics: Bernoulli's equation, usable height of fall, hydrological measures, loss mechanisms, efficiencies Classification of Hydropower: Flow and Storage hydropower, low and high pressure systems Construction of hydroelectric power plants: description of the individual components and their technical system interaction Structural engineering components; representation of dams, weirs, dams, power houses, computer systems, etc. Energy Technical Components: Illustration of the different types of hydraulic machinery, generators and grid connection Hydropower and the Environment Examples from practice |
| Literature | Schröder, W.; Euler, G.; Schneider, K.: Grundlagen des Wasserbaus; Werner, Düsseldorf, 1999, 4. Auflage Quaschning, V.: Regenerative Energiesysteme: Technologie - Berechnung - Simulation; Carl Hanser, München, 2011, 7. Auflage Giesecke, J.; Heimerl, S.; Mosony, E.: Wasserkraftanlagen - Planung, Bau und Betrieb; Springer, Berlin, Heidelberg, 2009, 5. Auflage von König, F.; Jehle, C.: Bau von Wasserkraftanlagen - Praxisbezogene Planungsunterlagen; C. F. Müller, Heidelberg, 2005, 4. Auflage Strobl, T.; Zunic, F.: Wasserbau: Aktuelle Grundlagen - Neue Entwicklungen; Springer, Berlin, Heidelberg, 2006 |

| Course L0011: Wind Turbine | Plants |
|----------------------------|---|
| Тур | Lecture |
| Hrs/wk | 2 |
| СР | 3 |
| Workload in Hours | Independent Study Time 62, Study Time in Lecture 28 |
| Lecturer | Dr. Rudolf Zellermann |
| Language | DE |
| Cycle | SoSe |
| Content | Historical development Wind: origins, geographic and temporal distribution, locations Power coefficient, rotor thrust Aerodynamics of the rotor Operating performance Power limitation, partial load, pitch and stall control Plant selection, yield prediction, economy Excursion |
| Literature | Gasch, R., Windkraftanlagen, 4. Auflage, Teubner-Verlag, 2005 |

| Course L0012: Wind Energy | Use - Focus Offshore |
|---------------------------|--|
| Тур | Lecture |
| Hrs/wk | 1 |
| CP | 1 |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 |
| Lecturer | Prof. Martin Skiba |
| Language | DE |
| Cycle | SoSe |
| Content | Introduction, importance of offshore wind power generation, Specific requirements for offshore engineering Physical fundamentals for utilization of wind energy Design and operation of offshore wind turbines, presentation of different concepts of offshore wind turbines, representation of the individual system components and their system-technical relationships Foundation engineering, offshore site investigation, presentation of different concepts of offshore foundation structures, planning and fabrication of foundation structures Electrical infrastructure of an offshore wind farm, Inner Park cabling, offshore substation, grid connection Installation of offshore wind farms, installation techniques and auxiliary devices, construction logistics Development and planning of offshore wind farms Operation and optimization of offshore wind farms Day excursion |
| Literature | Gasch, R.; Twele, J.: Windkraftanlagen - Grundlagen, Entwurf, Planung und Betrieb; Vieweg + Teubner, Stuttgart, 2007, 7. Auflage Molly, J. P.: Windenergie - Theorie, Anwendung, Messung; C. F. Müller, Heidel-berg, 1997, 3. Auflage Hau, E.: Windkraftanlagen; Springer, Berlin, Heidelberg, 2008, 4.Auflage Heier, S.: Windkraftanlagen - Systemauslegung, Integration und Regelung; Vieweg + Teubner, Stuttgart, 2009, 5. Auflage Jarass, L.; Obermair, G.M.; Voigt, W.: Windenergie: Zuverlässige Integration in die Energieversorgung; Springer, Berlin, Heidelberg, 2009, 2. Auflage |

| Lingineering | | | | |
|------------------------------------|---|---|-----------------|--|
| Module M0871: Hydro | logical Systems | | | |
| | | | | |
| Courses | | | | |
| Title | | Тур | Hrs/wk | СР |
| Applied Surface Hydrology (L0289) | | Lecture | 2 | 2 |
| Applied Surface Hydrology (L1412) | | Project-/problem-based Learning | 1 | 2 |
| Interaction Water - Environment in | | Project-/problem-based Learning | 1 | 2 |
| Module Responsible | Prof. Peter Fröhle | | | |
| Admission Requirements | None | | | |
| Recommended Previous | Fundamentals of Hydromechanics and Hyd | draulic Engineering: Hydraulic Engineering I and Hydra | ulic Engineerir | ng II |
| Knowledge | | | | |
| Educational Objectives | After taking part successfully, students have | ve reached the following learning results | | |
| Professional Competence | | | | |
| Knowledge | The students are able to define the basic | concepts of hydrology and water management. They | are able to d | escribe and quantif |
| | the relevant processes of the hydrological | l water cycle. Besides, the students know the main as | pects of rainfa | ll-run-off-models an |
| | are able to theoretically derive established | d reservoir / storage models and a unit-hydrograph. | | |
| CL 111- | | | | and the second state of th |
| SKIIIS | | hydrological concepts and approaches and are able | | - |
| | • | ograph as the basis for rainfall-run-off-models. The stu | | |
| | | al and hydrodynamic values in nature and are able to | | |
| | assess these measurements. Furthermore, they are able to apply a hydrological model to basic hydrological problems. | | | |
| Personal Competence | | | | |
| Social Competence | The students are able to deploy their gain | ed knowledge in applied problems of the hydrology an | d water mana | gement. Additionaly |
| | they will be able to work in team with engi | ineers of other disciplines. | | |
| Autonomy | The students will be able to independently extend their knowledge and apply it to new problems | | | |
| Workload in Hours | Independent Study Time 124, Study Time | in Lecture 56 | | |
| Credit points | 6 | | | |
| Course achievement | None | | | |
| Examination | Written exam | | | |
| Examination duration and | The duration of the examination is 90 min. | . The examination includes tasks with respect to the ge | eneral underst | anding of the lectur |
| scale | contents and calculations tasks. | | | |
| Assignment for the | Civil Engineering: Specialisation Computat | ional Engineering: Elective Compulsory | | |
| Following Curricula | Civil Engineering: Specialisation Water and | d Traffic: Compulsory | | |
| | Environmental Engineering: Core Qualifica | ition: Elective Compulsory | | |
| | Joint European Master in Environmental St | udies - Cities and Sustainability: Core Qualification: Co | mpulsory | |
| | Water and Environmental Engineering: Spe | ecialisation Cities: Elective Compulsory | | |
| | Water and Environmental Engineering: Sp | ecialisation Environment: Elective Compulsory | | |
| | | | | |

| Course L0289: Applied Surfa | ce Hydrology |
|-----------------------------|---|
| Тур | Lecture |
| Hrs/wk | 2 |
| CP | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Prof. Peter Fröhle |
| Language | DE/EN |
| Cycle | SoSe |
| Content | Basics of hydrology: Hydrological cycle Data acquisition Data analyses and statistical assessment Statistics of extremes Regionalization methods for hydrological values Rainfall-run-off modelling on the basis of a unit hydrograph conceps Application of rainfall-run-off models on the basis of Kalypso-Hydrology which is an OpenSource Software Tool. |
| Literature | http://de.wikipedia.org/wiki/Kalypso_(Software) http://kalypso.bjoernsen.de/ http://sourceforge.net/projects/kalypso/ |

| Course L1412: Applied Surface Hydrology | | |
|---|---|--|
| Тур | Project-/problem-based Learning | |
| Hrs/wk | 1 | |
| СР | 2 | |
| Workload in Hours | Independent Study Time 46, Study Time in Lecture 14 | |
| Lecturer | Prof. Peter Fröhle | |
| Language | DE/EN | |
| Cycle | SoSe | |
| Content | See interlocking course | |
| Literature | See interlocking course | |

| Course L0295: Interaction W | ourse L0295: Interaction Water - Environment in Fluvial Areas | | | | |
|-----------------------------|--|--|--|--|--|
| Тур | Project-/problem-based Learning | | | | |
| Hrs/wk | 1 | | | | |
| СР | 2 | | | | |
| Workload in Hours | Independent Study Time 46, Study Time in Lecture 14 | | | | |
| Lecturer | Prof. Peter Fröhle | | | | |
| Language | DE/EN | | | | |
| Cycle | SoSe | | | | |
| Content | A problem based learning course. The problem will be solved by the students more or less self-contained. The topics will be introduced and elaborated over the semester. | | | | |
| Literature | - | | | | |

| Module M2002: Waste | e and Resource | Management | | | | |
|------------------------------------|---|---------------------------|-----------------------|------------------------------------|----------------|---------------------|
| Courses | | | | | | |
| Title | | | | Тур | Hrs/wk | СР |
| Waste management (L3261) | | | | Project-/problem-based Learning | 3 | 3 |
| International waste concepts (L325 | 9) | | | Lecture | 2 | 2 |
| International waste concepts (L326 | 0) | | | Recitation Section (small) | 1 | 1 |
| Module Responsible | Prof. Kerstin Kuchta | | | | | |
| Admission Requirements | None | | | | | |
| Recommended Previous | Basics in process engi | neering | | | | |
| Knowledge | | | | | | |
| Educational Objectives | After taking part succe | essfully, students have | reached the following | ng learning results | | |
| Professional Competence | | | | | | |
| Knowledge | The students are able | to describe waste as | a resource as well a | as advanced technologies for re | cycling and r | ecovery of resource |
| | from waste in detail. T | his covers collection, to | ansport, treatment | and disposal in national and inte | ernational con | texts. |
| Skille | Students are able to s | alact cuitable processo | for the treatment | with respect to the national or cu | ultural and do | volonmental contex |
| SKIIIS | | | | | | |
| | They can evaluate the | ecological impact and | | of different technologies and ma | anagement sy | stems. |
| Personal Competence | | | | | | |
| Social Competence | e Students can work together as a team of 2-5 persons, participate in subject-specific and interdisciplinary discussions, develop | | | | | |
| | cooperated solutions | and defend their own v | vork results in front | t of others and promote the scie | entific develo | oment of colleague |
| | Furthermore, they car | give and accept profe | ssional constructive | criticisms. | | |
| Autonomy | Students can indeper | dently gain additional | knowledge of the | subject area and apply it in so | lving the giv | en course tasks ar |
| Autonomy | Students can independently gain additional knowledge of the subject area and apply it in solving the given course tasks and projects. | | | | | |
| | projects. | | | | | |
| Workload in Hours | Independent Study Tir | ne 96, Study Time in Le | ecture 84 | | | |
| Credit points | 6 | | | | | |
| Course achievement | Compulsory Bonus | Form | Description | | | |
| | Yes 20 % | Written elaboration | | | | |
| Examination | Presentation | | | | | |
| Examination duration and | PowerPoint presentati | on (10-15 minutes) | | | | |
| scale | | | | | | |
| • | Civil Engineering: Spe | | | • | | |
| Following Curricula | - | | | ocess Engineering: Elective Comp | | |
| | | | | Engineering: Elective Compulsor | | |
| | - | | | rocess Engineering: Elective Con | | |
| | | | | nd Bio process Engineering: Elec | tive Compuls | ory |
| | | ess Engineering: Core C | | | | |
| | _ | ering: Specialisation En | | | 1 | |
| | - | | | newable Energy: Elective Compu | isory | |
| | | | | eering: Elective Compulsory | | |
| | | ntal Engineering: Speci | | | | |
| | water and Environme | ntai Engineering: Speci | ausation Environme | nt: Elective Compulsory | | |

| Course L3261: Waste manag | ement | | |
|---------------------------|---|--|--|
| Тур | Project-/problem-based Learning | | |
| Hrs/wk | | | |
| СР | 3 | | |
| Workload in Hours | Independent Study Time 48, Study Time in Lecture 42 | | |
| Lecturer | Prof. Rüdiger Siechau | | |
| Language | EN | | |
| Cycle | SoSe | | |
| Content | Introduction into the "Waste Management" consisting of: Thermal Process (incinerator, RDF combustion) Biological processes (Wet-/Dryfermentation) technology, energy, emissions, approval, etc. Group work design of systems/plants for energy recovery from waste The following points are to be processed: Input: waste (fraction collection and transportation, current quantity, material flows, possible amount of development) Plant (design, process diagram, technology, energy production) Output (energy quantity / type, by-products) Costs and resource protection (CO2 balance, substitution of primary raw materials / fossil fuels) Location and approval (infrastructure, expiration authorization procedure) Focus at the whole concept (advantages, disadvantages, risks and opportunities, discussion) | | |
| Literature | Einführung in die Abfallwirtschaft; Martin Kranert, Klaus Cord-Landwehr (Hrsg.); Vieweg + Teubner Verlag; 2010 | | |
| | Powerpoint-Folien in Stud IP | | |

| Course L3259: International | waste concepts |
|-----------------------------|--|
| Тур | Lecture |
| Hrs/wk | 2 |
| СР | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Prof. Kerstin Kuchta |
| Language | EN |
| Cycle | SoSe |
| Content | Waste avoidance and recycling are the focus of this lecture. Additionally, waste logistics (Collection, transport, export, fees and taxes) as well as international waste shipment solutions are presented. |
| | Other specific wastes, e.g. industrial waste, treatment concepts will be presented and developed by students themselves |
| | Waste composition and production on international level, wast eulogistic, collection and treatment in emerging and developing countries. |
| | Single national projects and studies will be prepared and presented by students |
| Literature | Basel convention |

| Course L3260: International | ourse L3260: International waste concepts | | |
|-----------------------------|---|--|--|
| Тур | Recitation Section (small) | | |
| Hrs/wk | 1 | | |
| CP | 1 | | |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 | | |
| Lecturer | Prof. Kerstin Kuchta | | |
| Language | EN | | |
| Cycle | SoSe | | |
| Content | See interlocking course | | |
| Literature | See interlocking course | | |

| Module M2032: Adva | nced Vadose Zone Hydrology | | | | |
|--|---|-----------------------------------|------------------------------------|------------------------------|--------------------------|
| _ | | | | | |
| Courses | | | | | |
| Title Modeling Processes in Vadose Zone Vadose Zone Hydrology (L2732) Vadose Zone Hydrology (L2733) | e (L2735) | Lecture | Section (small) Section (large) | Hrs/wk 2 2 2 | CP 2 2 2 |
| Module Responsible | Prof. Nima Shokri | | | | |
| Admission Requirements | None | | | | |
| Recommended Previous Knowledge | Basic knowledge in water and soil Comfortable with math and physics, critical thinking, creative problem solving Analytic skills | | | | |
| Educational Objectives | After taking part successfully, students hav | e reached the following learning | results | | |
| Professional Competence | | | | | |
| | The students will learn about soil characterization (solid and liquid phase), the energy state of soil water, the soil wate characteristic curve, flow in saturated and unsaturated soil as well as about solute transport in soil | | | | vater, the soil water |
| Skills | Students will work on practical examples modelling transport processes in soil using different quantitative tools including computer simulations and analytical tools. This will help them to apply knowledge in order to solve problems and tasks. | | | | |
| Personal Competence Social Competence | The module aims at raising awareness and enthusiasm for new knowledge related to water, soil and environment. This wi positively contribute to shape their work and life environment. | | | | |
| Autonomy | The students will be involved in many problem solving exercises. This will contribute toward their willingness to work independently and responsibly. | | | | |
| Workload in Hours | Independent Study Time 96, Study Time in Lecture 84 | | | | |
| Credit points | 6 | | | | |
| Course achievement | None | | | | |
| Examination | Written elaboration | | | | |
| Examination duration and | Report and Presentation | | | | |
| scale | | | | | |
| Assignment for the | | | ulsory | | |
| Following Curricula | Civil Engineering: Specialisation Water and | | | | |
| | Environmental Engineering: Core Qualificat | | | | |
| | Water and Environmental Engineering: Spe | | - | | |
| | Water and Environmental Engineering: Spe | cialisation Environment: Elective | e Compulsory | | |

| Course L2735: Modeling Processes in Vadose Zone | | |
|---|--|--|
| Тур | Recitation Section (small) | |
| Hrs/wk | 2 | |
| СР | 2 | |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 | |
| Lecturer | Mohammad Aziz Zarif | |
| Language | EN | |
| Cycle | SoSe | |
| Content | Numerical tools will be introduced and used to quantify flow and transport processes in soil | |
| Literature | NA | |

| Course L2732: Vadose Zone Hydrology | |
|-------------------------------------|--|
| Тур | Lecture |
| Hrs/wk | 2 |
| СР | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Prof. Nima Shokri |
| Language | EN |
| Cycle | SoSe |
| Content | Soil solid phase characterization, Soil liquid phase characterization, The energy state of soil water, Soil Water Characteristic |
| | Curve, Flow in saturated soil, Flow in unsaturated soil, Solute transport in porous media |
| Literature | - Environmental Soil Physics, by Daniel Hillel |
| | - Soil Physics, Sixth Edition, by William A. Jury and Robert Horton |
| | - Physical Hydrology, Second Edition, by S. Lawrence Dingman |
| | - Introduction to Physical Hydrology, by Martin R. Hendriks |

| Course L2733: Vadose Zone Hydrology | |
|-------------------------------------|---|
| Тур | Recitation Section (large) |
| Hrs/wk | 2 |
| СР | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Prof. Nima Shokri |
| Language | EN |
| Cycle | SoSe |
| Content | See interlocking course |
| Literature | See interlocking course |
| Module M0801: Wate | r Resources and -Supply | | | | |
|---|---|---------------------------|-------------------------------|-------------------|---------------------|
| Courses | | | | | |
| Title | | | Тур | Hrs/wk | СР |
| Chemistry of Drinking Water Treatment (L0311) | | | Lecture | 2 | 1 |
| Chemistry of Drinking Water Treat | ment (L0312) | | Recitation Section (large) | 1 | 2 |
| Water Resource Management (L04 | 02) | | Lecture | 2 | 2 |
| Water Resource Management (L04 | 03) | | Recitation Section (small) | 1 | 1 |
| Module Responsible | Prof. Mathias Ernst | | | | |
| Admission Requirements | None | | | | |
| Recommended Previous | Knowledge of water management and the | key processes involved | d in water treatment. | | |
| Knowledge | | | | | |
| Educational Objectives | After taking part successfully, students have | ve reached the followin | ig learning results | | |
| Professional Competence | | | | | |
| Knowledge | Students will be able to outline key areas | of conflict in water m | nanagement, as well as thei | r mutual depend | lence for sustainal |
| | water supply. They will understand releva | | | | |
| | outline the organisational structures of wat | | | | |
| | the scope of their application. | ter companies. mey w | in be able to explain the ava | | inene processes e |
| | the scope of their application. | | | | |
| Skills | Students will be able to assess comple | ex problems in drink | ing water production and | establish soluti | ons involving wa |
| | management and technical measures. The | | | | |
| | be able to carry out chemical calculation | | | | |
| | | | ene processes and apply ge | includy accepted | |
| | standards to these processes. | | | | |
| Personal Competence | | | | | |
| Social Competence | Working in a diverse group of specialists, | students will be able t | o develop and document co | mplex solutions | for the managem |
| | Social Competence Working in a diverse group of specialists, students will be able to develop and document complex solutions for the ma and treatment of drinking water. They will be able to take an appropriate professional position, for example represent interests. They will be able to develop joint solutions in teams of diverse experts and present these solutions to others. | | | - | |
| | | | | | |
| | interests. They will be able to develop joint | | uiverse experts and present | these solutions t | o others. |
| Autonomy | Students will be in a position to work on a s | subject independently | and present on this subject. | | |
| | | | | | |
| | Independent Study Time 96, Study Time in | Lecture 84 | | | |
| Credit points | | | | | |
| Course achievement | | | | | |
| | Written exam | | | | |
| | 60 min (chemistry) + presentation | | | | |
| scale | | | | | |
| - | Civil Engineering: Specialisation Structural | | | | |
| Following Curricula | Civil Engineering: Specialisation Geotechnic | | ve Compulsory | | |
| | Civil Engineering: Specialisation Water and | | | | |
| | Civil Engineering: Specialisation Coastal En | 5 5 | 1 , | | |
| | Chemical and Bioprocess Engineering: Tech | hnical Complementary | Course: Elective Compulsory | У | |
| | Chemical and Bioprocess Engineering: Tech | hnical Complementary | Course: Elective Compulsory | y | |
| | International Management and Engineering | g: Specialisation II. Ene | rgy and Environmental Engir | neering: Elective | Compulsory |
| | Process Engineering: Specialisation Enviror | nmental Process Engin | eering: Elective Compulsory | | |
| | Process Engineering: Specialisation Process | • | • • • | | |
| | Water and Environmental Engineering: Spe | 5 5 | | | |
| | Water and Environmental Engineering: Spe | | | | |
| | Water and Environmental Engineering: Spe | | | | |
| | water and Environmental Engineering: Spe | cialisation Citles: Elect | live compulsory | | |

| Course L0311: Chemistry of | Drinking Water Treatment |
|----------------------------|---|
| Тур | Lecture |
| Hrs/wk | 2 |
| СР | 1 |
| Workload in Hours | Independent Study Time 2, Study Time in Lecture 28 |
| Lecturer | Dr. Klaus Johannsen |
| Language | DE |
| Cycle | WiSe |
| Content | The topic of this course is water chemistry with respect to drinking water treatment and water distribution |
| | Major topics are solubility of gases, carbonic acid system and calcium carbonate, blending, softening, redox processes, materials and legal requirements on drinking water treatment. Focus is put on generally accepted rules of technology (DVGW- and DIN- standards). Special emphasis is put on calculations using realistic analysis data (e.g. calculation of pH or calcium carbonate dissolution potential) in exercises. Students can get a feedback and gain extra points for exam by solving problems for homework. Knowledge of drinking water treatment processes is vital for this lecture. Therefore the most important processes are explained coordinated with the course " Water resources management" in the beginning of the semester. |
| Literature | MHW (rev. by Crittenden, J. et al.): Water treatment principles and design. John Wiley & Sons, Hoboken, 2005. |
| | Stumm, W., Morgan, J.J.: Aquatic chemistry. John Wiley & Sons, New York, 1996. |
| | DVGW (Hrsg.): Wasseraufbereitung - Grundlagen und Verfahren. Oldenbourg Industrie Verlag, München, 2004. |
| | Jensen, J. N.: A Problem Solving Approach to Aquatic Chemistry. John Wiley & Sons, Inc., New York, 2003. |
| | |

| Course L0312: Chemistry of Drinking Water Treatment | | |
|---|---|--|
| Тур | Recitation Section (large) | |
| Hrs/wk | 1 | |
| CP | 2 | |
| Workload in Hours | Independent Study Time 46, Study Time in Lecture 14 | |
| Lecturer | Dr. Klaus Johannsen | |
| Language | DE | |
| Cycle | WiSe | |
| Content | See interlocking course | |
| Literature | See interlocking course | |

| Course L0402: Water Resour | ce Management |
|----------------------------|---|
| Тур | Lecture |
| Hrs/wk | 2 |
| СР | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Prof. Mathias Ernst |
| Language | DE |
| Cycle | WiSe |
| Content | The lecture provides comprehensive knowledge on interaction of water ressource management and drinking water supply. Content |
| | overview: • Current situation of global water resources • User and Stakeholder conflicts • Wasserressourcenmanagement in urbane Gebieten • Rechtliche Aspekte, Organisationsformen Trinkwasserversorgungsunternehmen. • Ökobilanzierung, Benchmarking in der Wasserversorgung |
| Literature | Aktuelle UN World Water Development Reports Branchenbild der deutschen Wasserwirtschaft, VKU (2011) Aktuelle Artikel wissenschaftlicher Zeitschriften Ppt der Vorlesung |

Module Manual M.Sc. "Water and Environmental Engineering"

| Course L0403: Water Resource Management | | |
|---|---|--|
| Тур | Recitation Section (small) | |
| Hrs/wk | 1 | |
| СР | 1 | |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 | |
| Lecturer | Prof. Mathias Ernst | |
| Language | DE | |
| Cycle | WiSe | |
| Content | See interlocking course | |
| Literature | See interlocking course | |

| Module M0802: Meml | | | | | |
|-----------------------------|---|---|---------------------|--------------------|--|
| Courses | | | | | |
| Title | | Тур | Hrs/wk | СР | |
| Membrane Technology (L0399) | | Lecture | 2 | 3 | |
| Membrane Technology (L0400) | | Recitation Section (small) | 1 | 2 | |
| Membrane Technology (L0401) | | Practical Course | 1 | 1 | |
| Module Responsible | | | | | |
| Admission Requirements | | | | | |
| Recommended Previous | | | | | |
| Knowledge | | | | | |
| | After taking part successfully, students have i | reached the following learning results | | | |
| Professional Competence | | | | | |
| Knowledge | | plications of industrially important membrane | | | |
| | the different driving forces behind existing | membrane separation processes. Students wi | ill be able to nar | ne materials used | |
| | membrane filtration and their advantages ar | nd disadvantages. Students will be able to exp | plain the key diffe | erences in the use | |
| | membranes in water, other liquid media, gases and in liquid/gas mixtures. | | | | |
| Skills | Students will be able to prepare mathematic | al equations for material transport in porous | and solution-diffu | sion membranes a | |
| Skiis | | | | | |
| | calculate key parameters in the membrane separation process. They will be able to handle technical membrane processes using | | | | |
| | available boundary data and provide recommendations for the sequence of different treatment processes. Through their own | | | | |
| | experiments, students will be able to classify the separation efficiency, filtration characteristics and application of different membrane materials. Students will be able to characterise the formation of the fouling layer in different waters and apply technic | | | | |
| | membrane materials. Students will be able to characterise the formation of the founing layer in different waters and apply technic measures to control this. | | | | |
| | | | | | |
| Personal Competence | | | | | |
| Social Competence | Students will be able to work in diverse team | ns on tasks in the field of membrane technolog | y. They will be ab | le to make decisio | |
| | within their group on laboratory experiments | to be undertaken jointly and present these to o | thers. | | |
| 4 | Chudente will be in a position to solve been | | | | |
| Autonomy | Students will be in a position to solve homework on the topic of membrane technology independently. They will be capable | | | | |
| | finding creative solutions to technical questio | ns. | | | |
| Workload in Hours | Independent Study Time 124, Study Time in L | Lecture 56 | | | |
| Credit points | 6 | | | | |
| Course achievement | None | | | | |
| Examination | Written exam | | | | |
| Examination duration and | 90 min | | | | |
| scale | | | | | |
| Assignment for the | Civil Engineering: Specialisation Water and Tr | affic: Elective Compulsory | | | |
| Following Curricula | Bioprocess Engineering: Specialisation A - Ger | neral Bioprocess Engineering: Elective Compuls | ory | | |
| | Bioprocess Engineering: Specialisation B - Industrial Bioprocess Engineering: Elective Compulsory | | | | |
| | Chemical and Bioprocess Engineering: Specialisation General Process Engineering: Elective Compulsory | | | | |
| | Chemical and Bioprocess Engineering: Specialisation Chemical Process Engineering: Elective Compulsory | | | | |
| | Chemical and Bioprocess Engineering: Technical Complementary Course: Elective Compulsory | | | | |
| | Chemical and Bioprocess Engineering: Technical Complementary Course: Elective Compulsory | | | | |
| | Environmental Engineering: Specialisation Water Quality and Water Engineering: Elective Compulsory | | | | |
| | Process Engineering: Specialisation Process E | | | | |
| | Process Engineering: Specialisation Environm | ental Process Engineering: Elective Compulsory | / | | |
| | Water and Environmental Engineering: Specia | alisation Water: Elective Compulsory | | | |
| | Water and Environmental Engineering: Specia | alisation Environment: Elective Compulsory | | | |
| | | | | | |

| Course L0399: Membrane Te | chnology |
|---------------------------|--|
| Тур | Lecture |
| Hrs/wk | 2 |
| CP | 3 |
| Workload in Hours | Independent Study Time 62, Study Time in Lecture 28 |
| Lecturer | Prof. Mathias Ernst |
| Language | EN |
| Cycle | WiSe |
| Content | The lecture on membrane technology supply provides students with a broad understanding of existing membrane treatment processes, encompassing pressure driven membrane processes, membrane application in electrodialyis, pervaporation as well as membrane distillation. The lectures main focus is the industrial production of drinking water like particle separation or desalination; however gas separation processes as well as specific wastewater oriented applications such as membrane bioreactor systems will be discussed as well. Initially, basics in low pressure and high pressure membrane applications are presented (microfiltration, ultrafiltration, nanofiltration, reverse osmosis). Students learn about essential water quality parameter, transport equations and key parameter for pore membrane as well as solution diffusion membrane systems. The lecture sets a specific focus on fouling and scaling issues and provides knowledge on methods how to tackle with these phenomena in real water treatment application. A further part of the lecture deals with the character and manufacturing of different membrane materials and the characterization of membrane material by simple methods and advanced analysis. The functions, advantages and drawbacks of different membrane housings and modules are explained. Students learn how an industrial membrane application is designed in the succession of treatment steps like pre-treatment, water conditioning, membrane integration and post-treatment of water. Besides theory, the students will be provided with knowledge on membrane |
| Literature | demo-site examples and insights in industrial practice. • T. Melin, R. Rautenbach: Membranverfahren: Grundlagen der Modul- und Anlagenauslegung (2., erweiterte Auflage), |
| | Springer-Verlag, Berlin 2004. Marcel Mulder, Basic Principles of Membrane Technology, Kluwer Academic Publishers, Dordrecht, The Netherlands Richard W. Baker, Membrane Technology and Applications, Second Edition, John Wiley & Sons, Ltd., 2004 |

| Course L0400: Membrane Te | irse L0400: Membrane Technology | | |
|---------------------------|---|--|--|
| Тур | Recitation Section (small) | | |
| Hrs/wk | 1 | | |
| СР | 2 | | |
| Workload in Hours | Independent Study Time 46, Study Time in Lecture 14 | | |
| Lecturer | Prof. Mathias Ernst | | |
| Language | EN | | |
| Cycle | WiSe | | |
| Content | See interlocking course | | |
| Literature | See interlocking course | | |

| Course L0401: Membrane Technology | | |
|-----------------------------------|---|--|
| Тур | Practical Course | |
| Hrs/wk | 1 | |
| СР | 1 | |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 | |
| Lecturer | Prof. Mathias Ernst | |
| Language | EN | |
| Cycle | WiSe | |
| Content | See interlocking course | |
| Literature | See interlocking course | |

| Module M0822: Proce | ess Modeling in Water Techno | logy | | |
|-----------------------------------|--|---|-------------------|---------------------------|
| Courses | | | | |
| Title | | Тур | Hrs/wk | СР |
| Process Modelling of Wastewater T | reatment (L0522) | Project-/problem-based Learnin | g 2 | 3 |
| Process Modeling in Drinking Wate | r Treatment (L0314) | Project-/problem-based Learnin | g 2 | 3 |
| Module Responsible | Dr. Klaus Johannsen | | | |
| Admission Requirements | None | | | |
| Recommended Previous | Knowledge of the most important processe | es in drinking water and waste water treatment. | | |
| Knowledge | | | | |
| Educational Objectives | After taking part successfully, students ha | ve reached the following learning results | | |
| Professional Competence | | | | |
| Knowledge | Students are able to explain selected pro | cesses of drinking water and waste water treatme | nt in detail. The | ey are able to expla |
| | basics as well as possibilities and limitation | ns of dynamic modeling. | | |
| Skills | Students are able to use the most import | ant features Modelica offers. They are able to tran | spose selected | processes in drinki |
| Skiis | | nathematical model in Modelica with respect to equ | | |
| | | and assess their possibilities and limitations. | | |
| | | | | |
| | | | | |
| Personal Competence | | | | |
| • | Students are able to solve problems and o | locument solutions in a group with members of diffe | erent technical l | background They a |
| | | work constructively with feedback concerning their | | a ang a ang a ang a ang a |
| | | ······································ | | |
| | | | | |
| Autonomy | Students are able to define a problem, gai | n the required knowledge and set up a model. | | |
| hatohomy | statents are able to define a problem, ga | n ne required knowledge and set up a model. | | |
| | | | | |
| Workload in Hours | Independent Study Time 124, Study Time | in Lecture 56 | | |
| Credit points | | | | |
| Course achievement | None | | | |
| Examination | Oral exam | | | |
| Examination duration and | 30 min | | | |
| scale | | | | |
| Assignment for the | Civil Engineering: Specialisation Water and | I Traffic: Elective Compulsory | | |
| Following Curricula | Chemical and Bioprocess Engineering: Tec | hnical Complementary Course: Elective Compulsory | | |
| - | | hnical Complementary Course: Elective Compulsory | | |
| | Environmental Engineering: Specialisation | Water Quality and Water Engineering: Elective Com | pulsory | |
| | Process Engineering: Specialisation Enviro | nmental Process Engineering: Elective Compulsory | | |
| | Process Engineering: Specialisation Proces | s Engineering: Elective Compulsory | | |
| | Water and Environmental Engineering: Spe | ecialisation Water: Elective Compulsory | | |
| | Water and Environmental Engineering: Spe | ecialisation Environment: Elective Compulsory | | |
| | Water and Environmental Engineering: Spe | ecialisation Cities: Elective Compulsory | | |

| Course L0522: Process Mode | lling of Wastewater Treatment |
|----------------------------|---|
| Тур | Project-/problem-based Learning |
| Hrs/wk | 2 |
| СР | 3 |
| Workload in Hours | Independent Study Time 62, Study Time in Lecture 28 |
| Lecturer | Dr. Joachim Behrendt |
| Language | DE/EN |
| Cycle | WiSe |
| Content | Mass and energy balances |
| | Tracer modelling |
| | |
| | Activated Sludge Model |
| | Wastewater Treatment Plant Modelling (continously and SBR) |
| | |
| | Sludge Treatment (ADM, aerobic autothermal) |
| | Biofilm Modelling |
| Literature | Henze, Mogens (Seminar on Activated Sludge Modelling, ; Kollekolle Seminar on Activated Sludge Modelling, ;) |
| | Activated sludge modelling : processes in theory and practice ; selected proceedings of the 5th Kollekolle Seminar on Activated |
| | Sludge Modelling, held in Kollekolle, Denmark, 10 - 12 September 2001 |
| | ISBN: 1843394146 |
| | [London] : IWA Publ., 2002 |
| | TUB_HH_Katalog |
| | Henze, Mogens |
| | Activated sludge models ASM1, ASM2, ASM2d and ASM3 |
| | ISBN: 1900222248 |
| | London : IWA Publ., 2002 |
| | TUB_HH_Katalog |
| | Henze, Mogens |
| | Wastewater treatment : biological and chemical processes ISBN: 3540422285 (Pp.) |
| | Berlin [u.a.] : Springer, 2002 |
| | TUB_HH_Katalog |
| | Wiesmann, Udo (Choi, In Su; Dombrowski, Eva-Maria;) |
| | Fundamentals of biological wastewater treatment |
| | ISBN: 3527312196 (Gb.) URL: http://deposit.ddb.de/cgi-bin/dokserv?id=2774611&prov=M&dok_var=1&dok_ext=htm |
| | Weinheim : WILEY-VCH, 2007 |
| | |
| | TUB_HH_Katalog |

| Course L0314: Process Mode | ling in Drinking Water Treatment |
|----------------------------|--|
| Тур | Project-/problem-based Learning |
| Hrs/wk | 2 |
| СР | 3 |
| Workload in Hours | Independent Study Time 62, Study Time in Lecture 28 |
| Lecturer | Dr. Klaus Johannsen |
| Language | EN |
| Cycle | WiSe |
| Content | In this course selected drinking water treatment processes (e.g. aeration or activated carbon adsorption) are modeled dynamically using the programming language Modelica, that is increasingly used in industry. In this course OpenModelica is used, an free access frontend of the programming language Modelica. |
| | In the beginning of the course the use of OpenModelica is explainded by means of simple examples. Together required elements and structure of the model are developed. The implementation in OpenModelica and the application of the model is done individually or in groups respectively. Students get feedback and can gain extra points for the exam. |
| Literature | OpenModelica: https://openmodelica.org/index.php/download/download-windows |
| | OpenModelica - Modelica Tutorial: https://openmodelica.org/index.php/useresresources/userdocumentation |
| | OpenModelica - Users Guide: https://openmodelica.org/index.php/useresresources/userdocumentation |
| | Peter Fritzson: Principles of Object-Oriented Modeling and Simulation with Modelica 2.1, Wiley-IEEE Press, ISBN 0-471-471631. |
| | MHW (rev. by Crittenden, J. et al.): Water treatment principles and design. John Wiley & Sons, Hoboken, 2005. |
| | Stumm, W., Morgan, J.J.: Aquatic chemistry. John Wiley & Sons, New York, 1996. |
| | DVGW (Hrsg.): Wasseraufbereitung - Grundlagen und Verfahren. Oldenbourg Industrie Verlag, München, 2004. |
| | |

| Courses | |
|---|---|
| Title | Typ Hrs/wk CP |
| Adaptation to climate change in hy | |
| Module Responsible | Prof. Peter Fröhle |
| Admission Requirements | None |
| Recommended Previous Knowledge | Hydrology, Hydraulic Engineering Hydromechanic, Hydraulics Fundamentals of Coastal Engineering, Coastal- and Flood Protection Hydrological Systems |
| Educational Objectives | After taking part successfully, students have reached the following learning results |
| Professional Competence Knowledge Skills | Climate protection and climate adaptation Insights into climate change and its regional characteristics - fundamentals, climate modelling / climate models Impacts of climate change on the components of the regional hydrological cycle Fundamentals of analysis of climate data Consequences of the impact of the climate change Measures for climate adaptation Assessment, prioritization and communication of adaptation measures Fundamentals of the analysis of hydrometeorological and hydrological data Critical thinking: analysis of processes and relations, assessment of needs for action Creative thinking: development of adaptation strategies and adaptation measures Practical thinking: inclusion of restrictions, application of calculation approaches, methods, numerical models, plann methods Consideration of complex tasks |
| Personal Competence Social Competence Autonomy | Working in heterogenous groups Working with different scientific / non-scientific disciplines Self reflection Application oriented use of knowledge and skills |
| | Autonomous work on complex tasks |
| Workload in Hours | Independent Study Time 124, Study Time in Lecture 56 |
| Credit points | 6 |
| Course achievement | None |
| Examination | Written elaboration |
| Examination duration and scale | Preparation of a written report and a presentation of a complex task. |
| Assignment for the | Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory |
| Following Curricula | Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory |
| | Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation Water and Traffic: Elective Compulsory |
| | Water and Environmental Engineering: Specialisation Cities: Elective Compulsory |
| | Water and Environmental Engineering: Specialisation Entres. Elective Compulsory |
| | Water and Environmental Engineering: Specialisation Water: Elective Compulsory |

| Course L2291: Adaptation to | climate change in hydraulic engineering | |
|-----------------------------|--|--|
| Тур | Project-/problem-based Learning | |
| Hrs/wk | 4 | |
| CP | 6 | |
| Workload in Hours | Independent Study Time 124, Study Time in Lecture 56 | |
| Lecturer | Prof. Peter Fröhle | |
| Language | DE | |
| Cycle | WiSe | |
| Content | Climate protection and climate adaptation Findings on climate change and its regional characteristics: fundamentals of climate change, climate modelling / climate models Impacts of climate change on the components of the regional hydrological cycle(climate science view) Fundamentals of the analysis of climate data Concequences of the impacts of climate change (ingenieering science view) Measures for climate change adaptation Assessment, prioritization and communication of measures Fundamentals of analysis of hydrometeorological and hydrological data | |
| Literature | Wird bereitgestellt über die HOOU - eLearning Plattform abhängig von den jeweils schwerpunktmäßig behandelten Fragestellungen wird das Schrifttum (aktuelle Paper) in der Veranstaltung bzw. über StudIP zur Verfügung gestellt. | |

| Module M1123: Selec | ted Topics in Environmental E | Engineering | | |
|-------------------------------------|--|--|--------|----|
| Courses | | | | |
| Title | | Тур | Hrs/wk | СР |
| Environmental Aquatic Chemistry (| _1444) | Lecture | 2 | 3 |
| Solid Matter Process Technology fo | · Biomass (L0052) | Lecture | 2 | 3 |
| Sustainable landfill design and ope | ation (L3270) | Integrated Lecture | 3 | 3 |
| Sludge Treatment (L0520) | | Lecture | 2 | 3 |
| Special topics of the Environmenta | | | 1 | 1 |
| Special topics of the Environmenta | | | 2 | 2 |
| Special topics of the Environmenta | | | 3 | 3 |
| Thermal Biomass Utilization (L1767 | , | Lecture | 2 | 2 |
| Thermal Biomass Utilization (L2386 |) | Practical Course | 1 | 1 |
| Module Responsible | Prof. Mathias Ernst | | | |
| Admission Requirements | None | | | |
| Recommended Previous | | | | |
| Knowledge | | | | |
| Educational Objectives | After taking part successfully, students hav | ve reached the following learning results | | |
| Professional Competence | | | | |
| Knowledge | | | | |
| Skills | | | | |
| Personal Competence | | | | |
| Social Competence | | | | |
| Autonomy | | | | |
| Workload in Hours | Depends on choice of courses | | | |
| Credit points | 6 | | | |
| Assignment for the | Environmental Engineering: Core Qualificat | tion: Elective Compulsory | | |
| Following Curricula | Water and Environmental Engineering: Spe | cialisation Cities: Elective Compulsory | | |
| | Water and Environmental Engineering: Spe | cialisation Environment: Elective Compulsory | | |
| | Water and Environmental Engineering: Spe | | | |

| Course L1444: Environmenta | I Aquatic Chemistry |
|----------------------------|---|
| Тур | Lecture |
| Hrs/wk | 2 |
| СР | 3 |
| Workload in Hours | Independent Study Time 62, Study Time in Lecture 28 |
| Examination Form | Klausur |
| Examination duration and | 60 min |
| scale | |
| Lecturer | Dr. Klaus Johannsen |
| Language | EN |
| Cycle | SoSe |
| Content | Concentration and activity Gas-water partitioning Acid/base equilibria Alkalinity and acidity Precipitation/dissolution equilibria Redox equilibria Complex formation Sorption |
| Literature | Worch, E.: Hydrochemistry. Basic Concepts and Exercises. De Gruyter, Berlin, 2015 |

| Course L0052: Solid Matter F | Process Technology for Biomass |
|------------------------------|--|
| Тур | Lecture |
| Hrs/wk | 2 |
| СР | 3 |
| Workload in Hours | Independent Study Time 62, Study Time in Lecture 28 |
| Examination Form | Klausur |
| Examination duration and | 60 min |
| scale | |
| Lecturer | Prof. Werner Sitzmann |
| Language | DE |
| Cycle | SoSe |
| Content | The industrial application of unit operations as part of process engineering is explained by actual examples of solid biomass |
| | processes. Size reduction, transportation and dosing, drying and agglomeration of renewable resources are described as important |
| | unit operations when producing solid fuels and bioethanol, producing and refining edible oils, when making Btl - and WPC - |
| | products. Aspects of explosion protection and plant design complete the lecture. |
| Literature | Kaltschmitt M., Hartmann H. (Hrsg.): Energie aus Bioamsse, Springer Verlag, 2001, ISBN 3-540-64853-4 |
| | Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz, Schriftenreihe Nachwachsende Rohstoffe, |
| | Fachagentur Nachwachsende Rohstoffe e.V. www.nachwachsende-rohstoffe.de |
| | Bockisch M.: Nahrungsfette und -öle, Ulmer Verlag, 1993, ISBN 380000158175 |
| | |

| Course L3270: Sustainable la | andfill design and operation |
|------------------------------|--|
| Тур | Integrated Lecture |
| Hrs/wk | 3 |
| СР | 3 |
| Workload in Hours | Independent Study Time 48, Study Time in Lecture 42 |
| Examination Form | Klausur |
| Examination duration and | 60 min |
| scale | |
| Lecturer | Dr. Marco Ritzkowski |
| Language | EN |
| Cycle | SoSe |
| Content | The course introduces the development of modern waste resource management and demonstrates the importance of landfills in the context of recycling processes. Based on international (EU) and national legislation, the current landfill situation is presented and the future significance of landfills will be discussed. A central element of the course deals with the main transformation processes in the landfilled waste, the emission of gases and leachate, the long-term behaviour of landfills as well as aftercare and after-utilisation measures. Further focal points of the course are measures for the sustainable reduction of environmentally and climate-damaging emissions and aspects of landfill technology in an international context. |
| Literature | Waste Management. Bernd Bilitewski; Georg Härdtle; Klaus Marek (Eds.), ISBN: 9783540592105, Springer Verlag Lehrbuchsammlung der TUB, Signatur USH-305 Solid Waste Technology and Management. Thomas Christensen (Ed.), ISBN: 978-1-4051-7517-3, Wiley Verlag Lesesaal 2: US - Umweltschutz, Signatur USH-332 Solid Waste Landfilling - Concepts, Processes, Technologies. Cossu, R. and Stegmann, R. (Eds.), ISBN: 978-0-12-818336-6 PDF (Volltext) über TUB |

Module Manual M.Sc. "Water and Environmental Engineering"

| Lingineering | | |
|--------------------------------|---|--|
| Course L0520: Sludge Treatment | | |
| Тур | Lecture | |
| Hrs/wk | 2 | |
| СР | 3 | |
| Workload in Hours | Independent Study Time 62, Study Time in Lecture 28 | |
| Examination Form | Klausur | |
| Examination duration and | 60 min | |
| scale | | |
| Lecturer | Dr. Joachim Behrendt | |
| Language | EN | |
| Cycle | SoSe | |
| Content | Sedimentation characteristic and thickening, | |
| | Centrifugation, | |
| | Flotation, | |
| | Filtration, | |
| | Aerobic sludge stabilisation, | |
| | Sludge Digestion, | |
| | Sludge Disintegration, | |
| | Sludge Dewatering, | |
| | Natural Processes for Sludge Treatment, | |
| | Nutrient Recovery from Sludge, | |
| | Thermal Processes and Incineration. | |
| Literature | Tchobanoglous, George (Metcalf & Eddy, Inc., ;) | |
| | Wastewater engineering : treatment and reuse | |
| | ISBN: 0070418780 (alk. paper) ISBN: 0071122508 (ISE (*pbk)) | |
| | Boston [u.a.] : McGraw-Hill, 2003 | |
| | TUB_HH_Katalog | |
| | Cleverson Vitorio Andreoli, Marcos von Sperling, Fernando Fernandes | |
| | Sludge Treatment and Disposal | |
| | ISBN 9781843391661 | |
| | IWA Publishing, 2007 | |
| | | |

| Course L3289: Special topics of the Environmental engineering 1CP | |
|---|---|
| Тур | |
| Hrs/wk | 1 |
| СР | 1 |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 |
| Examination Form | Fachtheoretisch-fachpraktische Arbeit |
| Examination duration and | wird zu Beginn der Veranstaltung festgelegt |
| scale | |
| Lecturer | Dozenten des SD B |
| Language | DE/EN |
| Cycle | WiSe/SoSe |
| Content | The course occurs only if required. The content is defined at short notice. |
| Literature | Die Literatur wird kurzfristig festgelegt. |

| Course L3290: Special topics of the Environmental engineering 2CP | | |
|---|---|--|
| Тур | | |
| Hrs/wk | 2 | |
| СР | 2 | |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 | |
| Examination Form | Fachtheoretisch-fachpraktische Arbeit | |
| Examination duration and | wird zu Beginn der Veranstaltung festgelegt | |
| scale | | |
| Lecturer | Dozenten des SD B | |
| Language | DE/EN | |
| Cycle | WiSe/SoSe | |
| Content | The course occurs only if required. The content is defined at short notice. | |
| Literature | Die Literatur wird kurzfristig festgelegt. | |

| Course L3291: Special topics of the Environmental engineering 3CP | |
|---|---|
| Тур | |
| Hrs/wk | 3 |
| СР | 3 |
| Workload in Hours | Independent Study Time 48, Study Time in Lecture 42 |
| Examination Form | Fachtheoretisch-fachpraktische Arbeit |
| Examination duration and | wird zu Beginn der Veranstaltung festgelegt |
| scale | |
| Lecturer | Dozenten des SD B |
| Language | DE/EN |
| Cycle | WiSe/SoSe |
| Content | The course occurs only if required. The content is defined at short notice. |
| Literature | Die Literatur wird kurzfristig festgelegt. |

| Course L1767: Thermal Biom | ass Utilization | |
|----------------------------|--|--|
| Тур | Lecture | |
| Hrs/wk | 2 | |
| CP | 2 | |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 | |
| Examination Form | Klausur | |
| Examination duration and | 60 min | |
| scale | | |
| Lecturer | Prof. Martin Kaltschmitt | |
| Language | DE | |
| Cycle | WiSe | |
| Content | Goal of this course is it to discuss the physical, chemical, and biological as well as the technical, economic, and environmental basics of all options to provide energy from biomass from a German and international point of view. Additionally different system approaches to use biomass for energy, aspects to integrate bioenergy within the energy system, technical and economic development potentials, and the current and expected future use within the energy system are presented. The course is structured as follows: | |
| | Biomass as an energy carrier within the energy system; use of biomass in Germany and world-wide, overview on the content of the course Photosynthesis, composition of organic matter, plant production, energy crops, residues, organic waste Biomass provision chains for woody and herbaceous biomass, harvesting and provision, transport, storage, drying Thermo-chemical conversion of solid biofuels Basics of thermo-chemical conversion Direct thermo-chemical conversion through combustion: combustion technologies for small and large scale units electricity generation technologies, flue gas treatment technologies, ashes and their use Gasification: Gasification technologies, producer gas cleaning technologies, options to use the cleaned producer gas | |
| | for the provision of heat, electricity and/or fuels Fast and slow pyrolysis: Technologies for the provision of bio-oil and/or for the provision of charcoal, oil cleaning technologies, options to use the pyrolysis oil and charcoal as an energy carrier as well as a raw material Physical-chemical conversion of biomass containing oils and/or fats: Basics, oil seeds and oil fruits, vegetable oil production production of a biofuel with standardized characteristics (trans-esterification, hydrogenation, co-processing in existing refineries), options to use this fuel, options to use the residues (i.e. meal, glycerine) Bio-chemical conversion of biomass Basics of bio-chemical conversion Biogas: Process technologies for plants using agricultural feedstock, sewage sludge (sewage gas), organic waste fraction (landfill gas), technologies for the provision of bio methane, use of the digested slurry Ethanol production: Process technologies for feedstock containing sugar, starch or celluloses, use of ethanol as a fuel use of the stillage | |
| Literature | Kaltschmitt, M.; Hartmann, H. (Hrsg.): Energie aus Biomasse; Springer, Berlin, Heidelberg, 2009, 2. Auflage | |

| Course L2386: Thermal Biom | ass Utilization |
|----------------------------|---|
| Тур | Practical Course |
| Hrs/wk | 1 |
| СР | 1 |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 |
| Examination Form | Schriftliche Ausarbeitung |
| Examination duration and | Protokolle |
| scale | |
| Lecturer | Prof. Martin Kaltschmitt, Dr. Marvin Scherzinger |
| Language | DE |
| Cycle | WiSe |
| Content | The experiments of the practical lab course illustrate the different aspects of heat generation from biogenic solid fuels. First, different biomasses (e.g. wood, straw or agricultural residues) will be investigated; the focus will be on the calorific value of the biomass. Furthermore, the used biomass will be pelletized, the pellet properties analysed and a combustion test carried out on a pellet combustion system. The gaseous and solid pollutant emissions, especially the particulate matter emissions, are measured and the composition of the particulate matter is investigated in a further experiment. Another focus of the practical course is the consideration of options for the reduction of particulate matter emissions from biomass combustion. In the practical course, a method for particulate matter reduction will be developed and tested. All experiments will be evaluated and the results presented. Within the practical lab course the students discuss different technical-scientific tasks, both subject-specifically and interdisciplinary. They discuss various approaches to solving the problem and advise on the theoretical or practical implementation. |
| Literature | Kaltschmitt, Martin; Hartmann, Hans; Hofbauer, Hermann: Energie aus Biomasse: Grundlagen, Techniken und Verfahren. 3. Auflage. Berlin Heidelberg: Springer Science & Business Media, 2016ISBN 978-3-662-47437-2 Versuchsskript |

| Module M1720: Emerging Trends in Environmental Engineering | | | | |
|--|---|--|---------------------|----------------------|
| | | | | |
| Courses | | | | |
| Title | | Тур | Hrs/wk | СР |
| Environmental Research Trends (L2 | | Seminar | 2 | 2 |
| Microplastics in Environment (L275 | | Lecture | 2 | 2 |
| Scientific Communication and Meth | | Lecture | 1 | 2 |
| Module Responsible | | | | |
| Admission Requirements | | | | |
| | Basic knowledge on water, soil and enviro | onmental research. | | |
| Knowledge | After taking part successfully, students by | ave reached the following learning results | | |
| Professional Competence | After taking part successfully, students ha | ave reached the following learning results | | |
| Knowledge | The students will be exposed to up-to-date research topics focused on soil, water and climate related challenges with a particula focus on the effects of microplastics in environment. Data analysis, data measurement, curation and presentation will be othe skills that the students will develop in this module. | | | |
| Skills | Students' research skills will be improved in this module. How to prepare and deliver an effective presentation, how to write an abstract, research paper and proposal will be discussed in this module. Moreover, through Research-Based Learning approaches the students will be exposed to current research trends in environmental engineering. | | | |
| Personal Competence Social Competence | Developing teamwork and problem solvin | ng skills through Research-Based Teaching approad | ches will be at the | core of this module. |
| | | · · · · · · · · · · · · · · · · · · · | | |
| Autonomy | The students will be involved in writing willingness to work independently and res | g individual reports and presentation. This will esponsibly. | contribute to the | students' ability an |
| Workload in Hours | Independent Study Time 110, Study Time | e in Lecture 70 | | |
| Credit points | 6 | | | |
| Course achievement | None | | | |
| Examination | Subject theoretical and practical work | | | |
| Examination duration and | Report and Presentation | | | - |
| scale | | | | |
| Assignment for the | Civil Engineering: Specialisation Water an | nd Traffic: Elective Compulsory | | |
| Following Curricula | Environmental Engineering: Specialisation | n Environment and Climate: Elective Compulsory | | |
| | Water and Environmental Engineering: Sp | pecialisation Cities: Elective Compulsory | | |
| | Water and Environmental Engineering: Sp | pecialisation Environment: Elective Compulsory | | |
| | - • • | | | |

| Course L2752: Environmenta | I Research Trends |
|----------------------------|--|
| Тур | Seminar |
| Hrs/wk | 2 |
| СР | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Dr. Salome Shokri-Kuehni |
| Language | EN |
| Cycle | WiSe |
| Content | Introduction - course objectives, expectations and format |
| | Analyzing the Audience, purpose and occasion |
| | Constructing and delivering effective technical presentations |
| | How to write an abstract |
| | How to write a scientific paper |
| | Developing competitive and persuasive research proposals |
| | Databases and resources available for water and environmental research |
| | Individual proposal on water and environmental research |
| | Individual project on water and environmental research |
| | Presentation on water and environmental research |
| Literature | The Craft of Scientific Writing Fourth edition Author: Michael Alley Springer-Verlag New York, Copyright 2018, DOI 10.1007/978-1-4419-8288-9 Supplemental materials and web links which will be available to registered students. |

| Course L2750: Microplastics | in Environment |
|-----------------------------|---|
| Тур | Lecture |
| Hrs/wk | 2 |
| СР | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Prof. Nima Shokri |
| Language | |
| Cycle | |
| Content | - Introduction, objectives, expectations, format, importance |
| | - Sources of microplastics in environment |
| | - Microplastics sampling; Characterization of microplastics |
| | - Distribution of microplastics in terrestrial environments |
| | - Fate of microplastics in terrestrial environments |
| | - Project discussion |
| | - Effects of microplastics on terrestrial environments |
| | - Health risks of microplastics in environments |
| | - Project presentations by all students |
| Literature | - Microplastics in Terrestrial Environments (2021), Edited by Defu He and Yongming Luo |
| | - Particulate Plastics in Terrestrial and Aquatic Environments (2020), Edited by Nanthi S. Bolan et al. |
| | - Microplastic Pollutants (2017), by Christopher B. Crawford and Brian Quinn |

| Course L2751: Scientific Con | munication and Methods |
|------------------------------|--|
| Тур | Lecture |
| Hrs/wk | 1 |
| СР | 2 |
| Workload in Hours | Independent Study Time 46, Study Time in Lecture 14 |
| Lecturer | Prof. Nima Shokri |
| Language | EN |
| Cycle | WiSe |
| Content | Introduction - course objectives, expectations and format |
| | Analyzing the Audience, purpose and occasion |
| | Constructing and delivering effective technical presentations |
| | How to write an abstract |
| | How to create a scientific poster |
| | How to write a scientific paper |
| | Developing competitive and persuasive research proposals |
| | Individual project (report and presentation) related to soil, water and environmental research |
| | |
| Literature | The Craft of Scientific Writing Fourth edition |
| | Author: Michael Alley |
| | Springer-Verlag New York, Copyright 2018, DOI 10.1007/978-1-4419-8288-9 |
| | Supplemental materials and web links which will be available to registered students. |

| | | Тур | Hrs/wk | СР |
|---|---|---|---|--|
| rotection in a Changing Climate (SeaP | 'iaC) (L2926) | Project-/problem-based Learning | 4 | 6 |
| Prof. Peter Fröhle | | | | |
| None | | | | |
| | | | | |
| | s | | | |
| | | od Protection | | |
| | .g.neering, eeastar ana rio | | | |
| After taking part successfully, stud | lents have reached the follo | owing learning results | | |
| | | | | |
| Climate and Climate Change | ٩ | | | |
| - | | nd Water Cvcle | | |
| | | | | |
| | | | | |
| • Fundamentals of Climate Ad | daptation | | | |
| Nature-based Solutions (NB | S) for Coastal Protection | | | |
| | | | | |
| Critical thinking: analysis of | processes and relations, a | ssessment of needs for action | | |
| Creative thinking: developm | nent of adaptation strategie | es and adaptation measures | | |
| Practical thinking: inclusior | n of restrictions, applicatio | on of calculation approaches, meth | ods, numerical | l models, plannir |
| methods | | | | |
| Consideration of complex ta | asks | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | tific / non-scientific discipli | nes | | |
| Self reflection | | | | |
| | | | | |
| | | | | |
| Autonomous work on compl | ex tasks | | | |
| Independent Study Time 124, Stuc | dy Time in Lecture 56 | | | |
| 6 | | | | |
| None | | | | |
| Written elaboration | | | | |
| Preparation of a written report on | a complex task with a pre | esentation and subsequent discussion | on. The work or | n the complex tas |
| happens in the course of the lectur | re. | | | |
| Civil Engineering: Specialisation Co | oastal Engineering: Elective | 2 Compulsory | | |
| Civil Engineering: Specialisation Ge | eotechnical Engineering: El | ective Compulsory | | |
| | • • | | | |
| | | | | |
| | | | | |
| Water and Environmental Engineer | ring: Specialisation Cities: I | Elective Compulsory | | |
| Water and Environmental Engineer | | | | |
| | Prof. Peter Fröhle None • Hydraulic Engineering • Hydromechanics, Hydraulic • Fundamentals of Coastal Er After taking part successfully, stud • Climate and Climate Chang • General Impacts of Climate • Consequences of Climate OC • Coastal Protection in Taiwar • Fundamentals of Climate Ad • Nature-based Solutions (NB • Critical thinking: analysis of • Creative thinking: developm • Practical thinking: inclusion • Critical thinking: inclusion • Critical thinking: inclusion • Working in heterogenous gr • Working in international gro • Working with different scier • Self reflection • Application oriented use of • Autonomous work on compi Independent Study Time 124, Stude None Written elaboration Preparation of a written report on happens in the course of the lectu Civil Engineering: Specialisation G Civil Engineering: Specialisation St Civil Engineering: Specialisation W Environmental Engineering: Specialisation W | None • Hydraulic Engineering • Hydromechanics, Hydraulics • Fundamentals of Coastal Engineering, Coastal- and Flo After taking part successfully, students have reached the follo • Climate and Climate Change • General Impacts of Climate Change on Wind Regime and • Consequences of Climate Change for Coastal Processee • Coastal Protection in Taiwan and Germany • Fundamentals of Climate Adaptation • Nature-based Solutions (NBS) for Coastal Protection • Critical thinking: analysis of processes and relations, and • Creative thinking: inclusion of restrictions, application methods • Consideration of complex tasks • Working in heterogenous groups • Working with different scientific / non-scientific discipli • Self reflection • Application oriented use of knowledge and skills • Autonomous work on complex tasks Independent Study Time 124, Study Time in Lecture 56 6 None Written elaboration Preparation of a written report on a complex task with a prehappens in the course of the lecture. Civil Engineering: Specialisation Coastal Engineering: Elective Civil Engineering: Specialisation Structural Engineering: Elective Civil Engineering: Specialisation Structural Engineering: Elective Civil Engi | rotection in a Changing Climate (SeaPiaC) (L2926) Prof. Peter Fröhle None | rotection in a Changing Climate (SeaPlaC) (12926) Project-/problem-based Learning 4 Prof. Peter Fröhle None Hydraulic Engineering Hydraulic Engineering Hydraulic Engineering, Coastal - and Flood Protection After taking part successfully, students have reached the following learning results Climate and Climate Change General Impacts of Climate Change on Wind Regime and Water Cycle Consequences of Climate Change for Coastal Processes Coastal Protection in Taiwan and Germany Fundamentals of Coastal Engineering Processes and relations, assessment of needs for action Critical thinking: analysis of processes and relations, assessment of needs for action Creative thinking: inclusion of restrictions, application of calculation measures Practical thinking: inclusion of restrictions, application of calculation approaches, methods, numerical methods Consideration of complex tasks Working in heterogenous groups Working in international groups Working in international groups Self reflection Application oriented use of knowledge and skills Autonomous work on complex tasks Independent Study Time 124, Study Time in Lecture 56 Sone Written elaboration Preparation of a written report on a complex task with a presentation and subsequent discussion. The work or happens in the course of the lecture. Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory Civil Engineering: Specialisation Statur Tarific: Elective Compulsory Civil Engineering: Specialisation Statur Tarific: Elective Compulsory Environmental Engineering: Specialisation Environment and Climate: Elective Compulsory E |

| Course L2926: Sustainable N | lature-based Coastal Protection in a Changing Climate (SeaPiaC) |
|-----------------------------|---|
| Тур | Project-/problem-based Learning |
| Hrs/wk | 4 |
| СР | 6 |
| Workload in Hours | Independent Study Time 124, Study Time in Lecture 56 |
| Lecturer | Prof. Peter Fröhle |
| Language | EN |
| Cycle | WiSe |
| Content | Climate and Climate Change General Impacts of Climate Change on Wind Regime and Water Cycle Consequences of Climate Change for Coastal Processes Coastal Protection in Taiwan and Germany Fundamentals of Climate Adaptation Nature-Based Solutions (NBS) for Coastal Protection |
| Literature | Materials provided on eLearning Platform (HOOU Platform) Depending on the main topics of the course in the respective year, the literature (recent papers) will be provided in the course-material or via StudIP. |

| 3 3 | | | | |
|-------------------------------------|---|---|-----------------|----------------------|
| Module M0859: Coast | al Hydraulic Engineering II | | | |
| Courses | | | | |
| Title | | Тур | Hrs/wk | СР |
| Coastal- and Flood Protection (L080 | 8) | Lecture | 2 | 3 |
| Coastal- and Flood Protection (L141 | | Project-/problem-based Learning | 1 | 1 |
| Maintenance and Defence of Flood | Protection Structures (L1411) | Lecture | 2 | 2 |
| Module Responsible | Prof. Peter Fröhle | | | |
| Admission Requirements | None | | | |
| Recommended Previous | Coastal Engineering I | | | |
| Knowledge | | | | |
| Educational Objectives | After taking part successfully, students hav | e reached the following learning results | | |
| Professional Competence | | | | |
| Knowledge | The students have the capability to define | and explain in detail the important aspects of erosi | on protection | and flood protectio |
| | and are able to apply the aspects to prace | ctical coastal protection problems. They are able to | design and | dimension importar |
| | coastal protection measures from the funct | ional and from the constructional point of view. | | |
| Chille | The students are able to colort design an | proaches for the functional and constructional desi | an of oracion | and flood protoctio |
| SKIIIS | Skills The students are able to select design approaches for the functional and constructional design of erosion and flood measures and apply these approaches to practical design tasks. | | | and nood protectio |
| | measures and apply these approaches to p | | | |
| Personal Competence | | | | |
| Social Competence | The students are able to deploy their gain | ned knowledge in applied problems such as the fun | ctional and c | onstructive design o |
| | coastal and flood protection structures. Add | litionaly, they will be able to work in team with engin | eers of other o | disciplines. |
| Autonomy | The students will be able to independently e | extend their knowledge and apply it to new problems | | |
| Workload in Hours | Independent Study Time 110, Study Time in | n Lecture 70 | | |
| Credit points | 6 | | | |
| Course achievement | None | | | |
| Examination | Written exam | | | |
| Examination duration and | The duration of the examination is 130 m | in. The examination includes tasks with respect to | the general | understanding of th |
| scale | lecture contents and calculations tasks. | | | |
| Assignment for the | Civil Engineering: Specialisation Coastal Eng | gineering: Compulsory | | |
| Following Curricula | Civil Engineering: Specialisation Geotechnic | cal Engineering: Elective Compulsory | | |
| | Civil Engineering: Specialisation Structural I | Engineering: Elective Compulsory | | |
| | Environmental Engineering: Specialisation E | Environment and Climate: Elective Compulsory | | |
| | Environmental Engineering: Specialisation V | Nater Quality and Water Engineering: Elective Comp | ulsory | |
| | Water and Environmental Engineering: Spec | cialisation Environment: Elective Compulsory | | |
| | Water and Environmental Engineering: Spec | cialisation Water: Elective Compulsory | | |

| Course L0808: Coastal- and I | Flood Protection |
|------------------------------|--|
| Тур | Lecture |
| Hrs/wk | 2 |
| CP | 3 |
| Workload in Hours | Independent Study Time 62, Study Time in Lecture 28 |
| Lecturer | Prof. Peter Fröhle |
| Language | EN |
| Cycle | WiSe |
| Content | Protection of sandy coasts |
| Literature | Sediment transport Morphology Technical solution for the protection of sandy coasts Construction in direction of the coast Constructions perpendicular to the coast Other Concepst Calculation approaches and numerical models Flood Protection Classification of constructions / measures Dikes Dunes Foreland - constructions Flood-Protection Walls Drainage of the hinterland |
| Literature | Vorlesungsumdruck |
| | Coastal Engineering Manual CEM |
| | |
| | |

| Course L1415: Coastal- and I | ourse L1415: Coastal- and Flood Protection | | |
|------------------------------|---|--|--|
| Тур | Project-/problem-based Learning | | |
| Hrs/wk | 1 | | |
| СР | 1 | | |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 | | |
| Lecturer | Prof. Peter Fröhle | | |
| Language | EN | | |
| Cycle | WiSe | | |
| Content | See interlocking course | | |
| Literature | See interlocking course | | |

| Course L1411: Maintenance | Course L1411: Maintenance and Defence of Flood Protection Structures | |
|---------------------------|--|--|
| Тур | Lecture | |
| Hrs/wk | 2 | |
| СР | 2 | |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 | |
| Lecturer | Dr. Olaf Müller | |
| Language | EN | |
| Cycle | WiSe | |
| Content | Dike protection Maintennance of flood protection measures | |
| Literature | Vorlesungsumdruck | |

| Module M2003: Biolo | gical Waste Treatment | | | |
|--|--|---|-----------------|---------------------|
| Courses | | | | |
| īitle | | Тур | Hrs/wk | СР |
| Vaste and Environmental Chemist | ry (L0328) | Practical Course | 2 | 2 |
| Biological Waste Treatment (L0318 | - | Project-/problem-based Learning | 3 | 4 |
| Module Responsible | Prof. Kerstin Kuchta | | | |
| Admission Requirements | None | | | |
| Recommended Previous | chemical and biological basics | | | |
| Knowledge | | | | |
| Educational Objectives | After taking part successfully, students have reached | the following learning results | | |
| Professional Competence | | | | |
| Knowledge | The module aims possess knowledge concerning the design and layout of anaerobic and aerobic waste tree plants for biological waste treatment plants and expla | eatment plants in detail, describe different t | | |
| Skills | The students are able to discuss the compilation of d control measurements. The students can recherché and plan additional tests. They are capable of reflecti | and evaluate literature and date connected | - | |
| Developed Competence | | | | |
| Personal Competence Social Competence | Students can participate in subject-specific and inter work results in front of others and promote the sci | | | |
| Autonomy | Students can independently tap knowledge from lite are capable, in consultation with supervisors as well a steps on this basis. Furthermore, they can define ta potential social, economic and cultural impact. | as in the interim presentation, to assess the | ir learning lev | vel and define furt |
| Workload in Hours | | 70 | | |
| Credit points | | | | |
| Course achievement | Compulsory Bonus Form Dot Yes None Subject theoretical and practical work | escription | | |
| Examination | Presentation | | | |
| Examination duration and scale | Elaboration and Presentation (15-25 minutes in group | ps) | | |
| - | Civil Engineering: Specialisation Coastal Engineering: | | | |
| Following Curricula | Civil Engineering: Specialisation Geotechnical Engine | ering: Elective Compulsory | | |
| | Civil Engineering: Specialisation Structural Engineerin | | | |
| | Civil Engineering: Specialisation Water and Traffic: El | | | |
| | Bioprocess Engineering: Specialisation A - General Bio | | | |
| | Chemical and Bioprocess Engineering: Specialisation | | | |
| | Chemical and Bioprocess Engineering: Specialisation | | | |
| | Chemical and Bioprocess Engineering: Specialisation | | | ргу |
| | Chemical and Bioprocess Engineering: Specialisation Chemical and Bioprocess Engineering: Specialisation | | - | |
| | TO DEDUCAL AND DIODIOLESS ENGINEERING. Specialisation | chemical and bioprocess Engineering: Elect | live compuls | |
| | | | | bry |
| | Environmental Engineering: Core Qualification: Comp | bulsory | lson | bry |
| | Environmental Engineering: Core Qualification: Comp International Management and Engineering: Specialis | oulsory sation II. Renewable Energy: Elective Compu | llsory | bry |
| | Environmental Engineering: Core Qualification: Comp International Management and Engineering: Specialis Process Engineering: Specialisation Environmental Pr | oulsory sation II. Renewable Energy: Elective Compu rocess Engineering: Elective Compulsory | ilsory | эгу |
| | Environmental Engineering: Core Qualification: Comp International Management and Engineering: Specialis | oulsory sation II. Renewable Energy: Elective Compu- rocess Engineering: Elective Compulsory n Cities: Elective Compulsory | ilsory | Jry |

| Course L0328: Waste and En | vironmental Chemistry |
|----------------------------|--|
| Тур | Practical Course |
| Hrs/wk | 2 |
| СР | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Prof. Kerstin Kuchta |
| Language | EN |
| Cycle | WiSe |
| Content | The participants are divided into groups. Each group prepares a transcript on the experiment performed, which is then used as basis for discussing the results and to evaluate the performance of the group and the individual student. In some experiments the test procedure and the results are presented in seminar form, accompanied by discussion and results evaluation. Experiments ar e.g. Screening and particle size determination Fos/Tac AAS Chalorific value |
| Literature | Scripte |

| Course L0318: Biological Wa | ste Treatment |
|-----------------------------|---|
| Тур | Project-/problem-based Learning |
| Hrs/wk | 3 |
| СР | 4 |
| Workload in Hours | Independent Study Time 78, Study Time in Lecture 42 |
| Lecturer | Prof. Kerstin Kuchta |
| Language | EN |
| Cycle | WiSe |
| Content | Introduction biological basics determination process specific material characterization aerobic degradation (Composting, stabilization) anaerobic degradation (Biogas production, fermentation) Technical layout and process design Flue gas treatment Plant design practical phase |
| Literature | |

| Courses | |
|--------------------------|--|
| litle | Typ Hrs/wk CP |
| Module Responsible | |
| Admission Requirements | |
| Recommended Previous | |
| Knowledge | |
| - | After taking part successfully, students have reached the following learning results |
| Professional Competence | |
| Knowledge | The students are able to demonstrate their detailed knowledge in the field of Water and Environmental Engineering. They c exemplify the state of technology and application and discuss critically in the context of actual problems and general conditions science and society. |
| | The students can develop solving strategies and approaches for fundamental and practical problems in the field of Water a Environmental Engineering. They may apply theory based procedures and integrate safety-related, ecological, ethical, a economic view points of science and society. |
| | Scientific work techniques that are used can be described and critically reviewed. |
| Skills | The students are able to independently select methods or planning approaches for the project work and to justify their choi They can explain how these methods or approaches relate to solutions in the field of work and how the context of application l to be adjusted. General findings and further developments may essentially be outlined. |
| Personal Competence | |
| Social Competence | The students are able to condense the relevance and the structure of the project work, the work steps and the sub-problems the presentation and discussion in front of a bigger group. They can lead the discussion and give a feedback on the project to the colleagues. |
| Autonomy | The students are capable of independently planning and documenting the work steps and procedures while considering the giv deadlines. This includes the ability to accurately procure the newest scientific information. Furthermore, they can obtain feedba from experts with regard to the progress of the work, and to accomplish results on the state of the art in science and technology |
| Workload in Hours | Independent Study Time 360, Study Time in Lecture 0 |
| Credit points | 12 |
| Course achievement | None |
| Examination | Study work |
| Examination duration and | |
| scale | |
| Assignment for the | Water and Environmental Engineering: Specialisation Environment: Compulsory |
| Following Curricula | |

| Module M2033: Subsu | | | | |
|-----------------------------------|---|---|----------------------|---------------------|
| Courses | | | | |
| Гitle | | Тур | Hrs/wk | СР |
| Modeling of Subsurface Processes | (L2731) | Recitation Section (small) | 3 | 3 |
| Subsurface Solute Transport (L272 | 8) | Lecture | 2 | 2 |
| Subsurface Solute Transport (L272 | 9) | Recitation Section (large) | 1 | 1 |
| Module Responsible | Dr. Milad Aminzadeh | | | |
| Admission Requirements | None | | | |
| Recommended Previous | Basic Mathematics, Hydrology | | | |
| Knowledge | | | | |
| Educational Objectives | After taking part successfully, students | have reached the following learning results | | |
| Professional Competence | | | | |
| Knowledge | Upon completion of this module, the | students will understand the mechanisms controlli | ng solute transpo | rt in soil and natu |
| | porous media and will be able to work w | with the equations that govern the fate and transpor | t of solutes in porc | ous media. Analyti |
| | numerical and experimental tools and t | echniques will be used in this module. | | |
| CL 111 | | | | |
| SKIIIS | | students will be exposed to analytical, experimenta | | |
| | | n excellent opportunity to improve their skills on mu | itiple fronts which | will be useful in t |
| | future career. | | | |
| Personal Competence | | | | |
| | Teamwork & problem solving | | | |
| Autonomy | | ing individual reports and presentation. This will o | contribute to the | students' ability a |
| | willingness to work independently and i | | | |
| | Independent Study Time 96, Study Time | e in Lecture 84 | | |
| Credit points | 6 | | | |
| Course achievement | None | | | |
| Examination | Subject theoretical and practical work | | | |
| Examination duration and | Report | | | |
| scale | | | | |
| Assignment for the | Civil Engineering: Specialisation Structu | Iral Engineering: Elective Compulsory | | |
| Following Curricula | Civil Engineering: Specialisation Geotec | hnical Engineering: Elective Compulsory | | |
| | Civil Engineering: Specialisation Coasta | l Engineering: Elective Compulsory | | |
| | Civil Engineering: Specialisation Water | and Traffic: Elective Compulsory | | |
| | Civil Engineering: Specialisation Compu | tational Engineering: Elective Compulsory | | |
| | Chemical and Bioprocess Engineering: | Technical Complementary Course: Elective Compulse | ory | |
| | Chemical and Bioprocess Engineering: | Technical Complementary Course: Elective Compulse | ory | |
| | Environmental Engineering: Core Qualif | fication: Compulsory | | |
| | Process Engineering: Specialisation Env | rironmental Process Engineering: Elective Compulsor | У | |
| | Process Engineering: Specialisation Pro | cess Engineering: Elective Compulsory | | |
| | Water and Environmental Engineering: | Specialisation Water: Compulsory | | |
| | Water and Environmental Engineering: | | | |

| Course L2731: Modeling of S | ubsurface Processes |
|-----------------------------|---|
| Тур | Recitation Section (small) |
| Hrs/wk | 3 |
| СР | 3 |
| Workload in Hours | Independent Study Time 48, Study Time in Lecture 42 |
| Lecturer | Mohammad Aziz Zarif |
| Language | EN |
| Cycle | WiSe |
| Content | Basic usage and background of chosen computer software to calculate flow and transport in the saturated and unsaturated zone and to analyze field data like pumping test data |
| Literature | |

| Course L2728: Subsurface So | olute Transport |
|-----------------------------|---|
| Тур | Lecture |
| Hrs/wk | 2 |
| СР | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Dr. Milad Aminzadeh |
| Language | EN |
| Cycle | WiSe |
| Content | Basic physical properties of soil: Definition and quantification; Liquid flow in soils (Darcy's law); Solute transport in soils; Practical analysis to measure dispersion coefficient in soil under different boundary conditions; Advanced topics (e.g. Application of Artificial Intelligence to predict soil salinization) |
| Literature | - Environmental Soil Physics, by Daniel Hillel - Soil Physics, Sixth Edition, by William A. Jury and Robert Horton |

| Course L2729: Subsurface So | olute Transport |
|-----------------------------|---|
| Тур | Recitation Section (large) |
| Hrs/wk | 1 |
| СР | 1 |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 |
| Lecturer | Dr. Milad Aminzadeh |
| Language | EN |
| Cycle | WiSe |
| Content | See interlocking course |
| Literature | See interlocking course |

| Courses Title Typ Hrs/wk CP Methods in Climate Informed Engineering (L3347) Lecture 3 3 Topics in Climate Informed Engineering (L3340) Lecture 3 3 Module Responsible Prof. Nima Shokri Admission Requirements None Recommended Previous Students are expected to have a foundational understanding of environmental science, basic engineering principles Knowledge Interest in sustainability. Recommended knowledge includes climate science, data analysis, and familiarity with engineering processes. Analytical and critical thinking and creative problem-solving skills are also beneficial Educational Objectives After taking part successfully, students have reached the following learning results Professional Competence Knowledge This module explores next-generation climate models and high-resolution data, emphasizing their impact on environme engineering products and processes. It covers how various engineering disclines can benefit from climate information. R based learning activities, expert talks, and presentations will expose students to state-of-the-art modeling, measurem analysis in climate informed engineering adaptation strategies, problem-solving, ethical responsibility, and interdis collaboration. Personal Competence Social Competence Collaboration, interdisciplinary teamwork, communication skills, problem-solving, ethical r | ntroducti | - | M2076: Intro | duction to Climate Informed En | gineering | | |
|---|---------------------|---------------|-------------------|---|---|---------------------------|---------------------|
| Title Typ Hrs/wk CP Methods in Climate Informed Engineering (L3347) Lecture 3 3 Topics in Climate Informed Engineering (L3347) Lecture 3 3 Topics in Climate Informed Engineering (L3348) Lecture 3 3 Module Responsible Prof. Nima Shokri Admission Requirements None Recommended Previous Students are expected to have a foundational understanding of environmental science, basic engineering principles interest in sustainability. Recommended knowledge includes climate science, data analysis, and familiarity with engineering processes. Analytical and critical thinking and creative problem-solving skills are also beneficial Professional Competence After taking part successfully, students have reached the following learning results Professional Competence Inis module explores next-generation climate models and high-resolution data, emphasizing their impact on environme engineering aroutives, expert talks, and presentations will expose students to state-of-the-art modeling, measurem analysis in climate-informed engineering. Skills Climate data analysis, engineering adaptation strategies, problem-solving, ethical responsibility, and decision-m climate-resilient engineering. Skills Claboration, interdisciplinary teamwork, communication skills, problem-solving, ethical responsibility, and decision-m climate-resilient engineering. <tr< th=""><th></th><th></th><th></th><th></th><th></th><th></th><th></th></tr<> | | | | | | | |
| Methods in Climate Informed Engineering (L3347) Lecture 3 3 Topics in Climate Informed Engineering (L3348) Lecture 3 3 Module Responsible Prof. Nima Shokri Lecture 3 3 Admission Requirements None Interset in sustainability. Recommended knowledge includes climate science, data analysis, and familiarity with engineering processes. Analytical and critical thinking and creative problem-solving skills are also beneficial Forfessional Competence Professional Competence After taking part successfully, students have reached the following learning results Forfessional competence <i>Knowledge</i> This module explores next-generation climate models and high-resolution data, emphasizing their impact on environme engineering products and processes. It covers how various engineering disciplines can benefit from climate information. P based learning activities, expert talks, and presentations will expose students to state-of-the-art modeling, measurem analysis in climate-informed engineering. Personal Competence Collaboration, Interdisciplinary teamwork, communication skills, problem-solving, ethical responsibility, and decision-n climate-resilient engineering. Workload in Houra Independent Study Time 96, Study Time in Lecture 84 Course achievement None Examination duration and Refer talking Report and Presentation Subject theoretical and practical work Comp | | | | | | | |
| Topics in Climate Informed Engineering (13348) Lecture 3 3 Module Responsible Prof. Nima Shokri None Image: Climate Informed Infor | | | | | •• | | |
| Module Responsible Prof. Nima Shokri Admission Requirements None Recommended Previous Students are expected to have a foundational understanding of environmental science, basic engineering principles interest in sustainability. Recommended knowledge includes climate science, data analysis, and familiarity with engineering processes. Analytical and critical thinking and creative problem-solving skills are also beneficial Educational Objectives After taking part successfully, students have reached the following learning results Professional Competence Knowledge This module explores next-generation climate models and high-resolution data, emphasizing their impact on environme engineering products and processes. It covers how various engineering disciplines can benefit from climate information. R based learning activities, expert talks, and presentations will expose students to state-of-the-art modeling, measurem analysis in climate-informed engineering. Skills Climate data analysis, engineering adaptation strategies, problem-solving, research-based learning, and interdis collaboration, interdisciplinary teamwork, communication skills, problem-solving, ethical responsibility, and decision-m climate-resilient engineering. Workload in Hours Independent Study Time 96, Study Time in Lecture 84 Course achievement None Examination Subject theoretical and practical work Resonal Competence Kent and presentation Outelest and make informed decisions in climate-informed engineering.< | | | | - | | | |
| Admission Requirements None Recommended Previous Knowledge Students are expected to have a foundational understanding of environmental science, basic engineering principles Knowledge Recommended Previous Knowledge Students are expected to have a foundational understanding of environmental science, basic engineering principles Knowledge Educational Objectives Arter taking part successfully, students have reached the following learning results Professional Competence Knowledge This module explores next-generation climate models and high-resolution data, emphasizing their impact on environme engineering products and processes. It covers how various engineering disciplines can benefit from climate information. R based learning activities, expert talks, and presentations will expose students to state-of-the-art modeling, measurem analysis in climate-informed engineering. Skills Climate data analysis, engineering adaptation strategies, problem-solving, research-based learning, and interdis collaboration. Personal Competence Social Competence Collaboration, interdisciplinary teamwork, communication skills, problem-solving, ethical responsibility, and decision-m climate-resilient engineering. Workload in Hours Independent Study Time 96, Study Time in Lecture 84 Course achievement scale None Examination duration and Report and Presentation scale Report and Presentation | | | | | Lecture | 3 | 3 |
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| Educational Objectives After taking part successfully, students have reached the following learning results Professional Competence Knowledge This module explores next-generation climate models and high-resolution data, emphasizing their impact on environme engineering products and processes. It covers how various engineering disciplines can benefit from climate information. R based learning activities, expert talks, and presentations will expose students to state-of-the-art modeling, measurem analysis in climate-informed engineering. Skills Climate data analysis, engineering adaptation strategies, problem-solving, research-based learning, and interdis collaboration. Personal Competence Social Competence Social Competence Collaboration, interdisciplinary teamwork, communication skills, problem-solving, ethical responsibility, and decision-m climate-resilient engineering. Autonomy Time management, self-directed learning, critical thinking, accountability, initiative, and the ability to conduct inder research and make informed decisions in climate-informed engineering. Workload in Hours Independent Study Time 96, Study Time in Lecture 84 Course achievement Subject theoretical and practical work Examination duration and scale Report and Presentation Assignment for the Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory | - | Knowled | Knowledg | | | | n engineering des |
| Professional Competence This module explores next-generation climate models and high-resolution data, emphasizing their impact on environme engineering products and processes. It covers how various engineering disciplines can benefit from climate information. R based learning activities, expert talks, and presentations will expose students to state-of-the-art modeling, measurem analysis in climate-informed engineering. Skills Climate data analysis, engineering adaptation strategies, problem-solving, research-based learning, and interdisciplication. Personal Competence Collaboration, interdisciplinary teamwork, communication skills, problem-solving, ethical responsibility, and decision-m climate-resilient engineering. Autonomy Time management, self-directed learning, critical thinking, accountability, initiative, and the ability to conduct inder research and make informed decisions in climate-informed engineering. Workload in Hours Independent Study Time 96, Study Time in Lecture 84 Course achievement None Examination duration and Report and Presentation Subject theoretical and practical work Examination duration and Report and Presentation Subject theoretical and practical work | proce | | | processes. Analytical and critical trinking and | a creative problem-solving skills are also b | enencial | |
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| engineering products and processes. It covers how various engineering disciplines can benefit from climate information. R based learning activities, expert talks, and presentations will expose students to state-of-the-art modeling, measurem skills Climate data analysis, engineering adaptation strategies, problem-solving, research-based learning, and interdisciplinary teamwork, communication skills, problem-solving, ethical responsibility, and decision-rr <i>Personal Competence</i> Collaboration, interdisciplinary teamwork, communication skills, problem-solving, ethical responsibility, and decision-rr <i>Autonomy</i> Time management, self-directed learning, critical thinking, accountability, initiative, and the ability to conduct inder research and make informed decisions in climate-informed engineering. Independent Study Time 96, Study Time in Lecture 84 Credit points 6 Course achievement None Examination duration and Report and Presentation scial Guit Leoretical and practical work Examination duration and Report and Presentation | tence | nal Compete | ional Competenc | | | | |
| based learning activities, expert talks, and presentations will expose students to state-of-the-art modeling, measurem analysis in climate-informed engineering. Skills Climate data analysis, engineering adaptation strategies, problem-solving, research-based learning, and interdiscollaboration. Personal Competence Collaboration, interdisciplinary teamwork, communication skills, problem-solving, ethical responsibility, and decision-modeling. Autonomy Time management, self-directed learning, critical thinking, accountability, initiative, and the ability to conduct inder research and make informed decisions in climate-informed engineering. Workload in Hours Independent Study Time 96, Study Time in Lecture 84 Course achievement None Examination duration and seport and Presentation Subject theoretical and practical work Examination for the Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory | <i>ledge</i> This r | Knowle | Knowledg | This module explores next-generation climat | te models and high-resolution data, emph | nasizing their impact or | n environmental a |
| Analysis in climate-informed engineering. Skills Climate data analysis, engineering adaptation strategies, problem-solving, research-based learning, and interdisciplication. Personal Competence Collaboration, interdisciplinary teamwork, communication skills, problem-solving, ethical responsibility, and decision-modelinate-resilient engineering. Autonomy Time management, self-directed learning, critical thinking, accountability, initiative, and the ability to conduct inder research and make informed decisions in climate-informed engineering. Workload in Hours Independent Study Time 96, Study Time in Lecture 84 Course achievement None Examination Subject theoretical and practical work Examination duration and scale Report and Presentation Assignment for the Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory | engin | | | engineering products and processes. It cover | s how various engineering disciplines can | benefit from climate in | formation. Researd |
| Skills Climate data analysis, engineering adaptation strategies, problem-solving, research-based learning, and interdis collaboration. Personal Competence Social Competence Social Competence Collaboration, interdisciplinary teamwork, communication skills, problem-solving, ethical responsibility, and decision-meticinate-resilient engineering. Autonomy Time management, self-directed learning, critical thinking, accountability, initiative, and the ability to conduct inder research and make informed decisions in climate-informed engineering. Workload in Hours Independent Study Time 96, Study Time in Lecture 84 Course achievement None Examination duration and scale Report and Presentation Assignment for the Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory | based | | | based learning activities, expert talks, and | presentations will expose students to sta | ate-of-the-art modeling, | measurement, a |
| Personal Competence collaboration. Social Competence Collaboration, interdisciplinary teamwork, communication skills, problem-solving, ethical responsibility, and decision-m climate-resilient engineering. Autonomy Time management, self-directed learning, critical thinking, accountability, initiative, and the ability to conduct inder research and make informed decisions in climate-informed engineering. Workload in Hours Independent Study Time 96, Study Time in Lecture 84 Credit points 6 Course achievement None Examination duration and scale Report and Presentation Assignment for the Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory | analy | | | analysis in climate-informed engineering. | | | |
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| Personal Competence Social Competence Social Competence Collaboration, interdisciplinary teamwork, communication skills, problem-solving, ethical responsibility, and decision-metaintic climate-resilient engineering. Autonomy Time management, self-directed learning, critical thinking, accountability, initiative, and the ability to conduct independent study Time 96, Study Time in Lecture 84 Credit points 6 Course achievement None Examination duration and seale Subject theoretical and practical work Examination for the Givil Engineering: Specialisation Coastal Engineering: Elective Compulsory | | 5 | 0.00 | | | inen babea rearring, e | |
| Social Competence Collaboration, interdisciplinary teamwork, communication skills, problem-solving, ethical responsibility, and decision relimate-resilient engineering. Autonomy Time management, self-directed learning, critical thinking, accountability, initiative, and the ability to conduct inderesearch and make informed decisions in climate-informed engineering. Workload in Hours Independent Study Time 96, Study Time in Lecture 84 Credit points 6 Course achievement None Examination duration and scale Report and Presentation Subject theoretical and practical work Report and Presentation Assignment for the Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory | contab | | | | | | |
| Autonomy Climate-resilient engineering. Autonomy Time management, self-directed learning, critical thinking, accountability, initiative, and the ability to conduct inder research and make informed decisions in climate-informed engineering. Workload in Hours Independent Study Time 96, Study Time in Lecture 84 Credit points 6 Course achievement None Examination Subject theoretical and practical work Examination duration and scale Report and Presentation Assignment for the Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory | tence | nal Compete | sonal Competenc | | | | |
| Autonomy Time management, self-directed learning, critical thinking, accountability, initiative, and the ability to conduct inder research and make informed decisions in climate-informed engineering. Workload in Hours Independent Study Time 96, Study Time in Lecture 84 Credit points 6 Course achievement None Examination duration and scale Report and Presentation Assignment for the Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory | tence Collab | ocial Compete | Social Competend | Collaboration, interdisciplinary teamwork, co | ommunication skills, problem-solving, eth | nical responsibility, and | I decision-making |
| research and make informed decisions in climate-informed engineering. Workload in Hours Independent Study Time 96, Study Time in Lecture 84 Credit points 6 Course achievement None Examination Subject theoretical and practical work Report and Presentation Report and Presentation scale Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory | climat | | | climate-resilient engineering. | | | |
| research and make informed decisions in climate-informed engineering. Workload in Hours Independent Study Time 96, Study Time in Lecture 84 Credit points 6 Course achievement None Examination Subject theoretical and practical work Report and Presentation Report and Presentation scale Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory | nomv Time | Auton | Autonon | Time management, self-directed learning, | critical thinking, accountability, initiative | . and the ability to c | onduct independe |
| Credit points 6 Course achievement None Examination Subject theoretical and practical work Examination duration and scale Report and Presentation Assignment for the Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory | - | | | | • • | , , | |
| Credit points 6 Course achievement None Examination Subject theoretical and practical work Examination duration and scale Report and Presentation Assignment for the Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory | | | | | | | |
| Course achievement None Examination Subject theoretical and practical work Examination duration and scale Report and Presentation Assignment for the Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory | lours Indep | orkload in Ho | Workload in Hou | Independent Study Time 96, Study Time in Le | ecture 84 | | |
| Examination Subject theoretical and practical work Examination duration and scale Report and Presentation Assignment for the Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory | | · | | | | | |
| Examination duration and scale Report and Presentation Assignment for the Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory | ment None | se achievem | ourse achievemer | None | | | |
| scale Assignment for the Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory | ation Subje | Examinat | Examinatio | Subject theoretical and practical work | | | |
| Assignment for the Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory | n and Repor | on duration a | ation duration an | Report and Presentation | | | |
| | scale | so | scal | | | | |
| | | - | - | | | | |
| Following Curricula Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory | | owing Curric | ollowing Curricu | | | | |
| Civil Engineering: Specialisation Structural Engineering: Elective Compulsory | | | | | | | |
| Civil Engineering: Specialisation Water and Traffic: Elective Compulsory | | | | | | | |
| Civil Engineering: Specialisation Computational Engineering: Elective Compulsory | | | | | | | |
| Data Science: Specialisation III. Applications: Elective Compulsory Environmental Engineering: Core Qualification: Elective Compulsory | | | | | | | |
| Process Engineering: Specialisation Process Engineering: Elective Compulsory | | | | | | | |
| Water and Environmental Engineering: Specialisation Process Engineering: Elective Compulsory | | | | | | | |
| Water and Environmental Engineering: Specialisation Cities: Elective Compulsory | | | | | | v | |
| Water and Environmental Engineering: Specialisation Environment: Elective Compulsory | | | | | | , | |

| Course L3347: Methods in Cl | imate Informed Engineering |
|-----------------------------|---|
| Тур | Lecture |
| Hrs/wk | 3 |
| СР | 3 |
| Workload in Hours | Independent Study Time 48, Study Time in Lecture 42 |
| Lecturer | Prof. Nima Shokri, Prof. Cathy Hohenegger, Prof. Irina Smirnova |
| Language | EN |
| Cycle | WiSe |
| Content | Students will learn techniques for incorporating climate data and environmental factors into engineering design. It covers climate modelling and the use of sensors and devices to measure climate-related parameters and engineering processes. Students will have the opportunity to conduct their own measurements, analyze the collected data, and write a report on their findings. This hands-on experience will be assessed and contribute to their final grade. |
| Literature | |

| Course L3348: Topics in Clim | ate Informed Engineering |
|------------------------------|--|
| Тур | Lecture |
| Hrs/wk | 3 |
| СР | 3 |
| Workload in Hours | Independent Study Time 48, Study Time in Lecture 42 |
| Lecturer | Prof. Irina Smirnova, Prof. Cathy Hohenegger, Prof. Nima Shokri |
| Language | EN |
| Cycle | WiSe |
| Content | Exploring specific applications of climate data in various engineering disciplines. Invited speakers will present their research and discuss the relevance of climate-informed engineering to their work. Additionally, there will be a segment on effective communication, covering how to give impactful presentations and write research papers. Students will also give presentations on their own class projects related to climate-informed engineering, applying the concepts they've learned. This hands-on experience will be assessed and contribute to their final grade. |
| Literature | |

| | | g for Enginee | | | | |
|--|--|---|--|---|--|--|
| ourses | | | | | | |
| itle | | | Тур | | Hrs/wk | СР |
| ncertainty Modelling for Engineer | rs (L3458) | | Integ | rated Lecture | 6 | 6 |
| Module Responsible | Prof. Simon Michael Pa | apalexiou | | | | |
| Admission Requirements | None | | | | | |
| Recommended Previous Knowledge | General familiar Elementary prol | - | , and mathematical skills. | | | |
| | | skills for handling da ng engineering probl | ems using statistical and pr | obabilistic methods | | |
| Educational Objectives | After taking part succe | essfully, students hav | ve reached the following lea | rning results | | |
| Professional Competence | | | | | | |
| | introduces probability probability distribution uncertainty in enginee decision-making and p and disutility and learn By the end of the cour | as a measure of un ns, extreme value the ering problems. The predictive modeling. In how to apply Bayes rse, students will be a | n in uncertainty, probability neertainty, covering frequen- eory, joint probability distri- course also covers linear a Additionally, students will g ian Decision Theory to optimable to apply probabilistic m approach bility distributions | ncy-based methods butions, and stoch and nonlinear regre gain insight into risi mize engineering sc odels to quantify un | S. Students will explose astic optimization to ession methods, essee k assessment as a fur olutions under uncertain neertainty and assess | ore Bayes' Theore model and quan ential for data-driv inction of probabi ainty. s risks in engineer |
| | inference to real-worl enabling them to anal | d engineering challe yze complex enginee | ng probability distributions, enges. Students will also c ering datasets and improve ethods and optimization tec | levelop skills in lir risk predictions. Th | near and nonlinear r rough hands-on com | egression modeli putational exercis |
| Personal Competence | | | | | | |
| Social Competence | - | | k collaboratively on engin | eering risk assess | ments, communicatii | ng technical resu |
| | | | cision-makers. They will en engineering analyses are | | | safety factors, a |
| Autonomy | uncertainty quantifica challenges. Students will learn to distributions, regressio | ation, ensuring that independently analy on methods, and sto natural and human-n | | both rigorous and uncertainties, selec ous applications. T | d applicable to real- ting and applying ap hey will also gain th | , safety factors, a world infrastruct propriate probabi e ability to evalu |
| | uncertainty quantifica challenges. Students will learn to distributions, regressio risks associated with r assessment, and disas | ation, ensuring that independently analy on methods, and sto natural and human-n ster mitigation. | engineering analyses are ze and model engineering ochastic techniques for vari nade hazards, ensuring they | both rigorous and uncertainties, selec ous applications. T | d applicable to real- ting and applying ap hey will also gain th | , safety factors, a world infrastruct propriate probabi e ability to evalu |
| Workload in Hours | uncertainty quantifica challenges. Students will learn to distributions, regressio risks associated with r assessment, and disas Independent Study Tin | ation, ensuring that independently analy on methods, and sto natural and human-n ster mitigation. | engineering analyses are ze and model engineering ochastic techniques for vari nade hazards, ensuring they | both rigorous and uncertainties, selec ous applications. T | d applicable to real- ting and applying ap hey will also gain th | , safety factors, a world infrastruct propriate probabi e ability to evalu |
| Workload in Hours Credit points | uncertainty quantifica challenges. Students will learn to distributions, regressid risks associated with r assessment, and disas Independent Study Tin 6 | ation, ensuring that independently analy on methods, and sto natural and human-n ster mitigation. | engineering analyses are ze and model engineering ochastic techniques for vari nade hazards, ensuring they | both rigorous and uncertainties, selec ous applications. T | d applicable to real- ting and applying ap hey will also gain th | , safety factors, a world infrastruct propriate probabi e ability to evalu |
| Workload in Hours | uncertainty quantifica challenges. Students will learn to distributions, regressid risks associated with r assessment, and disas Independent Study Tin 6 | ation, ensuring that independently analy on methods, and sto natural and human-n ster mitigation. me 96, Study Time in | engineering analyses are ze and model engineering ochastic techniques for vari nade hazards, ensuring they Lecture 84 | both rigorous and uncertainties, select ous applications. T v can make informe | d applicable to real- ting and applying ap hey will also gain th ed engineering decisio | , safety factors, a world infrastruct propriate probabi e ability to evalu |
| Workload in Hours Credit points | uncertainty quantifica challenges. Students will learn to distributions, regressio risks associated with r assessment, and disas Independent Study Tin 6 Compulsory Bonus Yes 20 % | ation, ensuring that independently analy on methods, and sto natural and human-n ster mitigation. me 96, Study Time in Form | engineering analyses are ze and model engineering to bochastic techniques for vari nade hazards, ensuring they Lecture 84 Description | both rigorous and uncertainties, select ous applications. T v can make informe | d applicable to real- ting and applying ap hey will also gain th ed engineering decisio | , safety factors, a world infrastruct propriate probabi e ability to evalu |
| Workload in Hours Credit points Course achievement | uncertainty quantifica challenges. Students will learn to distributions, regression risks associated with r assessment, and disas Independent Study Tim 6 Compulsory Bonus Yes 20 % Written exam | ation, ensuring that independently analy on methods, and sto natural and human-n ster mitigation. me 96, Study Time in Form | engineering analyses are ze and model engineering to bochastic techniques for vari nade hazards, ensuring they Lecture 84 Description | both rigorous and uncertainties, select ous applications. T v can make informe | d applicable to real- ting and applying ap hey will also gain th ed engineering decisio | , safety factors, a world infrastruct propriate probabi e ability to evalu |
| Workload in Hours Credit points Course achievement Examination | uncertainty quantifica challenges. Students will learn to distributions, regression risks associated with r assessment, and disas Independent Study Tim 6 Compulsory Bonus Yes 20 % Written exam | ation, ensuring that independently analy on methods, and sto natural and human-n ster mitigation. me 96, Study Time in Form | engineering analyses are ze and model engineering to bochastic techniques for vari nade hazards, ensuring they Lecture 84 Description | both rigorous and uncertainties, select ous applications. T v can make informe | d applicable to real- ting and applying ap hey will also gain th ed engineering decisio | , safety factors, a world infrastruct propriate probabi e ability to evalu |
| Workload in Hours Credit points Course achievement Examination Examination duration and | uncertainty quantifica challenges. Students will learn to distributions, regression risks associated with r assessment, and disass Independent Study Tim 6 Compulsory Bonus Yes 20 % Written exam 150 min | ation, ensuring that independently analy on methods, and sto natural and human-n ster mitigation. ne 96, Study Time in Form Presentation | engineering analyses are ze and model engineering to bochastic techniques for vari nade hazards, ensuring they Lecture 84 Description | both rigorous and uncertainties, select ous applications. T r can make informe atation von Arbeitse | d applicable to real- ting and applying ap hey will also gain th ed engineering decisio | , safety factors, a world infrastruct propriate probabi e ability to evalu |
| Workload in Hours Credit points Course achievement Examination Examination duration and scale | uncertainty quantification challenges. Students will learn to distributions, regression risks associated with massessment, and disass independent Study Tim 6 Compulsory Bonus Yes 20 % Written exam 150 min Civil Engineering: Spece | ation, ensuring that independently analy on methods, and sto natural and human-n ster mitigation. me 96, Study Time in Form Presentation | engineering analyses are ze and model engineering o ochastic techniques for vari nade hazards, ensuring they Lecture 84 Description 10-minütige Präser | both rigorous and uncertainties, select ous applications. T r can make informe utation von Arbeitse | d applicable to real- ting and applying ap hey will also gain th ed engineering decisio | , safety factors, a world infrastruct propriate probabi e ability to evalu |
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| Course L3458: Uncertainty M | Iodelling for Engineers |
|-----------------------------|---|
| Тур | Integrated Lecture |
| Hrs/wk | 6 |
| СР | 6 |
| Workload in Hours | Independent Study Time 96, Study Time in Lecture 84 |
| Lecturer | Prof. Simon Michael Papalexiou |
| Language | EN |
| Cycle | SoSe |
| Content | Engineering decisions are rarely made with complete certainty—uncertainty affects material properties, environmental conditions, structural performance, and risk assessments. This course provides students with theoretical foundations and practical tools to quantify uncertainty, assess risks, and enhance decision-making in civil, structural, geotechnical, and environmental engineering applications. Students will begin with fundamental probability concepts, learning how Bayes' Theorem, probability distributions, and extreme value theory help evaluate engineering uncertainties. They will explore linear and nonlinear regression methods for analyzing complex datasets, as well as joint probability distributions and stochastic optimization to improve predictive modeling and reliability assessments. The course also introduces Bayesian Decision Theory, offering a structured approach to decision-making under uncertainty. With a focus on real-world engineering problems, students will apply probabilistic models, extreme value analysis, and stochastic techniques to assess risks in infrastructure design, system reliability, and disaster resilience. Hands-on computational exercises will reinforce key concepts, preparing students to work with data-driven models and uncertainty quantification techniques used in engineering practice. This course is ideal for students interested in engineering risk assessment, reliability analysis, and data-driven modeling. By the end of the course, students will have developed critical analytical and problem-solving skills, equipping them for careers in structural safety, geotechnical engineering, environmental risk management, and beyond. |
| Literature | |

Specialization Water

| | r Resources and -Supply | | | |
|------------------------------------|---|---|------------------------|--------------------|
| Courses | | | | |
| Title | - | Тур | Hrs/wk | СР |
| Chemistry of Drinking Water Treatr | nent (L0311) | Lecture | 2 | 1 |
| Chemistry of Drinking Water Treatr | nent (L0312) | Recitation Section (large) | 1 | 2 |
| Water Resource Management (L040 | 02) | Lecture | 2 | 2 |
| Water Resource Management (L040 | 03) | Recitation Section (small) | 1 | 1 |
| Module Responsible | Prof. Mathias Ernst | | | |
| Admission Requirements | None | | | |
| Recommended Previous | Knowledge of water management and the k | ey processes involved in water treatment. | | |
| Knowledge | | | | |
| Educational Objectives | After taking part successfully, students have | e reached the following learning results | | |
| Professional Competence | | | | |
| Knowledge | Students will be able to outline key areas | of conflict in water management, as well as | their mutual depen | dence for sustaina |
| | water supply. They will understand relevant | nt economic, environmental and social factor | ors. Students will be | able to explain a |
| | outline the organisational structures of wat | er companies. They will be able to explain the | e available water trea | atment processes a |
| | the scope of their application. | | | |
| Skille | Students will be able to access comple | w problems in drinking water production | and actablich colut | ions involving wa |
| SKIIIS | | ex problems in drinking water production | | - |
| | | y will be able to assess the evaluation method | | |
| | - | s for selected treatment processes and app | ly generally accepte | |
| | standards to these processes. | | | |
| Personal Competence | | | | |
| Social Competence | Working in a diverse group of specialists, s | students will be able to develop and docume | nt complex solutions | for the managem |
| | and treatment of drinking water. They will | I be able to take an appropriate professiona | I position, for exam | ole representing u |
| | interests. They will be able to develop joint | solutions in teams of diverse experts and pre | sent these solutions | to others. |
| | | | | |
| Autonomy | Students will be in a position to work on a s | ubject independently and present on this sub | ject. | |
| Workload in Hours | Independent Study Time 96, Study Time in | Lecture 84 | | |
| Credit points | 6 | | | |
| Course achievement | None | | | |
| Examination | Written exam | | | |
| Examination duration and | 60 min (chemistry) + presentation | | | |
| scale | | | | |
| Assignment for the | Civil Engineering: Specialisation Structural E | Engineering: Elective Compulsory | | |
| Following Curricula | Civil Engineering: Specialisation Geotechnic | al Engineering: Elective Compulsory | | |
| - | Civil Engineering: Specialisation Water and | Traffic: Compulsory | | |
| | Civil Engineering: Specialisation Coastal Eng | aincaring, Elective Compulson, | | |
| | | gineering: Elective Compulsory | | |
| | Chemical and Bioprocess Engineering: Tech | nical Complementary Course: Elective Comp | ulsory | |
| | | nnical Complementary Course: Elective Comp | - | Compulsory |
| | International Management and Engineering | nical Complementary Course: Elective Comp : Specialisation II. Energy and Environmental | Engineering: Elective | Compulsory |
| | International Management and Engineering Process Engineering: Specialisation Environ | nical Complementary Course: Elective Compl : Specialisation II. Energy and Environmental mental Process Engineering: Elective Compul | Engineering: Elective | e Compulsory |
| | International Management and Engineering Process Engineering: Specialisation Environ Process Engineering: Specialisation Process | nnical Complementary Course: Elective Compo : Specialisation II. Energy and Environmental mental Process Engineering: Elective Compul s Engineering: Elective Compulsory | Engineering: Elective | Compulsory |
| | International Management and Engineering Process Engineering: Specialisation Environ Process Engineering: Specialisation Process Water and Environmental Engineering: Spec | nnical Complementary Course: Elective Compo : Specialisation II. Energy and Environmental mental Process Engineering: Elective Compul s Engineering: Elective Compulsory | Engineering: Elective | e Compulsory |

| Course L0311: Chemistry of Drinking Water Treatment | |
|---|---|
| Тур | Lecture |
| Hrs/wk | 2 |
| СР | 1 |
| Workload in Hours | Independent Study Time 2, Study Time in Lecture 28 |
| Lecturer | Dr. Klaus Johannsen |
| Language | DE |
| Cycle | WiSe |
| Content | The topic of this course is water chemistry with respect to drinking water treatment and water distribution |
| | Major topics are solubility of gases, carbonic acid system and calcium carbonate, blending, softening, redox processes, materials and legal requirements on drinking water treatment. Focus is put on generally accepted rules of technology (DVGW- and DIN- standards). Special emphasis is put on calculations using realistic analysis data (e.g. calculation of pH or calcium carbonate dissolution potential) in exercises. Students can get a feedback and gain extra points for exam by solving problems for homework. Knowledge of drinking water treatment processes is vital for this lecture. Therefore the most important processes are explained coordinated with the course " Water resources management" in the beginning of the semester. |
| Literature | MHW (rev. by Crittenden, J. et al.): Water treatment principles and design. John Wiley & Sons, Hoboken, 2005. Stumm, W., Morgan, J.J.: Aquatic chemistry. John Wiley & Sons, New York, 1996. DVGW (Hrsg.): Wasseraufbereitung - Grundlagen und Verfahren. Oldenbourg Industrie Verlag, München, 2004. Jensen, J. N.: A Problem Solving Approach to Aquatic Chemistry. John Wiley & Sons, Inc., New York, 2003. |

| Course L0312: Chemistry of Drinking Water Treatment | |
|---|---|
| Тур | Recitation Section (large) |
| Hrs/wk | 1 |
| CP | 2 |
| Workload in Hours | Independent Study Time 46, Study Time in Lecture 14 |
| Lecturer | Dr. Klaus Johannsen |
| Language | DE |
| Cycle | WiSe |
| Content | See interlocking course |
| Literature | See interlocking course |

| Course L0402: Water Resource Management | |
|---|--|
| Тур | Lecture |
| Hrs/wk | 2 |
| СР | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Prof. Mathias Ernst |
| Language | DE |
| Cycle | WiSe |
| Content | The lecture provides comprehensive knowledge on interaction of water ressource management and drinking water supply. Content |
| | overview: Current situation of global water resources User and Stakeholder conflicts Wasserressourcenmanagement in urbane Gebieten Rechtliche Aspekte, Organisationsformen Trinkwasserversorgungsunternehmen. Ökobilanzierung, Benchmarking in der Wasserversorgung |
| Literature | Aktuelle UN World Water Development Reports Branchenbild der deutschen Wasserwirtschaft, VKU (2011) Aktuelle Artikel wissenschaftlicher Zeitschriften Ppt der Vorlesung |

Module Manual M.Sc. "Water and Environmental Engineering"

| Course L0403: Water Resource Management | |
|---|---|
| Тур | Recitation Section (small) |
| Hrs/wk | 1 |
| СР | 1 |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 |
| Lecturer | Prof. Mathias Ernst |
| Language | DE |
| Cycle | WiSe |
| Content | See interlocking course |
| Literature | See interlocking course |

| Module M2033: Subsu | Irface Processes | | | | |
|------------------------------------|---|--|------------------|-------------------|-----------------------|
| Courses | | | | | |
| Title | | Тур | | Hrs/wk | СР |
| Modeling of Subsurface Processes (| L2731) | Recitation Sec | tion (small) | 3 | 3 |
| Subsurface Solute Transport (L272) | 3) | Lecture | | 2 | 2 |
| Subsurface Solute Transport (L2729 | 9) | Recitation Sec | tion (large) | 1 | 1 |
| Module Responsible | Prof. Nima Shokri | | | | |
| Admission Requirements | None | | | | |
| Recommended Previous | Basic Mathematics, Hydrology | | | | |
| Knowledge | | | | | |
| Educational Objectives | After taking part successfully, students ha | ave reached the following learning res | sults | | |
| Professional Competence | | | | | |
| Knowledge | Upon completion of this module, the stu | udents will understand the mechani | sms controlling | solute transpor | t in soil and natura |
| | porous media and will be able to work wit | h the equations that govern the fate | and transport of | f solutes in poro | us media. Analytica |
| | numerical and experimental tools and tec | hniques will be used in this module. | | | |
| | | | | | |
| Skills | In addition to the physical insights, the st | | | | |
| | this module. This provides them with an e | excellent opportunity to improve their | skills on multip | le fronts which | will be useful in the |
| | future career. | | | | |
| Personal Competence | | | | | |
| Social Competence | Teamwork & problem solving | | | | |
| Autonomy | The students will be involved in writing individual reports and presentation. This will contribute to the students' ability and | | | | |
| | willingness to work independently and res | ponsibly. | | | |
| Workload in Hours | Independent Study Time 96, Study Time i | n Lecture 84 | | | |
| Credit points | 6 | | | | |
| Course achievement | None | | | | |
| Examination | Subject theoretical and practical work | | | | |
| Examination duration and | Report | | | | |
| scale | | | | | |
| Assignment for the | Civil Engineering: Specialisation Structura | l Engineering: Elective Compulsory | | | |
| Following Curricula | Civil Engineering: Specialisation Geotechr | ical Engineering: Elective Compulsor | У | | |
| | Civil Engineering: Specialisation Coastal E | ngineering: Elective Compulsory | | | |
| | Civil Engineering: Specialisation Water an | d Traffic: Elective Compulsory | | | |
| | Civil Engineering: Specialisation Computa | tional Engineering: Elective Compulso | ory | | |
| | Chemical and Bioprocess Engineering: Teo | chnical Complementary Course: Elect | ive Compulsory | | |
| | Environmental Engineering: Core Qualifica | ation: Compulsory | | | |
| | Process Engineering: Specialisation Enviro | onmental Process Engineering: Electiv | e Compulsory | | |
| | Process Engineering: Specialisation Proces | ss Engineering: Elective Compulsory | | | |
| | Water and Environmental Engineering: Sp | ecialisation Water: Compulsory | | | |
| | Water and Environmental Engineering: Sp | ecialisation Environment: Elective Co | mpulsory | | |

| Course L2731: Modeling of Subsurface Processes | |
|--|--|
| Тур | Recitation Section (small) |
| Hrs/wk | 3 |
| CP | 3 |
| Workload in Hours | Independent Study Time 48, Study Time in Lecture 42 |
| Lecturer | Mohammad Aziz Zarif |
| Language | EN |
| Cycle | WiSe |
| Content | Basic usage and background of chosen computer software to calculate flow and transport in the saturated and unsaturated zone |
| | and to analyze field data like pumping test data |
| Literature | |

| Course L2728: Subsurface So | Course L2728: Subsurface Solute Transport | |
|-----------------------------|---|--|
| Тур | Lecture | |
| Hrs/wk | 2 | |
| СР | 2 | |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 | |
| Lecturer | Dr. Milad Aminzadeh | |
| Language | EN | |
| Cycle | WiSe | |
| Content | Basic physical properties of soil: Definition and quantification; Liquid flow in soils (Darcy's law); Solute transport in soils; Practical analysis to measure dispersion coefficient in soil under different boundary conditions; Advanced topics (e.g. Application of Artificial Intelligence to predict soil salinization) | |
| Literature | - Environmental Soil Physics, by Daniel Hillel - Soil Physics, Sixth Edition, by William A. Jury and Robert Horton | |

| Course L2729: Subsurface So | urse L2729: Subsurface Solute Transport | |
|-----------------------------|---|--|
| Тур | Recitation Section (large) | |
| Hrs/wk | 1 | |
| СР | 1 | |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 | |
| Lecturer | Dr. Milad Aminzadeh | |
| Language | EN | |
| Cycle | WiSe | |
| Content | See interlocking course | |
| Literature | See interlocking course | |
| Lingineering | | | | |
|--|---|---------------------------------------|---------------------|------------------------|
| Module M0513: Syste | m Aspects of Renewable Energies | | | |
| | | | | |
| Courses | | | | |
| Title | | Тур | Hrs/wk | СР |
| | ge: New Materials for Energy Production and Storage (L0021) | Lecture | 2 | 2 |
| Energy Trading (L0019) | | Lecture | 1 | 1 |
| Energy Trading (L0020) Deep Geothermal Energy (L0025) | | Recitation Section (small) Lecture | 1 2 | 1 |
| | Prof. Martin Kaltschmitt | Lecture | L | L |
| Admission Requirements | | | | |
| • | Module: Technical Thermodynamics I | | | |
| Knowledge | | | | |
| | Module: Technical Thermodynamics II | | | |
| Educational Objectives | After taking part successfully, students have reached the fo | llowing learning results | | |
| Professional Competence | | | | |
| Knowledge | Students are able to describe the processes in energy tradir | ng and the design of energy mark | ets and can critic | ally evaluate them in |
| | relation to current subject specific problems. Furtherm | ore, they are able to explain | the basics of | thermodynamics of |
| | electrochemical energy conversion in fuel cells and can es | tablish and explain the relations | nip to different ty | pes of fuel cells and |
| | their respective structure. Students can compare this techn | ology with other energy storage | options. In additic | on, students can give |
| | an overview of the procedure and the energetic involvemen | t of deep geothermal energy. | | |
| | | | | |
| Skills | Students can apply the learned knowledge of storage system | ms for excessive energy to explai | n for various ener | gy systems different |
| | approaches to ensure a secure energy supply. In particul | ar, they can plan and calculate | domestic, comm | ercial and industrial |
| | heating equipment using energy storage systems in an er | ergy-efficient way and can asses | s them in relatio | n to complex power |
| | systems. In this context, students can assess the potenti | al and limits of geothermal pow | er plants and exp | plain their operating |
| | mode. | | | |
| | Furthermore, the students are able to explain the procedure | es and strategies for marketing of | f energy and appl | v it in the context of |
| | other modules on renewable energy projects. In this conte | | | |
| | markets and energy trades. | | | j |
| | | | | |
| Personal Competence | | | | |
| Social Competence | Students are able to discuss issues in the thematic fields in | the renewable energy sector add | ressed within the | module. |
| Autonomy | Students can independently exploit sources , acquire the | particular knowledge about the | subject area and | transform it to new |
| | questions. | | | |
| Wayldand in Harris | Index and set Church Time OC. Church Time in Lochum O.4 | | | |
| Credit points | Independent Study Time 96, Study Time in Lecture 84 | | | |
| Course achievement | | | | |
| Examination | | | | |
| Examination duration and | | | | |
| scale | | | | |
| - | Bioprocess Engineering: Specialisation A - General Bioproce | ss Engineering: Elective Compulse | ory | |
| - | Aircraft Systems Engineering: Core Qualification: Elective Co | | - | |
| | International Management and Engineering: Specialisation I | | npulsory | |
| | International Management and Engineering: Specialisation I | ••• | | Compulsory |
| | International Management and Engineering: Specialisation I | | | |
| | Aeronautics: Core Qualification: Elective Compulsory | | | |
| | Renewable Energies: Core Qualification: Compulsory | | | |
| | Theoretical Mechanical Engineering: Specialisation Energy S | systems: Elective Compulsory | | |
| | Process Engineering: Specialisation Environmental Process I | | | |
| | Process Engineering: Specialisation Process Engineering: Ele | | | |
| | Water and Environmental Engineering: Specialisation Water | | | |
| | Water and Environmental Engineering: Specialisation Enviro | | | |
| | 5 5 | | | |

| Course L0021: Fuel Cells, Batteries, and Gas Storage: New Materials for Energy Production and Storage | |
|---|--|
| Тур | Lecture |
| Hrs/wk | 2 |
| CP | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Prof. Michael Fröba |
| Language | DE |
| Cycle | SoSe |
| Content | Introduction to electrochemical energy conversion Function and structure of electrolyte Low-temperature fuel cell Types Thermodynamics of the PEM fuel cell Cooling and humidification strategy High-temperature fuel cell The MCFC The SOFC Integration Strategies and partial reforming Fuels Supply of fuel Reforming of natural gas and biogas Reforming of liquid hydrocarbons Energetic Integration and control of fuel cell systems |
| Literature | • Hamann, C.; Vielstich, W.: Elektrochemie 3. Aufl.; Weinheim: Wiley - VCH, 2003 |

| Course L0019: Energy Tradin | g |
|-----------------------------|--|
| Тур | Lecture |
| Hrs/wk | 1 |
| СР | 1 |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 |
| Lecturer | Robert Gersdorf |
| Language | DE |
| Cycle | SoSe |
| Content | Basic concepts and tradable products in energy markets Primary energy markets Electricity Markets European Emissions Trading Scheme Influence of renewable energy Real options Risk management Within the exercise the various tasks are actively discussed and applied to various cases of application. |
| Literature | |

| Course L0020: Energy Tradin | Course L0020: Energy Trading | |
|-----------------------------|---|--|
| Тур | Recitation Section (small) | |
| Hrs/wk | 1 | |
| СР | 1 | |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 | |
| Lecturer | Robert Gersdorf | |
| Language | DE | |
| Cycle | SoSe | |
| Content | See interlocking course | |
| Literature | See interlocking course | |

| Course L0025: Deep Geother | mal Energy |
|----------------------------|---|
| Тур | Lecture |
| Hrs/wk | 2 |
| СР | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Dr. Ben Norden |
| Language | DE |
| Cycle | SoSe |
| Content | Introduction to the deep geothermal use Geological Basics I Geological Basics II Geology and thermal aspects Rock Physical Aspects Geochemical aspects Geochemical aspects Exploration of deep geothermal reservoirs Drilling technologies, piping and expansion Borehole Geophysics Underground system characterization and reservoir engineering Microbiology and Upper-day system components Adapted investment concepts, cost and environmental aspect |
| Literature | Dipippo, R.: Geothermal Power Plants: Principles, Applications, Case Studies and Environmental Impact. Butterworth Heinemann; 3rd revised edition. (29. Mai 2012) www.geo-energy.org Edenhofer et al. (eds): Renewable Energy Sources and Climate Change Mitigation; Special Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, 2012. Kaltschmitt et al. (eds): Erneuerbare Energien: Systemtechnik, Wirtschaftlichkeit, Umweltaspekte. Springer, 5. Aufl. 2013. Kaltschmitt et al. (eds): Energie aus Erdwärme. Spektrum Akademischer Verlag; Auflage: 1999 (3. September 2001) Huenges, E. (ed.): Geothermal Energy Systems: Exploration, Development, and Utilization. Wiley-VCH Verlag GmbH & Co. KGaA; Auflage: 1. Auflage (19. April 2010) |

| Module M0870: Mana | gement of Surface Water | | | |
|--------------------------------------|---|---|-----------------------|----------------------|
| | - | | | |
| Courses | | | | |
| Title | | Тур | Hrs/wk | СР |
| Modelling of Flow in Rivers and Estu | | Lecture | 3 | 4 |
| | ring / Integrated Flood Protection (L0961) | Project-/problem-based Lea | rning 2 | 2 |
| Module Responsible | Prof. Peter Fröhle | | | |
| Admission Requirements | None | | | |
| Recommended Previous | Fundamentals of Hydromechanics, Hydraulics, | Hydrology and Hydraulic Engineering; | Hydraulic Engineer | ing I and Hydrauli |
| Knowledge | Engineering II | | | |
| Educational Objectives | After taking part successfully, students have reac | hed the following learning results | | |
| Professional Competence | | | | |
| Knowledge | Students are able to define in detail the basic | • | | |
| | Besides, they can describe the basic aspects of r | - | al models for the sin | nulation of flows ar |
| | waves. They can also depict the concepts of natu | re oriented hydraulic engineering. | | |
| Skills | Students are able to apply hydrodynamic-numerio | cal models to practical hydraulic engineer | ring tasks. Furtherm | ore, the students a |
| | able to set up flood-risk management concepts a | nd are able to apply basic concepts of ren | aturation to practic | al problems. |
| Personal Competence | | | | |
| Social Competence | The students are able to deploy their gained kno | wledge in applied problems of the pract | ical nature-based h | ydraulic engineerin |
| | Additionaly, they will be able to work in team with | engineers of other disciplines. | | |
| Autonomy | The students will be able to independently extend | their knowledge and apply it to new pro | blems. | |
| Workload in Hours | Independent Study Time 110, Study Time in Lectu | ure 70 | | |
| Credit points | 6 | | | |
| Course achievement | None | | | |
| Examination | Written exam | | | |
| Examination duration and | The duration of the examination is 150 min. Th | e examination includes tasks with respe | ect to the general u | understanding of th |
| scale | lecture contents and calculations tasks. | | | |
| Assignment for the | Civil Engineering: Specialisation Water and Traffic | :: Compulsory | | |
| Following Curricula | Environmental Engineering: Core Qualification: El | ective Compulsory | | |
| | Joint European Master in Environmental Studies - | Cities and Sustainability: Core Qualification | on: Compulsory | |
| | Water and Environmental Engineering: Specialisa | tion Water: Compulsory | | |
| | Water and Environmental Engineering: Specialisa | tion Environment: Compulsory | | |
| | Water and Environmental Engineering: Specialisa | tion Cities: Elective Compulsory | | |

| Course 10910: Martalling Co | Slow in Biyors and Estuarios |
|------------------------------|--|
| Course L0810: Modelling of F | |
| Тур | |
| Hrs/wk | |
| CP | |
| Workload in Hours | |
| Lecturer | |
| Language | |
| Cycle | Introduction to numerical flow modelling |
| | Processes affecting tht flow Examples and applications of numerical models Procedure of numerical modelling Model concept Basic equations of hydrodynamics Saint-Venant equations Euler Equations Navier-Stokes equations Reynolds-averaged Navier-Stokes equations Shallow water equations |
| | Solving schemes Numerical discretization Solution algorithms Convergence |
| Literature | Vorlesungsskript |
| | Bund der Ingenieure für Wasserwirtschaft, Abfallwirtschaft und Kulturbau (1997): Hydraulische Berechnung von naturnahen Fließgewässern. Düsseldorf: BWK (BWK-Merkblatt). Chow, Ven-te (1959): Open-channel Hydraulics. New York usw.: McGraw-Hill (McGraw-Hill Civil Engineering Series). Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische Modelle, DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019a): Merkblatt DWA-M 543-2 Geodaten in der Fließgewässermodellierung Teil 1: Geodaten in der Fließgewässermodellierung. Februar 2019. Hennef: Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (DWA-Regelwerk, 543-1). |
| | Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische Modelle, DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019b): Merkblatt DWA-M 543-2 Geodaten in der Fließgewässermodellierung Teil 2: Bedarfsgerechte Datenerfassung und -aufbereitung. Februar 2019. Hennef: Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (DWA-Regelwerk, 543-2). Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische Modelle, DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019c): Merkblatt DWA-M 543-3 Geodaten in der Fließgewässermodellierung - Teil 3: Aspekte der Strömungsmodellierung und Fallbeispiele. Februar 2019. Hennef: Deutsche |
| | Vereinigung für Wasserwirtschaft, Abwasser und Abfall (DWA-Regelwerk, 543-3). Hervouet, Jean-Michel (2007): Hydrodynamics of free surface flows. Modelling with the finite element method. Chichester: Wiley. Online verfügbar unter http://www.loc.gov/catdir/enhancements/fy0741/2007296953-b.html. |
| | IAHR (2015): Professional Specifications for Physical and Numerical Studies in Environmental Hydraulics. In: Hydrolink (3/2015), S. 90-92. |
| | Olsen, Nils Reidar B. (2012): Numerical Modelling and Hydraulics. 3. Aufl. Department of Hydraulic and Environmental Engineering, The Norwegian University of Science and Technology. |
| | Szymkiewicz, Romuald (2010): Numerical modeling in open channel hydraulics. Dordrecht: Springer (Water science and technology library, 83). |
| | van Waveren, Harold (1999-): Good modelling practice handbook. [Utrecht], Lelystad, Den Haag: STOWA; Rijkswaterstaat-RIZA; SDU, afd. SEO/RIZA [etc. distr.] (Nota, nr. 99.036). |
| | Zielke, Werner (Hg.) (1999): Numerische Modelle von Flüssen, Seen und Küstengewässern. Deutscher Verband für Wasserwirtschaft und Kulturbau. Bonn: Wirtschafts- und VerlGes. Gas und Wasser (Schriftenreihe des Deutschen Verbandes für Wasserwirtschaft und Kulturbau, 127). |

| Course L0961: Nature-Oriented Hydraulic Engineering / Integrated Flood Protection | |
|---|---|
| Тур | Project-/problem-based Learning |
| Hrs/wk | 2 |
| СР | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Dr. Natasa Manojlovic, Prof. Peter Fröhle |
| Language | DE/EN |
| Cycle | SoSe |
| Content | Regime-Theory and application for the development of environmental guiding priciples of rivers Engineering - biological measures for the stabilization of rivers Risk management in flood protection Design techniques in technical flood protection Methods for the assessment of flood caused damages |
| Literature | Vorlesungsumdruck |

| Lingineering | | | | | |
|------------------------------------|---|-----------------------------------|---------------------|-------------------|---------------------|
| Module M0874: Waste | ewater Systems | | | | |
| | | | | | |
| Courses | | | | | |
| Title | | Тур | | Hrs/wk | СР |
| Biological Wastewater Treatment (I | L0517) | Lecture | | 2 | 2 |
| Biological Wastewater Treatment (I | L3122) | Recitation | Section (large) | 1 | 1 |
| Advanced Wastewater Treatment (| L0357) | Lecture | | 2 | 2 |
| Advanced Wastewater Treatment (| L0358) | Recitation | Section (large) | 1 | 1 |
| Module Responsible | Dr. Joachim Behrendt | | | | |
| Admission Requirements | None | | | | |
| Recommended Previous | Knowledge of wastewater management an | d the key processes involved in | wastewater treatm | nent. | |
| Knowledge | | | | | |
| Educational Objectives | After taking part successfully, students have | ve reached the following learning | g results | | |
| Professional Competence | | | | | |
| Knowledge | Students are able to outline key areas of the | he full range of treatment syste | ms in waste water | management, as | well as their mutua |
| | dependence for sustainable water protection | on. They can describe relevant e | economic, environn | nental and social | factors. |
| | | | | | |
| Skills | Students are able to pre-design and expla | | eatment processes | and the scope o | f their application |
| | municipal and for some industrial treatmen | nt plants. | | | |
| Personal Competence | | | | | |
| | Social skills are not targeted in this module | 2 | | | |
| Social competence | Social Skills are not targeted in this module | | | | |
| Autonomy | Students are in a position to work on a s | subject and to organize their w | ork flow independ | lently. They can | also present on thi |
| | subject. | | | | |
| Workload in Hours | Independent Study Time 96, Study Time in | Lecture 84 | | | |
| Credit points | 6 | | | | |
| Course achievement | None | | | | |
| Examination | Written exam | | | | |
| Examination duration and | 120 min | | | | |
| scale | | | | | |
| Assignment for the | Civil Engineering: Specialisation Structural | Engineering: Elective Compulso | ry | | |
| | Civil Engineering: Specialisation Geotechni | | | | |
| - | Civil Engineering: Specialisation Coastal En | ngineering: Elective Compulsory | | | |
| | Civil Engineering: Specialisation Water and | | | | |
| | Bioprocess Engineering: Specialisation A - (| | : Elective Compulso | orv | |
| | Environmental Engineering: Specialisation | | | | |
| | International Management and Engineering | | | | Compulsory |
| | International Management and Engineering | | | | |
| | Process Engineering: Specialisation Enviror | | - | | . , |
| | Process Engineering: Specialisation Process | | | | |
| | Water and Environmental Engineering: Spe | | - 2 | | |
| | Water and Environmental Engineering: Spe | | e Compulsory | | |
| | Water and Environmental Engineering: Spe | | e compaisory | | |
| | water and Environmental Engineering. Spe | compuisory | | | |

| Course L0517: Biological Wastewater Treatment | |
|---|---|
| Тур | Lecture |
| Hrs/wk | 2 |
| СР | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Dr. Joachim Behrendt |
| Language | DE/EN |
| Cycle | SoSe |
| Content | Charaterisation of Wastewater |
| | Metobolism of Microorganisms |
| | Kinetic of mirobiotic processes |
| | Calculation of bioreactor for wastewater treatment |
| | Concepts of Wastewater treatment |
| | Design of WWTP |
| | Excursion to a WWTP |
| | Biofilms |
| | Biofim Reactors |
| | Anaerobic Wastewater and sldge treatment |
| | resources oriented sanitation technology |
| | Future challenges of wastewater treatment |
| Literature | Gujer, Willi |
| | Siedlungswasserwirtschaft : mit 84 Tabellen |
| 1 | |

| Engineering | |
|-------------|--|
| | ISBN: 3540343296 (Gb.) URL: http://www.gbv.de/dms/bs/toc/516261924.pdf URL: http://deposit.d-nb.de/cgi-bin/dokserv? |
| | id=2842122&prov=M&dok_var=1&dok_ext=htm |
| | Berlin [u.a.] : Springer, 2007 |
| | TUB_HH_Katalog |
| | Henze, Mogens |
| | Wastewater treatment : biological and chemical processes |
| | ISBN: 3540422285 (Pp.) |
| | Berlin [u.a.] : Springer, 2002 |
| | TUB_HH_Katalog |
| | Imhoff, Karl (Imhoff, Klaus R.;) |
| | Taschenbuch der Stadtentwässerung : mit 10 Tafeln |
| | ISBN: 3486263331 ((Gb.)) |
| | München [u.a.] : Oldenbourg, 1999 |
| | TUB_HH_Katalog |
| | Lange, Jörg (Otterpohl, Ralf; Steger-Hartmann, Thomas;) |
| | Abwasser : Handbuch zu einer zukunftsfähigen Wasserwirtschaft |
| | ISBN: 3980350215 (kart.) URL: http://www.gbv.de/du/services/agi/52567E5D44DA0809C12570220050BF25/000000700334 |
| | Donaueschingen-Pfohren : Mall-Beton-Verl., 2000 |
| | TUB_HH_Katalog |
| | Mudrack, Klaus (Kunst, Sabine;) |
| | Biologie der Abwasserreinigung : 18 Tabellen |
| | ISBN: 382741427X URL: http://www.gbv.de/du/services/agi/94B581161B6EC747C1256E3F005A8143/420000114903 |
| | Heidelberg [u.a.] : Spektrum, Akad. Verl., 2003 |
| | TUB HH Katalog |
| | Tchobanoglous, George (Metcalf & Eddy, Inc., ;) |
| | Wastewater engineering : treatment and reuse |
| | ISBN: 0070418780 (alk. paper) ISBN: 0071122508 (ISE (*pbk)) |
| | Boston [u.a.] : McGraw-Hill, 2003 |
| | TUB_HH_Katalog |
| | Henze, Mogens |
| | Activated sludge models ASM1, ASM2, ASM2d and ASM3 |
| | ISBN: 1900222248 |
| | London : IWA Publ., 2002 |
| | TUB_HH_Katalog |
| | Kunz, Peter |
| | Umwelt-Bioverfahrenstechnik |
| | Vieweg, 1992 |
| | Bauhaus-Universität., Arbeitsgruppe Weiterbildendes Studium Wasser und Umwelt (Deutsche Vereinigung für |
| | Wasserwirtschaft, Abwasser und Abfall, ;) |
| | Abwasserbehandlung : Gewässerbelastung, Bemessungsgrundlagen, Mechanische Verfahren, Biologische Verfahren, Reststoffe |
| | aus der Abwasserbehandlung, Kleinkläranlagen |
| | ISBN: 3860682725 URL: http://www.gbv.de/dms/weimar/toc/513989765_toc.pdf URL: |
| | http://www.gbv.de/dms/weimar/abs/513989765_abs.pdf |
| | Weimar : Universitätsverl, 2006 |
| | TUB_HH_Katalog |
| | Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall |
| | DWA-Regelwerk |
| | Hennef : DWA, 2004 |
| | |
| | TUB_HH_Katalog Wiesmann, Udo (Choi, In Su; Dombrowski, Eva-Maria;) |
| | Fundamentals of biological wastewater treatment |
| | - |
| | ISBN: 3527312196 (Gb.) URL: http://deposit.ddb.de/cgi-bin/dokserv?id=2774611&prov=M&dok_var=1&dok_ext=htm |
| | Weinheim : WILEY-VCH, 2007 |
| | TUB_HH_Katalog |

| Course L3122: Biological Wa | urse L3122: Biological Wastewater Treatment | |
|-----------------------------|---|--|
| Тур | Recitation Section (large) | |
| Hrs/wk | 1 | |
| CP | 1 | |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 | |
| Lecturer | Dr. Joachim Behrendt | |
| Language | DE/EN | |
| Cycle | SoSe | |
| Content | See interlocking course | |
| Literature | See interlocking course | |

| Course L0357: Advanced Wa | stewater Treatment |
|---------------------------|---|
| Тур | Lecture |
| Hrs/wk | 2 |
| СР | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Dr. Joachim Behrendt |
| Language | EN |
| Cycle | SoSe |
| Content | Survey on advanced wastewater treatment |
| | reuse of reclaimed municipal wastewater |
| | Precipitation |
| | Flocculation |
| | Depth filtration |
| | Membrane Processes |
| | Activated carbon adsorption |
| | Ozonation |
| | "Advanced Oxidation Processes" |
| | Disinfection |
| Literature | Metcalf & Eddy, Wastewater Engineering: Treatment and Reuse, McGraw-Hill, Boston 2003 |
| | Wassertechnologie, H.H. Hahn, Springer-Verlag, Berlin 1987 |
| | Membranverfahren: Grundlagen der Modul- und Anlagenauslegung, T. Melin und R. Rautenbach, Springer-Verlag, Berlin 2007 |
| | Trinkwasserdesinfektion: Grundlagen, Verfahren, Anlagen, Geräte, Mikrobiologie, Chlorung, Ozonung, UV-Bestrahlung, Membranfiltration, Qualitätssicherung, W. Roeske, Oldenbourg-Verlag, München 2006 |
| | Organische Problemstoffe in Abwässern, H. Gulyas, GFEU, Hamburg 2003 |

| Course L0358: Advanced Wa | stewater Treatment | | | |
|---------------------------|---|--|--|--|
| Тур | Recitation Section (large) | | | |
| Hrs/wk | 1 | | | |
| СР | 1 | | | |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 | | | |
| Lecturer | Dr. Joachim Behrendt | | | |
| Language | EN | | | |
| Cycle | SoSe | | | |
| Content | Aggregate organic compounds (sum parameters) | | | |
| | Industrial wastewater | | | |
| | Processes for industrial wastewater treatment | | | |
| | recipitation | | | |
| | Flocculation | | | |
| | Activated carbon adsorption | | | |
| | Recalcitrant organic compounds | | | |
| | | | | |
| Literature | Metcalf & Eddy, Wastewater Engineering: Treatment and Reuse, McGraw-Hill, Boston 2003 | | | |
| | Wassertechnologie, H.H. Hahn, Springer-Verlag, Berlin 1987 | | | |
| | Membranverfahren: Grundlagen der Modul- und Anlagenauslegung, T. Melin und R. Rautenbach, Springer-Verlag, Berlin 2007 | | | |
| | Trinkwasserdesinfektion: Grundlagen, Verfahren, Anlagen, Geräte, Mikrobiologie, Chlorung, Ozonung, UV-Bestrahlung, Membranfiltration, Qualitätssicherung, W. Roeske, Oldenbourg-Verlag, München 2006 | | | |
| | Organische Problemstoffe in Abwässern, H. Gulyas, GFEU, Hamburg 2003 | | | |

| Module M0875: Nexu | s Engineering - Water, Soil, Food | and Energy | | | |
|------------------------------------|---|--|-----------------------|--------------------|--|
| Courses | | | | | |
| Title | | Тур | Hrs/wk | СР | |
| Ecological Town Design - Water, Er | ergy, Soil and Food Nexus (L1229) | Seminar | 2 | 2 | |
| Water & Wastewater Systems in a | Global Context (L0939) | Lecture | 2 | 4 | |
| Module Responsible | Prof. Ralf Otterpohl | | | | |
| Admission Requirements | None | | | | |
| Recommended Previous Knowledge | Basic knowledge of the global situation with rising poverty, soil degradation, migration to cities, lack of water resources an sanitation | | | | |
| Educational Objectives | After taking part successfully, students have rea | ached the following learning results | | | |
| Professional Competence | | | | | |
| Knowledge | Students can describe the facets of the global water situation. Students can judge the enormous potential of the implementation o synergistic systems in Water, Soil, Food and Energy supply. | | | | |
| Skills | Students are able to design ecological settlements for different geographic and socio-economic conditions for the main climate around the world. | | | | |
| Personal Competence | | | | | |
| Social Competence | The students are able to develop a specific topic in a team and to work out milestones according to a given plan. | | | | |
| Autonomy | Students are in a position to work on a subject and to organize their work flow independently. They can also present on this subject. | | | | |
| Workload in Hours | Independent Study Time 124, Study Time in Leo | ture 56 | | | |
| Credit points | 6 | | | | |
| Course achievement | None | | | | |
| Examination | Subject theoretical and practical work | | | | |
| Examination duration and | During the course of the semester, the student | s work towards mile stones. The work i | ncludes presentations | and papers. Detail | |
| scale | information can be found at the beginning of the | e smester in the StudIP course module h | nandbook. | | |
| Assignment for the | Civil Engineering: Specialisation Water and Traf | fic: Elective Compulsory | | | |
| Following Curricula | Bioprocess Engineering: Specialisation A - Gene | ral Bioprocess Engineering: Elective Cor | npulsory | | |
| | Chemical and Bioprocess Engineering: Specialis | ation General Process Engineering: Elec | tive Compulsory | | |
| | Environmental Engineering: Core Qualification: I | Elective Compulsory | | | |
| | Joint European Master in Environmental Studies | - Cities and Sustainability: Core Qualific | ation: Compulsory | | |
| | Process Engineering: Specialisation Environmen | tal Process Engineering: Elective Compu | ulsory | | |
| | Process Engineering: Specialisation Process Eng | ineering: Elective Compulsory | | | |
| | Water and Environmental Engineering: Specialis | sation Water: Elective Compulsory | | | |
| | Water and Environmental Engineering: Specialis | sation Environment: Elective Compulsor | y | | |
| | Water and Environmental Engineering: Specialis | sation Cities: Elective Compulsory | | | |

| Course L1229: Ecological Tov | wn Design - Water, Energy, Soil and Food Nexus |
|------------------------------|--|
| Тур | Seminar |
| Hrs/wk | 2 |
| СР | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Prof. Ralf Otterpohl |
| Language | EN |
| Cycle | SoSe |
| Content | Participants Workshop: Design of the most attractive productive Town Keynote lecture and video The limits of Urbanization / Green Cities The tragedy of the Rural: Soil degradation, agro chemical toxification, migration to cities Global Ecovillage Network: Upsides and Downsides around the World Visit of an Ecovillage Participants Workshop: Resources for thriving rural areas, Short presentations by participants, video competion TUHH Rural Development Toolbox Integrated New Town Development Participants workshop: Design of New Towns: Northern, Arid and Tropical cases Outreach: Participants campaign City with the Rural: Resilience, quality of live and productive biodiversity |
| Literature | Ralf Otterpohl 2013: Gründer-Gruppen als Lebensentwurf: "Synergistische Wertschöpfung in erweiterten Kleinstadt- und Dorfstrukturen", in "Regionales Zukunftsmanagement Band 7: Existenzgründung unter regionalökonomischer Perspektive, Pabst Publisher, Lengerich http://youtu.be/9hmkgn0nBgk (Miracle Water Village, India, Integrated Rainwater Harvesting, Water Efficiency, Reforestation and Sanitation) TEDx New Town Ralf Otterpohl: http://youtu.be/_M0J2u9BrbU |

| Course L0939: Water & Wastewater Systems in a Global Context | | | |
|--|---|--|--|
| Тур | Lecture | | |
| Hrs/wk | 2 | | |
| СР | 4 | | |
| Workload in Hours | Independent Study Time 92, Study Time in Lecture 28 | | |
| Lecturer | Prof. Ralf Otterpohl | | |
| Language | EN | | |
| Cycle | SoSe | | |
| Content | Keynote lecture and video Water & Soil: Water availability as a consequence of healthy soils Water and it's utilization, Integrated Urban Water Management Water & Energy, lecture and panel discussion pro and con for a specific big dam project Rainwater Harvesting on Catchment level, Holistic Planned Grazing, Multi-Use-Reforestation Sanitation and Reuse of water, nutrients and soil conditioners, Conventional and Innovative Approaches Why are there excreta in water? Public Health, Awareness Campaigns Rehearsal session, Q&A | | |
| Literature | Montgomery, David R. 2007: Dirt: The Erosion of Civilizations, University of California Press Liu, John D.: http://eempc.org/hope-in-a-changing_climate/ (Integrated regeneration of the Loess Plateau, China, and sites in Ethiopia and Rwanda) http://youtu.be/9hmkgn0nBgk (Miracle Water Village, India, Integrated Rainwater Harvesting, Water Efficiency, Reforestation and Sanitation) | | |

| Madula M1701, Wata | and Funite sector Theory and Application | | | | |
|-------------------------------|--|-----------------------------|---------------------|-------------------|--|
| Module M1721: Wate | r and Environment: Theory and Application | | | | |
| Courses | | | | | |
| Title | Түр | 1 | Hrs/wk | СР | |
| Water and Environment (L2754) | | ect-/problem-based Learning | 3 | 3 | |
| Water and Environment (L2753) | Lect | | 3 | 3 | |
| Module Responsible | Prof. Nima Shokri | | | | |
| Admission Requirements | None | | | | |
| Recommended Previous | Basic knowledge in water and environmental research, Hydrology | | | | |
| Knowledge | | | | | |
| Educational Objectives | After taking part successfully, students have reached the following lea | arning results | | | |
| Professional Competence | | | | | |
| Knowledge | Common research tools and techniques together with the fundamental knowledge relevant to multi-scale and multi-phase challenges present in water and environmental research will be discussed in this module. Both theory and application will be considered. | | | | |
| Skills | In addition to the fundamental knowledge, the students will be exposed to several analytical, experimental and numerical tools and techniques relevant to water and environmental research at different scales. This will provide the students with an excellent opportunity to improve their skills on multiple fronts which will be useful in their future career. | | | | |
| Personal Competence | | | | | |
| Social Competence | Developing teamwork and problem solving skills through Research-Ba | ased Teaching approaches w | vill be at the core | e of this module. | |
| Autonomy | The students will be involved in writing individual reports and presentation. This will contribute to the students' ability and willingness to work independently and responsibly. | | | | |
| Workload in Hours | Independent Study Time 96, Study Time in Lecture 84 | | | | |
| Credit points | 6 | | | | |
| Course achievement | None | | | | |
| Examination | Subject theoretical and practical work | | | | |
| Examination duration and | Report and Presentation | | | | |
| scale | | | | | |
| Assignment for the | Civil Engineering: Specialisation Coastal Engineering: Elective Compu | lsory | | | |
| Following Curricula | Civil Engineering: Specialisation Water and Traffic: Elective Compulso | ry | | | |
| | Environmental Engineering: Specialisation Environment and Climate: | Elective Compulsory | | | |
| | Water and Environmental Engineering: Specialisation Cities: Elective | Compulsory | | | |
| | Water and Environmental Engineering: Specialisation Water: Elective | Compulsory | | | |
| | Water and Environmental Engineering: Specialisation Environment: C | ompulsory | | | |

| Course L2754: Water and En | Course L2754: Water and Environment | | |
|----------------------------|---|--|--|
| Тур | Project-/problem-based Learning | | |
| Hrs/wk | 3 | | |
| СР | 3 | | |
| Workload in Hours | Independent Study Time 48, Study Time in Lecture 42 | | |
| Lecturer | Dr. Salome Shokri-Kuehni | | |
| Language | EN | | |
| Cycle | SoSe | | |
| Content | See interlocking course | | |
| Literature | See interlocking course | | |

| Course L2753: Water and En | vironment |
|----------------------------|---|
| Тур | Lecture |
| Hrs/wk | 3 |
| СР | 3 |
| Workload in Hours | Independent Study Time 48, Study Time in Lecture 42 |
| Lecturer | Prof. Nima Shokri |
| Language | EN |
| Cycle | SoSe |
| Content | Research based learning: The students will be engaged in active research focused on water and environmental related challenges. |
| | The required knowledge and tools will be discussed during the semester. |
| Literature | NA |

| Engineering" | | | | | |
|-----------------------------------|---|---|--|--|--|
| Module M1724: Smar | rt Monitoring | | | | |
| Courses | | | | | |
| Title | Typ Hrs/wk | СР | | | |
| Smart Monitoring (L2762) | Integrated Lecture 2 | 2 | | | |
| Smart Monitoring (L2763) | Recitation Section (small) 2 | 4 | | | |
| Module Responsible | e Prof. Kay Smarsly | | | | |
| Admission Requirements | s None | | | | |
| Recommended Previous Knowledge | | | | | |
| Educational Objectives | s After taking part successfully, students have reached the following learning results | | | | |
| Professional Competence | e | | | | |
| | e The students will be able to work in groups, share parts of the work for their projects, and develop comm | uilt and in the natura ing state-of-the-art data lectures, project work i de. In small groups, the mented by the students erms will be mounted o urposes. The outcome of their smart monitoring inal grades. The modul a wide range of physica ents will be capable of ge backgrounds, and t Finally, the students wi | | | |
| Autonomy | achieving the common project goals. The students will be able to gain a solid basis on approaching and solving problems in engineering, as well as on documentin results, through their involvement in their monitoring group projects. | | | | |
| Workload in Hours | s Independent Study Time 124, Study Time in Lecture 56 | | | | |
| Credit points | | | | | |
| Course achievement | | | | | |
| | | | | | |
| | n Written elaboration | | | | |
| | d 10 pages of work with 15-minute oral presentation | | | | |
| scale | | | | | |
| - | Civil Engineering: Specialisation Water and Traffic: Elective Compulsory | | | | |
| Following Curricula | | | | | |
| | Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory | | | | |
| | Civil Engineering: Specialisation Structural Engineering: Elective Compulsory | | | | |
| | Computer Science: Specialisation II: Intelligence Engineering: Elective Compulsory | | | | |
| | Environmental Engineering: Specialisation Energy and Resources: Elective Compulsory | | | | |
| | Environmental Engineering: Specialisation Environment and Climate: Elective Compulsory | | | | |
| | Environmental Engineering: Specialisation Water Quality and Water Engineering: Elective Compulsory | | | | |
| | Mechatronics: Technical Complementary Course: Elective Compulsory | | | | |
| | Mechatronics: Core Qualification: Elective Compulsory | | | | |
| | Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory | | | | |
| | Water and Environmental Engineering: Specialisation Cities: Elective Compulsory | | | | |
| | Water and Environmental Engineering: Specialisation Environment: Elective Compulsory | | | | |
| | Water and Environmental Engineering: Specialisation Water: Elective Compulsory | | | | |

| Course L2762: Smart Monito | ring |
|----------------------------|--|
| Тур | Integrated Lecture |
| Hrs/wk | 2 |
| СР | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Prof. Kay Smarsly |
| Language | EN |
| Cycle | SoSe |
| Content | In this course, principles of smart monitoring will be taught, focusing on modern concepts of data acquisition, data storage, and data analysis. Also, fundamentals of intelligent sensors and embedded computing will be illuminated. Autonomous software and decentralized data processing are further crucial parts of the course, including concepts of the Internet of Things, Industry 4.0 and cyber-physical systems. Furthermore, measuring principles, data acquisition systems, data management and data analysis algorithms will be discussed. Besides the theoretical background, numerous practical examples will be shown to demonstrate how smart monitoring may advantageously be used for assessing the condition of systems in the built or natural environment. |
| Literature | The course contents couples different fields, such as signal processing, sensing technologies, data analytics, environmental engineering, civil engineering, artificial intelligence, database systems, and many more. The basics will be taught in this course. However, specific literature that covers all these topics does not exist. Instead, literature will be referenced in the lectures, all of which are papers that are freely available online. |

| Course L2763: Smart Monito | ring |
|----------------------------|--|
| Тур | Recitation Section (small) |
| Hrs/wk | 2 |
| CP | 4 |
| Workload in Hours | Independent Study Time 92, Study Time in Lecture 28 |
| Lecturer | Prof. Kay Smarsly |
| Language | EN |
| Cycle | SoSe |
| | The contents of the exercises are based on the lecture contents. In addition to the exercises, project work will be conducted throughout the semester, which will consume the majority of the workload. As part of the project work, students will design smart monitoring systems that will be tested in the laboratory or in the field. As mentioned in the module description, the students will participate in the "Smart Monitoring" competition, hosted annually by the Institute of Digital and Autonomous Construction. Students are encouraged to contribute their own ideas. The tools required to implement the smart monitoring systems will be taught in the group exercises as well as through external sources, such as video tutorials and literature. |
| Literature | The course contents couples different fields, such as signal processing, sensing technologies, data analytics, environmental engineering, civil engineering, artificial intelligence, database systems, and many more. The basics will be taught in this course However, specific literature that covers all these topics does not exist. Instead, literature will be referenced in the lectures, all of which are papers that are freely available online. |

| Module M0858: Coast | al Hydraulic Engineering I | | | | |
|------------------------------------|---|---------------------------|------------------------------------|-----------------|---------------------|
| Courses | | | | | |
| Title | | | Тур | Hrs/wk | СР |
| Basics of Coastal Engineering (L08 | 07) | | Lecture | 3 | 4 |
| Basics of Coastal Engineering (L14 | 13) | | Project-/problem-based Learning | 1 | 2 |
| Module Responsible | Prof. Peter Fröhle | | | | |
| Admission Requirements | None | | | | |
| Recommended Previous | Basics of hydraulic engineering, hydrology | and hydromechanics | | | |
| Knowledge | | | | | |
| Educational Objectives | After taking part successfully, students hav | ve reached the following | ng learning results | | |
| Professional Competence | | | | | |
| Knowledge | The students are able to define and explain the basic concepts of coastal engineering and port engineering. They are able to apply the concepts to selected practical problems of coastal engineering. Students can define and determine the basics for design and dimensioning of coastal engineering constructions. | | | | |
| Skills | The students are capable to apply basic design approaches to selected and pre-defined design tasks in coastal engineering. | | | | |
| Personal Competence | | | | | |
| Social Competence | The students are able to deploy their gain | ed knowledge in appl | ied problems such as the desig | n of coastal p | rotection structure |
| | Additionaly, they will be able to work in tea | am with engineers of o | ther disciplines, for instance des | signing of coas | stal breakwaters. |
| Autonomy | The students will be able to independently extend their knowledge and applyit to new problems. | | | | |
| Workload in Hours | Independent Study Time 124, Study Time i | n Lecture 56 | | | |
| Credit points | 6 | | | | |
| Course achievement | None | | | | |
| Examination | Written exam | | | | |
| Examination duration and | The duration of the examination is 2 hours. The examination includes tasks with respect to the general understanding of the | | | | |
| scale | lecture contents and calculations tasks. | | | | |
| Assignment for the | Civil Engineering: Specialisation Coastal En | gineering: Compulsor | y | | |
| Following Curricula | Civil Engineering: Specialisation Geotechnic | cal Engineering: Comp | oulsory | | |
| | Civil Engineering: Specialisation Structural | Engineering: Elective | Compulsory | | |
| | Environmental Engineering: Specialisation | Environment and Clim | ate: Elective Compulsory | | |
| | Environmental Engineering: Specialisation | Water Quality and Wa | ter Engineering: Elective Compu | lsory | |
| | International Management and Engineering | g: Specialisation II. Civ | il Engineering: Elective Compuls | ory | |
| | Water and Environmental Engineering: Spe | cialisation Environme | nt: Elective Compulsory | | |
| | Water and Environmental Engineering: Spe | cialisation Water: Elec | ctive Compulsory | | |

| Course L0807: Basics of Coastal Engineering | | | | |
|---|---|--|--|--|
| Тур | Lecture | | | |
| Hrs/wk | 3 | | | |
| CP | | | | |
| Workload in Hours | Independent Study Time 78, Study Time in Lecture 42 | | | |
| Lecturer | Prof. Peter Fröhle | | | |
| Language | EN | | | |
| Cycle | SoSe | | | |
| Content | | | | |
| | Basics of planning and design | | | |
| | Water levels | | | |
| | • Currents | | | |
| | Waves Ice | | | |
| | | | | |
| | Planning and Design in Coastal Engineering | | | |
| | Functional and constructional design | | | |
| | Determination of design parameters Design-approaches | | | |
| | Design-approaches Filter | | | |
| | Filter Rubble mound constructions | | | |
| | Rubble mound constructions Piles | | | |
| | Files Vertical constructions | | | |
| | | | | |
| | | | | |
| Literature | Coastal Engineering Manual, CEM | | | |
| Literature | Coastal Engineering Manual, CEM | | | |
| | rlesungsumdruck | | | |
| | | | | |
| | | | | |

| Course L1413: Basics of Coas | ourse L1413: Basics of Coastal Engineering | | | |
|------------------------------|--|--|--|--|
| Тур | Project-/problem-based Learning | | | |
| Hrs/wk | 1 | | | |
| СР | | | | |
| Workload in Hours | ependent Study Time 46, Study Time in Lecture 14 | | | |
| Lecturer | rof. Peter Fröhle | | | |
| Language | N | | | |
| Cycle | SoSe | | | |
| Content | ee interlocking course | | | |
| Literature | See interlocking course | | | |

| Courses | | | | | |
|-----------------------------------|---|------------------------------------|---------|----|--|
| Title | | Tun | Hrs/wk | СР | |
| Offshore Geotechnical Engineering | (10067) | Typ Lecture | 1 | 1 | |
| Hydro Power Use (L0013) | | Lecture | 1 | 1 | |
| Wind Turbine Plants (L0011) | | Lecture | 2 | 3 | |
| Wind Energy Use - Focus Offshore | L0012) | Lecture | 1 | 1 | |
| Module Responsible | Dr. Marvin Scherzinger | | | | |
| Admission Requirements | None | | | | |
| Recommended Previous | Module: Technical Thermodynamics I, | | | | |
| Knowledge | Market and the standard standard and the standard | | | | |
| | Module: Technical Thermodynamics II, | | | | |
| | Module: Fundamentals of Fluid Mechanics | | | | |
| Educational Objectives | After taking part successfully, students have reached | the following learning results | | | |
| Professional Competence | | | | | |
| Knowledge | <i>Knowledge</i> By ending this module students can explain in detail knowledge of wind turbines with a particular focus of wind energy offshore conditions and can critical comment these aspects in consideration of current developments. Furthermore, they to describe fundamentally the use of water power to generate electricity. The students reproduce and explain the basic print the implementation of renewable energy projects in countries outside Europe. | | | | |
| | Through active discussions of various topics within the seminar of the module, students improve their understanding and application of the theoretical background and are thus able to transfer what they have learned in practice. | | | | |
| Skills | Students are able to apply the acquired theoretical foundations on exemplary water or wind power systems and evaluate an assess technically the resulting relationships in the context of dimensioning and operation of these energy systems. They can i compare critically the special procedure for the implementation of renewable energy projects in countries outside Europe with th in principle applied approach in Europe and can apply this procedure on exemplary theoretical projects. | | | | |
| Personal Competence | | | | | |
| Social Competence | Students can discuss scientific tasks subjet-specificly | y and multidisciplinary within a s | eminar. | | |
| Autonomy | Students can independently exploit sources in the context of the emphasis of the lecture material to clear the contents of th lecture and to acquire the particular knowledge about the subject area. | | | | |
| Workload in Hours | Independent Study Time 110, Study Time in Lecture | 70 | | | |
| Credit points | | | | | |
| Course achievement | | | | | |
| Examination | Written exam | | | | |
| Examination duration and | 180 min | | | | |
| scale | | | | | |
| | Civil Engineering: Specialisation Structural Engineering | ng: Elective Compulsory | | | |
| | Civil Engineering: Specialisation Geotechnical Engine | | | | |
| j | Civil Engineering: Specialisation Coastal Engineering | • • • | | | |
| | International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory | | | | |
| | International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Renewable Energy: Elective Compulsory | | | | |
| | Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory | | | | |
| | Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory | | | | |
| | | | | | |
| | Product Development, Materials and Production: Specialisation Materials: Elective Compulsory | | | | |
| | Renewable Energies: Core Qualification: Compulsory | | | | |
| | Theoretical Mechanical Engineering: Specialisation E | | | | |
| | Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory | | | | |
| | Water and Environmental Engineering: Specialisation | | | | |
| | Water and Environmental Engineering: Specialisation | Environment: Elective Compulse | ory | | |
| | Water and Environmental Engineering: Specialisation | Matan Elective Course Inc | | | |

| Course L0067: Offshore Geo | technical Engineering | | |
|----------------------------|--|--|--|
| Тур | Lecture | | |
| Hrs/wk | | | |
| CP | 1 | | |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 | | |
| Lecturer | Dr. Jan Dührkop | | |
| Language | DE | | |
| Cycle | SoSe | | |
| Content | Overview and Introduction Offshore Geotechnics Introduction to Soil Mechanics Offshore soil investigation Focus on cyclical effects Geotechnical design of offshore foundations Monopiles Jackets Heavyweight foundations Geotechnical preliminary exploration for the use of lift boats and platforms | | |
| Literature | Randolph, M. and Gourvenec, S (2011): Offshore Geotechnical Engineering. Spon Press. Poulos H.G. (1988): Marine Geotechnics. Unwin Hyman, London BSH-Standard Baugrunderkundung für Offshore-Windenergieparks Lesny K. (2010): Foundations for Offshore Wind Turbines. VGE Verlag, Essen. EA-Pfähle (2012): Empfehlungen des Arbeitskreises Pfähle der DGGT. Ernst & Sohn, Berlin. | | |

| Course L0013: Hydro Power | Use | | | |
|---------------------------|--|--|--|--|
| Тур | Lecture | | | |
| Hrs/wk | 1 | | | |
| CP | | | | |
| Workload in Hours | dependent Study Time 16, Study Time in Lecture 14 | | | |
| Lecturer | Prof. Stefan Achleitner | | | |
| Language | DE | | | |
| Cycle | SoSe | | | |
| Content | Introduction, importance of water power in the national and global context Physical basics: Bernoulli's equation, usable height of fall, hydrological measures, loss mechanisms, efficiencies Classification of Hydropower: Flow and Storage hydropower, low and high pressure systems Construction of hydroelectric power plants: description of the individual components and their technical system interaction Structural engineering components; representation of dams, weirs, dams, power houses, computer systems, etc. Energy Technical Components: Illustration of the different types of hydraulic machinery, generators and grid connection Hydropower and the Environment Examples from practice | | | |
| Literature | Schröder, W.; Euler, G.; Schneider, K.: Grundlagen des Wasserbaus; Werner, Düsseldorf, 1999, 4. Auflage Quaschning, V.: Regenerative Energiesysteme: Technologie - Berechnung - Simulation; Carl Hanser, München, 2011, 7. Auflage Giesecke, J.; Heimerl, S.; Mosony, E.: Wasserkraftanlagen - Planung, Bau und Betrieb; Springer, Berlin, Heidelberg, 2009, 5. Auflage von König, F.; Jehle, C.: Bau von Wasserkraftanlagen - Praxisbezogene Planungsunterlagen; C. F. Müller, Heidelberg, 2005, 4. Auflage Strobl, T.; Zunic, F.: Wasserbau: Aktuelle Grundlagen - Neue Entwicklungen; Springer, Berlin, Heidelberg, 2006 | | | |

| Course L0011: Wind Turbine | Plants | | |
|----------------------------|---|--|--|
| Тур | cture | | |
| Hrs/wk | 2 | | |
| СР | 3 | | |
| Workload in Hours | Independent Study Time 62, Study Time in Lecture 28 | | |
| Lecturer | Dr. Rudolf Zellermann | | |
| Language | DE | | |
| Cycle | SoSe | | |
| Content | Historical development Wind: origins, geographic and temporal distribution, locations Power coefficient, rotor thrust Aerodynamics of the rotor Operating performance Power limitation, partial load, pitch and stall control Plant selection, yield prediction, economy Excursion | | |
| Literature | Gasch, R., Windkraftanlagen, 4. Auflage, Teubner-Verlag, 2005 | | |

| Course L0012: Wind Energy | Use - Focus Offshore | | | |
|---------------------------|--|--|--|--|
| Тур | Lecture | | | |
| Hrs/wk | | | | |
| CP | 1 | | | |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 | | | |
| Lecturer | Prof. Martin Skiba | | | |
| Language | DE | | | |
| Cycle | SoSe | | | |
| Content | Introduction, importance of offshore wind power generation, Specific requirements for offshore engineering Physical fundamentals for utilization of wind energy Design and operation of offshore wind turbines, presentation of different concepts of offshore wind turbines, representation of the individual system components and their system-technical relationships Foundation engineering, offshore site investigation, presentation of different concepts of offshore foundation structures, planning and fabrication of foundation structures Electrical infrastructure of an offshore wind farm, Inner Park cabling, offshore substation, grid connection Installation of offshore wind farms, installation techniques and auxiliary devices, construction logistics Development and planning of offshore wind farms Operation and optimization of offshore wind farms Day excursion | | | |
| Literature | Gasch, R.; Twele, J.: Windkraftanlagen - Grundlagen, Entwurf, Planung und Betrieb; Vieweg + Teubner, Stuttgart, 2007, 7. Auflage Molly, J. P.: Windenergie - Theorie, Anwendung, Messung; C. F. Müller, Heidel-berg, 1997, 3. Auflage Hau, E.: Windkraftanlagen; Springer, Berlin, Heidelberg, 2008, 4.Auflage Heier, S.: Windkraftanlagen - Systemauslegung, Integration und Regelung; Vieweg + Teubner, Stuttgart, 2009, 5. Auflage Jarass, L.; Obermair, G.M.; Voigt, W.: Windenergie: Zuverlässige Integration in die Energieversorgung; Springer, Berlin, Heidelberg, 2009, 2. Auflage | | | |

| | 1 | | | | |
|--|--|---|-----------------|----------------------|--|
| Module M0827: Mode | ling in Water Management | | | | |
| Courses | | | | | |
| Title | | Тур | Hrs/wk | СР | |
| Groundwater Modeling using Modfle | ow (L0543) | Lecture | 1 | 1 | |
| Groundwater Modeling using Modfle | | Recitation Section (small) | 2 | 2 | |
| Modeling of Water Supply Network | | Project-/problem-based Learning | 2 | 3 | |
| Module Responsible Admission Requirements | | | | | |
| Recommended Previous | | | | | |
| Knowledge | | | | | |
| | groundwater hydraulics and transport | of substances | | | |
| | Pipe Systems | | | | |
| | Knowledge on urban water infrastru | ictures, in particular drinking water systemsand | urban drainag | e systems including | |
| | special structures | | | | |
| | Hydraulics of drinking water supply sy | stems and sewer systems | | | |
| | Basic knowledge on water manageme | nt | | | |
| Educational Objectives | After taking part successfully, students have | reached the following learning results | | | |
| Professional Competence | | | | | |
| Knowledge | The students are able to describe the modelling of groundwater flow and transport as well as urban water infrastructures. The | | | | |
| | carry out systems analyses and can detect t | echnical and conceptual weak points within the sy | stems in case s | studies. Besides the | |
| | are able to analyse interdependencies of hydraulic and toxic phenomena in soil and water. | | | | |
| | | | | | |
| | | | | | |
| Skills | The students are able to construct and apply scientific groundwater models indipendently. They can work on different scenarios | | | | |
| | and can compare or assess different solutions for existing problems by application of selected software products. The students are | | | | |
| | able to use different software solutions (e.g. EPANET, EPA-SWMM). | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| Personal Competence | | | | | |
| Social Competence | Wird nicht vermittelt. | | | | |
| Autonomy | Wird nicht vermittelt. | | | | |
| Workload in Hours | Independent Study Time 110, Study Time in | Lecture 70 | | | |
| Credit points | | | | | |
| Course achievement | | | | | |
| Examination | | | | | |
| Examination duration and | 30 min | | | | |
| scale | | ning the time Come to a | | | |
| Assignment for the Following Curricula | Civil Engineering: Specialisation Structural E | | | | |
| Following Curricula | 5 5 1 | | | | |
| | Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory | | | | |
| | Civil Engineering: Specialisation Water and Traffic: Elective Compulsory Civil Engineering: Specialisation Computational Engineering: Elective Compulsory | | | | |
| | Water and Environmental Engineering: Specialisation Environment: Elective Compulsory | | | | |
| | | | | | |
| | Water and Environmental Engineering: Spec | | | | |

| Course L0543: Groundwater Modeling using Modflow | | | | |
|--|--|--|--|--|
| Тур | Lecture | | | |
| Hrs/wk | 1 | | | |
| СР | 1 | | | |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 | | | |
| Lecturer | Sonja Götz | | | |
| Language | DE/EN | | | |
| Cycle | SoSe | | | |
| Content | Introduction and application of the groundwater model MODFLOW (PMWIN); theoretical backround of the modell, students do work | | | |
| | with the model PMWIN for practical case studies. | | | |
| Literature | MODFLOW-Handbuch | | | |
| | Chiang, Wen Hsien: PMWIN | | | |
| | | | | |

| Course L0544: Groundwater | ourse L0544: Groundwater Modeling using Modflow | | | |
|---------------------------|--|--|--|--|
| Тур | Recitation Section (small) | | | |
| Hrs/wk | 2 | | | |
| CP | 2 | | | |
| Workload in Hours | ependent Study Time 32, Study Time in Lecture 28 | | | |
| Lecturer | nja Götz | | | |
| Language | DE/EN | | | |
| Cycle | SoSe | | | |
| Content | See interlocking course | | | |
| Literature | See interlocking course | | | |

| Course L0875: Modeling of W | ourse L0875: Modeling of Water Supply Network | | |
|-----------------------------|--|--|--|
| Тур | Project-/problem-based Learning | | |
| Hrs/wk | 2 | | |
| СР | | | |
| Workload in Hours | dependent Study Time 62, Study Time in Lecture 28 | | |
| Lecturer | or. Klaus Johannsen | | |
| Language | DE | | |
| Cycle | SoSe | | |
| Content | | | |
| Literature | Mutschmann/Stimmelmayr: Taschenbuch der Wasserversorgung, 16. Auflage. Springer Vieweg - Verlag. Wiesbaden 2014. | | |

| Lingineering | | | | | |
|------------------------------------|---|---|-----------------|----------------------|--|
| Module M0871: Hydro | logical Systems | | | | |
| | | | | | |
| Courses | | | | | |
| Title | | Тур | Hrs/wk | СР | |
| Applied Surface Hydrology (L0289) | | Lecture | 2 | 2 | |
| Applied Surface Hydrology (L1412) | | Project-/problem-based Learning | 1 | 2 | |
| Interaction Water - Environment in | | Project-/problem-based Learning | 1 | 2 | |
| Module Responsible | Prof. Peter Fröhle | | | | |
| Admission Requirements | None | | | | |
| Recommended Previous | Fundamentals of Hydromechanics and Hyd | draulic Engineering: Hydraulic Engineering I and Hydra | ulic Engineerir | ng II | |
| Knowledge | | | | | |
| Educational Objectives | After taking part successfully, students have | ve reached the following learning results | | | |
| Professional Competence | | | | | |
| Knowledge | The students are able to define the basic | concepts of hydrology and water management. They | are able to d | escribe and quantif | |
| | the relevant processes of the hydrological | l water cycle. Besides, the students know the main as | pects of rainfa | ll-run-off-models an | |
| | are able to theoretically derive established reservoir / storage models and a unit-hydrograph. | | | | |
| CL 111- | | | | | |
| SKIIIS | The students are able to use the basic hydrological concepts and approaches and are able to theoretically derive established | | | | |
| | reservoir / storage models or a unit-hydrograph as the basis for rainfall-run-off-models. The student are able to explain the basi | | | | |
| | concepts of measurements of hydrological and hydrodynamic values in nature and are able to perform, analyze and statisticall assess these measurements. Furthermore, they are able to apply a hydrological model to basic hydrological problems. | | | | |
| | assess these measurements. Furthermore, | , they are able to apply a hydrological model to basic r | iyarological pr | oblems. | |
| Personal Competence | | | | | |
| Social Competence | The students are able to deploy their gain | ed knowledge in applied problems of the hydrology an | d water mana | gement. Additionaly | |
| | they will be able to work in team with engi | ineers of other disciplines. | | | |
| Autonomy | The students will be able to independently extend their knowledge and apply it to new problems | | | | |
| Workload in Hours | Independent Study Time 124, Study Time | in Lecture 56 | | | |
| Credit points | 6 | | | | |
| Course achievement | None | | | | |
| Examination | Written exam | | | | |
| Examination duration and | The duration of the examination is 90 min. | . The examination includes tasks with respect to the ge | eneral underst | anding of the lectur | |
| scale | contents and calculations tasks. | | | | |
| Assignment for the | Civil Engineering: Specialisation Computat | ional Engineering: Elective Compulsory | | | |
| Following Curricula | Civil Engineering: Specialisation Water and Traffic: Compulsory | | | | |
| | Environmental Engineering: Core Qualification: Elective Compulsory | | | | |
| | Joint European Master in Environmental St | udies - Cities and Sustainability: Core Qualification: Co | mpulsory | | |
| | Water and Environmental Engineering: Specialisation Cities: Elective Compulsory | | | | |
| | Water and Environmental Engineering: Specialisation Environment: Elective Compulsory | | | | |
| | | | | | |

| Course L0289: Applied Surface Hydrology | | | |
|---|---|--|--|
| Тур | Lecture | | |
| Hrs/wk | 2 | | |
| CP | 2 | | |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 | | |
| Lecturer | Prof. Peter Fröhle | | |
| Language | DE/EN | | |
| Cycle | SoSe | | |
| Content | Basics of hydrology: Hydrological cycle Data acquisition Data analyses and statistical assessment Statistics of extremes Regionalization methods for hydrological values Rainfall-run-off modelling on the basis of a unit hydrograph conceps Application of rainfall-run-off models on the basis of Kalypso-Hydrology which is an OpenSource Software Tool. | | |
| Literature | http://de.wikipedia.org/wiki/Kalypso_(Software) http://kalypso.bjoernsen.de/ http://sourceforge.net/projects/kalypso/ | | |

| Course L1412: Applied Surface Hydrology | | |
|---|---|--|
| Тур | Project-/problem-based Learning | |
| Hrs/wk | 1 | |
| СР | 2 | |
| Workload in Hours | Independent Study Time 46, Study Time in Lecture 14 | |
| Lecturer | Prof. Peter Fröhle | |
| Language | DE/EN | |
| Cycle | SoSe | |
| Content | See interlocking course | |
| Literature | See interlocking course | |

| Course L0295: Interaction W | Course L0295: Interaction Water - Environment in Fluvial Areas | | | |
|-----------------------------|--|--|--|--|
| Тур | Project-/problem-based Learning | | | |
| Hrs/wk | 1 | | | |
| СР | 2 | | | |
| Workload in Hours | Independent Study Time 46, Study Time in Lecture 14 | | | |
| Lecturer | Prof. Peter Fröhle | | | |
| Language | DE/EN | | | |
| Cycle | SoSe | | | |
| Content | A problem based learning course. The problem will be solved by the students more or less self-contained. The topics will be introduced and elaborated over the semester. | | | |
| Literature | - | | | |

| Module M2032: Adva | nced Vadose Zone Hydrology | 1 | | | |
|-----------------------------------|--|----------------------------|------------------------------|-------------------|--------------------|
| Courses | | | | | |
| Title | | | Тур | Hrs/wk | СР |
| Modeling Processes in Vadose Zone | e (L2735) | I | Recitation Section (small) | 2 | 2 |
| Vadose Zone Hydrology (L2732) | | I | Lecture | 2 | 2 |
| Vadose Zone Hydrology (L2733) | | | Recitation Section (large) | 2 | 2 |
| Module Responsible | Prof. Nima Shokri | | | | |
| Admission Requirements | None | | | | |
| Recommended Previous | Basic knowledge in water and soil | | | | |
| Knowledge | Comfortable with math and physics, critic | al thinking creative prob | blom colving | | |
| | Comfortable with math and physics, critic | ai uninking, creative proi | bient solving | | |
| | Analytic skills | | | | |
| Educational Objectives | After taking part successfully, students ha | ave reached the following | g learning results | | |
| Professional Competence | | | | | |
| Knowledge | The students will learn about soil char | racterization (solid and | liquid phase), the energy | / state of soil w | ater, the soil wat |
| 2 | characteristic curve, flow in saturated and | | | | |
| Skills | Students will work on practical examples modelling transport processes in soil using different quantitative tools includ computer simulations and analytical tools. This will help them to apply knowledge in order to solve problems and tasks. | | | | |
| Personal Competence | | | | | |
| Social Competence | The module aims at raising awareness | and enthusiasm for ne | w knowledge related to w | ater, soil and er | nvironment. This w |
| | positively contribute to shape their work a | and life environment. | | | |
| | | | | | |
| | | | | | |
| Autonomy | The students will be involved in man | y problem solving exe | ercises. This will contribut | te toward their | willingness to wor |
| | independently and responsibly. | | | | |
| We the distance of | | | | | |
| Credit points | Independent Study Time 96, Study Time i | n Lecture 84 | | | |
| Course achievement | | | | | |
| | Written elaboration | | | | |
| Examination duration and | | | | | |
| scale | | | | | |
| Assignment for the | Civil Engineering: Specialisation Computa | tional Engineering: Elect | ive Compulsory | | |
| Following Curricula | Civil Engineering: Specialisation Water an | | | | |
| | Environmental Engineering: Core Qualifica | | | | |
| | Water and Environmental Engineering: Sp | | | | |
| | Water and Environmental Engineering: Sp | | | | |
| | | | 1 | | |

| Course L2735: Modeling Processes in Vadose Zone | | |
|---|--|--|
| Тур | Recitation Section (small) | |
| Hrs/wk | 2 | |
| СР | 2 | |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 | |
| Lecturer | Mohammad Aziz Zarif | |
| Language | EN | |
| Cycle | SoSe | |
| Content | Numerical tools will be introduced and used to quantify flow and transport processes in soil | |
| Literature | NA | |

| Course L2732: Vadose Zone | Hydrology | |
|---------------------------|---|--|
| Тур | Lecture | |
| Hrs/wk | 2 | |
| СР | 2 | |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 | |
| Lecturer | Prof. Nima Shokri | |
| Language | EN | |
| Cycle | SoSe | |
| Content | Soil solid phase characterization, Soil liquid phase characterization, The energy state of soil water, Soil Water Characteristi | |
| | Curve, Flow in saturated soil, Flow in unsaturated soil, Solute transport in porous media | |
| Literature | - Environmental Soil Physics, by Daniel Hillel | |
| | - Soil Physics, Sixth Edition, by William A. Jury and Robert Horton | |
| | - Physical Hydrology, Second Edition, by S. Lawrence Dingman | |
| | - Introduction to Physical Hydrology, by Martin R. Hendriks | |

| Course L2733: Vadose Zone | ourse L2733: Vadose Zone Hydrology | | |
|---------------------------|---|--|--|
| Тур | Recitation Section (large) | | |
| Hrs/wk | 2 | | |
| СР | 2 | | |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 | | |
| Lecturer | Prof. Nima Shokri | | |
| Language | EN | | |
| Cycle | SoSe | | |
| Content | See interlocking course | | |
| Literature | See interlocking course | | |

| Module M0802: Mem | | | | | |
|-----------------------------|--|---|---------------------|--------------------|--|
| Courses | | | | | |
| Fitle | | Тур | Hrs/wk | СР | |
| Membrane Technology (L0399) | | Lecture | 2 | 3 | |
| Membrane Technology (L0400) | | Recitation Section (small) | 1 | 2 | |
| Membrane Technology (L0401) | | Practical Course | 1 | 1 | |
| Module Responsible | | | | | |
| Admission Requirements | | | | | |
| Recommended Previous | Basic knowledge of water chemistry. Knowledge of | the core processes involved in water, gas | and steam treatr | nent | |
| Knowledge | | | | | |
| | After taking part successfully, students have reach | ed the following learning results | | | |
| Professional Competence | | | | | |
| Knowledge | Students will be able to rank the technical applicat | | | | |
| | the different driving forces behind existing meml | brane separation processes. Students wi | Il be able to nan | ne materials used | |
| | membrane filtration and their advantages and dis | sadvantages. Students will be able to exp | plain the key diffe | erences in the use | |
| | membranes in water, other liquid media, gases and | d in liquid/gas mixtures. | | | |
| Skills | Students will be able to prepare mathematical eq | juations for material transport in porous a | and solution-diffus | sion membranes a | |
| 511115 | calculate key parameters in the membrane separa | | | | |
| | | | | | |
| | available boundary data and provide recommend | | | | |
| | experiments, students will be able to classify the | | | | |
| | membrane materials. Students will be able to characterise the formation of the fouling layer in different waters and apply technic | | | | |
| | measures to control this. | | | | |
| Personal Competence | | | | | |
| Social Competence | Students will be able to work in diverse teams on | tasks in the field of membrane technolog | y. They will be ab | le to make decisio | |
| | within their group on laboratory experiments to be | undertaken jointly and present these to o | thers. | | |
| | | | | | |
| Autonomy | Students will be in a position to solve homework | on the topic of membrane technology in | dependently. The | ey will be capable | |
| | finding creative solutions to technical questions. | | | | |
| Workload in Hours | Independent Study Time 124, Study Time in Lectur | re 56 | | | |
| Credit points | 6 | | | | |
| Course achievement | None | | | | |
| Examination | Written exam | | | | |
| Examination duration and | 90 min | | | | |
| scale | | | | | |
| Assignment for the | Civil Engineering: Specialisation Water and Traffic: | Elective Compulsory | | | |
| Following Curricula | Bioprocess Engineering: Specialisation A - General | Bioprocess Engineering: Elective Compuls | ory | | |
| | Bioprocess Engineering: Specialisation B - Industrial Bioprocess Engineering: Elective Compulsory | | | | |
| | Chemical and Bioprocess Engineering: Specialisation General Process Engineering: Elective Compulsory | | | | |
| | Chemical and Bioprocess Engineering: Specialisation Chemical Process Engineering: Elective Compulsory | | | | |
| | Chemical and Bioprocess Engineering: Technical Complementary Course: Elective Compulsory | | | | |
| | Chemical and Bioprocess Engineering: Technical Complementary Course: Elective Compulsory | | | | |
| | Environmental Engineering: Specialisation Water Quality and Water Engineering: Elective Compulsory | | | | |
| | Process Engineering: Specialisation Process Engine | eering: Elective Compulsory | | | |
| | Process Engineering: Specialisation Environmental | Process Engineering: Elective Compulsory | | | |
| | | | | | |
| | Water and Environmental Engineering: Specialisation | on Water: Elective Compulsory | | | |
| | Water and Environmental Engineering: Specialisation Water and Environmental Engineering: Specialisation | | | | |

| Course L0399: Membrane Te | chnology |
|---------------------------|--|
| Тур | Lecture |
| Hrs/wk | 2 |
| СР | 3 |
| Workload in Hours | Independent Study Time 62, Study Time in Lecture 28 |
| Lecturer | Prof. Mathias Ernst |
| Language | EN |
| Cycle | WiSe |
| Content | The lecture on membrane technology supply provides students with a broad understanding of existing membrane treatment processes, encompassing pressure driven membrane processes, membrane application in electrodialyis, pervaporation as well as membrane distillation. The lectures main focus is the industrial production of drinking water like particle separation or desalination; however gas separation processes as well as specific wastewater oriented applications such as membrane bioreactor systems will be discussed as well. Initially, basics in low pressure and high pressure membrane applications are presented (microfiltration, ultrafiltration, nanofiltration, reverse osmosis). Students learn about essential water quality parameter, transport equations and key parameter for pore membrane as well as solution diffusion membrane systems. The lecture sets a specific focus on fouling and scaling issues and provides knowledge on methods how to tackle with these phenomena in real water treatment application. A further part of the lecture deals with the character and manufacturing of different membrane materials and the characterization of membrane material by simple methods and advanced analysis. The functions, advantages and drawbacks of different membrane housings and modules are explained. Students learn how an industrial membrane application is designed in the succession of treatment steps like pre-treatment, water conditioning, membrane integration and post-treatment of water. Besides theory, the students will be provided with knowledge on membrane |
| Literature | demo-site examples and insights in industrial practice. • T. Melin, R. Rautenbach: Membranverfahren: Grundlagen der Modul- und Anlagenauslegung (2., erweiterte Auflage), Springer-Verlag, Berlin 2004. |
| | Marcel Mulder, Basic Principles of Membrane Technology, Kluwer Academic Publishers, Dordrecht, The Netherlands Richard W. Baker, Membrane Technology and Applications, Second Edition, John Wiley & Sons, Ltd., 2004 |

| Course L0400: Membrane Te | urse L0400: Membrane Technology | | |
|---------------------------|---|--|--|
| Тур | Recitation Section (small) | | |
| Hrs/wk | 1 | | |
| СР | 2 | | |
| Workload in Hours | Independent Study Time 46, Study Time in Lecture 14 | | |
| Lecturer | Prof. Mathias Ernst | | |
| Language | EN | | |
| Cycle | WiSe | | |
| Content | See interlocking course | | |
| Literature | See interlocking course | | |

| Course L0401: Membrane Te | Course L0401: Membrane Technology | | |
|---------------------------|---|--|--|
| Тур | Practical Course | | |
| Hrs/wk | 1 | | |
| СР | 1 | | |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 | | |
| Lecturer | Prof. Mathias Ernst | | |
| Language | EN | | |
| Cycle | WiSe | | |
| Content | See interlocking course | | |
| Literature | See interlocking course | | |

| Module M0822: Proce | ss Modeling in Water Technology | / | | |
|------------------------------------|--|---|----------------|-----------------------|
| Courses | | | | |
| Title | | Тур | Hrs/wk | СР |
| Process Modelling of Wastewater T | reatment (L0522) | Project-/problem-based Learning | 2 | 3 |
| Process Modeling in Drinking Water | Treatment (L0314) | Project-/problem-based Learning | 2 | 3 |
| Module Responsible | Dr. Klaus Johannsen | | | |
| Admission Requirements | None | | | |
| Recommended Previous | Knowledge of the most important processes in d | rinking water and waste water treatment. | | |
| Knowledge | | | | |
| Educational Objectives | After taking part successfully, students have rea | ched the following learning results | | |
| Professional Competence | | | | |
| Knowledge | Students are able to explain selected processes | s of drinking water and waste water treatment i | n detail. The | ey are able to explai |
| | basics as well as possibilities and limitations of c | dynamic modeling. | | |
| Skills | Students are able to use the most important fe | atures Modelica offers. They are able to transpo | se selected | processes in drinkin |
| U.M.U | - | natical model in Modelica with respect to equilib | | |
| | They are able to set up and apply models and as | | | |
| | | | | |
| | | | | |
| Personal Competence | | | | |
| - | Students are able to solve problems and docum | ent solutions in a group with members of differen | nt technical l | background. They a |
| | | constructively with feedback concerning their wo | | |
| | | , | | |
| | | | | |
| Autonomv | Students are able to define a problem, gain the | required knowledge and set up a model. | | |
| | | | | |
| | | | | |
| Workload in Hours | Independent Study Time 124, Study Time in Lec | ture 56 | | |
| Credit points | | | | |
| Course achievement | | | | |
| Examination | Oral exam | | | |
| Examination duration and | 30 min | | | |
| scale | | | | |
| Assignment for the | Civil Engineering: Specialisation Water and Traff | ic: Elective Compulsory | | |
| Following Curricula | Chemical and Bioprocess Engineering: Technical | Complementary Course: Elective Compulsory | | |
| | Chemical and Bioprocess Engineering: Technical | Complementary Course: Elective Compulsory | | |
| | Environmental Engineering: Specialisation Wate | r Quality and Water Engineering: Elective Compu | lsory | |
| | Process Engineering: Specialisation Environment | tal Process Engineering: Elective Compulsory | | |
| | Process Engineering: Specialisation Process Engi | ineering: Elective Compulsory | | |
| | Water and Environmental Engineering: Specialis | ation Water: Elective Compulsory | | |
| | Water and Environmental Engineering: Specialis | ation Environment: Elective Compulsory | | |
| | Water and Environmental Engineering: Specialis | ation Cities: Elective Compulsory | | |

| Course L0522: Process Mode | lling of Wastewater Treatment |
|----------------------------|---|
| Тур | Project-/problem-based Learning |
| Hrs/wk | 2 |
| СР | 3 |
| Workload in Hours | Independent Study Time 62, Study Time in Lecture 28 |
| Lecturer | Dr. Joachim Behrendt |
| Language | DE/EN |
| Cycle | WiSe |
| Content | Mass and energy balances |
| | Tracer modelling |
| | |
| | Activated Sludge Model |
| | Wastewater Treatment Plant Modelling (continously and SBR) |
| | Sludge Treatment (ADM, aerobic autothermal) |
| | Biofilm Modelling |
| Literature | Henze, Mogens (Seminar on Activated Sludge Modelling, ; Kollekolle Seminar on Activated Sludge Modelling, ;) |
| | Activated sludge modelling : processes in theory and practice ; selected proceedings of the 5th Kollekolle Seminar on Activated |
| | Sludge Modelling, held in Kollekolle, Denmark, 10 - 12 September 2001 |
| | ISBN: 1843394146 |
| | [London] : IWA Publ., 2002 |
| | TUB_HH_Katalog |
| | Henze, Mogens |
| | Activated sludge models ASM1, ASM2, ASM2d and ASM3 |
| | ISBN: 1900222248 |
| | London : IWA Publ., 2002 |
| | TUB_HH_Katalog |
| | Henze, Mogens |
| | Wastewater treatment : biological and chemical processes |
| | ISBN: 3540422285 (Pp.) |
| | Berlin [u.a.] : Springer, 2002 |
| | TUB_HH_Katalog |
| | Wiesmann, Udo (Choi, In Su; Dombrowski, Eva-Maria;) |
| | Fundamentals of biological wastewater treatment |
| | ISBN: 3527312196 (Gb.) URL: http://deposit.ddb.de/cgi-bin/dokserv?id=2774611&prov=M&dok_var=1&dok_ext=htm |
| | Weinheim : WILEY-VCH, 2007 |
| | TUB_HH_Katalog |
| | |

| Course L0314: Process Modeling in Drinking Water Treatment | | |
|--|--|--|
| Тур | Project-/problem-based Learning | |
| Hrs/wk | 2 | |
| СР | 3 | |
| Workload in Hours | Independent Study Time 62, Study Time in Lecture 28 | |
| Lecturer | Dr. Klaus Johannsen | |
| Language | EN | |
| Cycle | WiSe | |
| Content | using the programming language Modelica, that is increasingly used in industry. In this course OpenModelica is used, an free access frontend of the programming language Modelica. | |
| | In the beginning of the course the use of OpenModelica is explainded by means of simple examples. Together required elements and structure of the model are developed. The implementation in OpenModelica and the application of the model is done individually or in groups respectively. Students get feedback and can gain extra points for the exam. | |
| Literature | OpenModelica: https://openmodelica.org/index.php/download/download-windows | |
| | OpenModelica - Modelica Tutorial: https://openmodelica.org/index.php/useresresources/userdocumentation | |
| | OpenModelica - Users Guide: https://openmodelica.org/index.php/useresresources/userdocumentation | |
| | Peter Fritzson: Principles of Object-Oriented Modeling and Simulation with Modelica 2.1, Wiley-IEEE Press, ISBN 0-471-471631. | |
| | MHW (rev. by Crittenden, J. et al.): Water treatment principles and design. John Wiley & Sons, Hoboken, 2005. | |
| | Stumm, W., Morgan, J.J.: Aquatic chemistry. John Wiley & Sons, New York, 1996. | |
| | DVGW (Hrsg.): Wasseraufbereitung - Grundlagen und Verfahren. Oldenbourg Industrie Verlag, München, 2004. | |

| Module M1123: Selec | ted Topics in Environmental En | gineering | | |
|-------------------------------------|---|--|--------|----|
| Courses | | | | |
| Title | | Тур | Hrs/wk | СР |
| Environmental Aquatic Chemistry (| L1444) | Lecture | 2 | 3 |
| Solid Matter Process Technology fo | r Biomass (L0052) | Lecture | 2 | 3 |
| Sustainable landfill design and ope | ration (L3270) | Integrated Lecture | 3 | 3 |
| Sludge Treatment (L0520) | | Lecture | 2 | 3 |
| Special topics of the Environmenta | | | 1 | 1 |
| Special topics of the Environmenta | | | 2 | 2 |
| Special topics of the Environmenta | | | 3 | 3 |
| Thermal Biomass Utilization (L1767 | | Lecture | 2 | 2 |
| Thermal Biomass Utilization (L2386 |) | Practical Course | 1 | 1 |
| Module Responsible | Prof. Mathias Ernst | | | |
| Admission Requirements | None | | | |
| Recommended Previous | | | | |
| Knowledge | | | | |
| Educational Objectives | After taking part successfully, students have i | reached the following learning results | | |
| Professional Competence | | | | |
| Knowledge | | | | |
| Skills | | | | |
| Personal Competence | | | | |
| Social Competence | | | | |
| Autonomy | | | | |
| | Depends on choice of courses | | | |
| Credit points | 1 | | | |
| · · | Environmental Engineering: Core Qualification | a: Elective Compulsory | | |
| • | Water and Environmental Engineering: Specia | | | |
| ronowing carricula | Water and Environmental Engineering: Specia | 1 , | | |
| | 5 1 | | | |
| | Water and Environmental Engineering: Specia | alisation water: Elective Compulsory | | |

| Course L1444: Environmenta | I Aquatic Chemistry |
|----------------------------|---|
| Тур | Lecture |
| Hrs/wk | 2 |
| СР | 3 |
| Workload in Hours | Independent Study Time 62, Study Time in Lecture 28 |
| Examination Form | Klausur |
| Examination duration and | 60 min |
| scale | |
| Lecturer | Dr. Klaus Johannsen |
| Language | EN |
| Cycle | SoSe |
| Content | Concentration and activity Gas-water partitioning Acid/base equilibria Alkalinity and acidity Precipitation/dissolution equilibria Redox equilibria Complex formation Sorption |
| Literature | Worch, E.: Hydrochemistry. Basic Concepts and Exercises. De Gruyter, Berlin, 2015 |

| Course L0052: Solid Matter F | Process Technology for Biomass |
|------------------------------|--|
| Тур | Lecture |
| Hrs/wk | 2 |
| CP | 3 |
| Workload in Hours | Independent Study Time 62, Study Time in Lecture 28 |
| Examination Form | Klausur |
| Examination duration and | 60 min |
| scale | |
| Lecturer | Prof. Werner Sitzmann |
| Language | DE |
| Cycle | SoSe |
| Content | The industrial application of unit operations as part of process engineering is explained by actual examples of solid biomass |
| | processes. Size reduction, transportation and dosing, drying and agglomeration of renewable resources are described as important |
| | unit operations when producing solid fuels and bioethanol, producing and refining edible oils, when making Btl - and WPC - |
| | products. Aspects of explosion protection and plant design complete the lecture. |
| Literature | Kaltschmitt M., Hartmann H. (Hrsg.): Energie aus Bioamsse, Springer Verlag, 2001, ISBN 3-540-64853-4 |
| | Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz, Schriftenreihe Nachwachsende Rohstoffe, |
| | Fachagentur Nachwachsende Rohstoffe e.V. www.nachwachsende-rohstoffe.de |
| | Bockisch M.: Nahrungsfette und -öle, Ulmer Verlag, 1993, ISBN 380000158175 |
| | |

| Course L3270: Sustainable la | andfill design and operation |
|------------------------------|--|
| Тур | Integrated Lecture |
| Hrs/wk | 3 |
| СР | 3 |
| Workload in Hours | Independent Study Time 48, Study Time in Lecture 42 |
| Examination Form | Klausur |
| Examination duration and | 60 min |
| scale | |
| Lecturer | Dr. Marco Ritzkowski |
| Language | EN |
| Cycle | SoSe |
| Content | The course introduces the development of modern waste resource management and demonstrates the importance of landfills in the context of recycling processes. Based on international (EU) and national legislation, the current landfill situation is presented and the future significance of landfills will be discussed. A central element of the course deals with the main transformation processes in the landfilled waste, the emission of gases and leachate, the long-term behaviour of landfills as well as aftercare and after-utilisation measures. Further focal points of the course are measures for the sustainable reduction of environmentally and climate-damaging emissions and aspects of landfill technology in an international context. |
| Literature | Waste Management. Bernd Bilitewski; Georg Härdtle; Klaus Marek (Eds.), ISBN: 9783540592105, Springer Verlag Lehrbuchsammlung der TUB, Signatur USH-305 Solid Waste Technology and Management. Thomas Christensen (Ed.), ISBN: 978-1-4051-7517-3, Wiley Verlag Lesesaal 2: US - Umweltschutz, Signatur USH-332 Solid Waste Landfilling - Concepts, Processes, Technologies. Cossu, R. and Stegmann, R. (Eds.), ISBN: 978-0-12-818336-6 PDF (Volltext) über TUB |

| Ligineering | | |
|--------------------------------|---|--|
| Course L0520: Sludge Treatment | | |
| Тур | Lecture | |
| Hrs/wk | 2 | |
| CP | 3 | |
| Workload in Hours | Independent Study Time 62, Study Time in Lecture 28 | |
| Examination Form | Klausur | |
| Examination duration and | 60 min | |
| scale | | |
| Lecturer | Dr. Joachim Behrendt | |
| Language | EN | |
| Cycle | SoSe | |
| Content | Sedimentation characteristic and thickening, | |
| | Centrifugation, | |
| | Flotation, | |
| | Filtration, | |
| | Aerobic sludge stabilisation, | |
| | Sludge Digestion, | |
| | Sludge Disintegration, | |
| | Sludge Dewatering, | |
| | Natural Processes for Sludge Treatment, | |
| | Nutrient Recovery from Sludge, | |
| | Thermal Processes and Incineration. | |
| Literature | Tchobanoglous, George (Metcalf & Eddy, Inc., ;) | |
| | Wastewater engineering : treatment and reuse | |
| | ISBN: 0070418780 (alk. paper) ISBN: 0071122508 (ISE (*pbk)) | |
| | Boston [u.a.] : McGraw-Hill, 2003 | |
| | TUB_HH_Katalog | |
| | Cleverson Vitorio Andreoli, Marcos von Sperling, Fernando Fernandes | |
| | Sludge Treatment and Disposal | |
| | ISBN 9781843391661 | |
| | IWA Publishing, 2007 | |
| | | |

| Course L3289: Special topics of the Environmental engineering 1CP | |
|---|---|
| Тур | |
| Hrs/wk | 1 |
| СР | 1 |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 |
| Examination Form | Fachtheoretisch-fachpraktische Arbeit |
| Examination duration and | wird zu Beginn der Veranstaltung festgelegt |
| scale | |
| Lecturer | Dozenten des SD B |
| Language | DE/EN |
| Cycle | WiSe/SoSe |
| Content | The course occurs only if required. The content is defined at short notice. |
| Literature | Die Literatur wird kurzfristig festgelegt. |

| Course L3290: Special topics of the Environmental engineering 2CP | |
|---|---|
| Тур | |
| Hrs/wk | 2 |
| СР | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Examination Form | Fachtheoretisch-fachpraktische Arbeit |
| Examination duration and | wird zu Beginn der Veranstaltung festgelegt |
| scale | |
| Lecturer | Dozenten des SD B |
| Language | DE/EN |
| Cycle | WiSe/SoSe |
| Content | The course occurs only if required. The content is defined at short notice. |
| Literature | Die Literatur wird kurzfristig festgelegt. |

| Course L3291: Special topics of the Environmental engineering 3CP | |
|---|---|
| Тур | |
| Hrs/wk | 3 |
| СР | 3 |
| Workload in Hours | Independent Study Time 48, Study Time in Lecture 42 |
| Examination Form | Fachtheoretisch-fachpraktische Arbeit |
| Examination duration and | wird zu Beginn der Veranstaltung festgelegt |
| scale | |
| Lecturer | Dozenten des SD B |
| Language | DE/EN |
| Cycle | WiSe/SoSe |
| Content | The course occurs only if required. The content is defined at short notice. |
| Literature | Die Literatur wird kurzfristig festgelegt. |

| Course L1767: Thermal Biom | ass Utilization |
|----------------------------|--|
| Тур | Lecture |
| Hrs/wk | 2 |
| СР | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Examination Form | Klausur |
| Examination duration and | 60 min |
| scale | |
| Lecturer | Prof. Martin Kaltschmitt |
| Language | DE |
| Cycle | WiSe |
| Content | Goal of this course is it to discuss the physical, chemical, and biological as well as the technical, economic, and environmental basics of all options to provide energy from biomass from a German and international point of view. Additionally different system approaches to use biomass for energy, aspects to integrate bioenergy within the energy system, technical and economic development potentials, and the current and expected future use within the energy system are presented. The course is structured as follows: Biomass as an energy carrier within the energy system; use of biomass in Germany and world-wide, overview on the content of the course Photosynthesis, composition of organic matter, plant production, energy crops, residues, organic waste Biomass provision chains for woody and herbaceous biomass, harvesting and provision, transport, storage, drying Thermo-chemical conversion of solid biofuels Basics of thermo-chemical conversion Direct thermo-chemical conversion Gasification: Gasification technologies, producer gas cleaning technologies, options to use the cleaned producer gas for the provision of heat, electricity and/or fuels Fast and slow pyrolysis: Technologies for the provision of bio-oil and/or for the provision of charcoal, oil cleaning technologies, options to use the pyrolysis oil and charcoal as an energy carrier as well as a raw material Physical-chemical conversion of biomass containing oils and/or fats: Basics, oil seeds and oil fruits, vegetable oil production, production, hydrogenation, co-processing in existing refinere), options to use this fuel, options to use the residues (i.e. meal, glycerine) Bio-chemical conversion of biomass Basics of bio-chemical conversion Bio-chemical conversion |
| | fraction (landfill gas), technologies for the provision of bio methane, use of the digested slurry Ethanol production: Process technologies for feedstock containing sugar, starch or celluloses, use of ethanol as a fuel, use of the stillage |
| Literature | Kaltschmitt, M.; Hartmann, H. (Hrsg.): Energie aus Biomasse; Springer, Berlin, Heidelberg, 2009, 2. Auflage |

| Course L2386: Thermal Biomass Utilization | | |
|---|---|--|
| Тур | Practical Course | |
| Hrs/wk | 1 | |
| СР | 1 | |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 | |
| Examination Form | Schriftliche Ausarbeitung | |
| Examination duration and | Protokolle | |
| scale | | |
| Lecturer | Prof. Martin Kaltschmitt, Dr. Marvin Scherzinger | |
| Language | DE | |
| Cycle | WiSe | |
| Content | The experiments of the practical lab course illustrate the different aspects of heat generation from biogenic solid fuels. First, different biomasses (e.g. wood, straw or agricultural residues) will be investigated; the focus will be on the calorific value of the biomass. Furthermore, the used biomass will be pelletized, the pellet properties analysed and a combustion test carried out on a pellet combustion system. The gaseous and solid pollutant emissions, especially the particulate matter emissions, are measured and the composition of the particulate matter is investigated in a further experiment. Another focus of the practical course is the consideration of options for the reduction of particulate matter emissions from biomass combustion. In the practical course, a method for particulate matter reduction will be developed and tested. All experiments will be evaluated and the results presented. Within the practical lab course the students discuss different technical-scientific tasks, both subject-specifically and interdisciplinary. They discuss various approaches to solving the problem and advise on the theoretical or practical implementation. | |
| Literature | Kaltschmitt, Martin; Hartmann, Hans; Hofbauer, Hermann: Energie aus Biomasse: Grundlagen, Techniken und Verfahren. 3. Auflage. Berlin Heidelberg: Springer Science & Business Media, 2016ISBN 978-3-662-47437-2 Versuchsskript | |

| Module M1720: Emerging Trends in Environmental Engineering | | | | |
|--|--|--|--------|----|
| | | | | |
| Courses | | | | |
| Title | | Тур | Hrs/wk | СР |
| Environmental Research Trends (L2752) | | Seminar | 2 | 2 |
| Microplastics in Environment (L2750) | | Lecture | 2 | 2 |
| Scientific Communication and Meth | | Lecture | 1 | 2 |
| Module Responsible | | | | |
| Admission Requirements | | | | |
| Recommended Previous Knowledge | Basic knowledge on water, soil and environmental research. | | | |
| | After taking part successfully, students have reached the following learning results | | | |
| Professional Competence | The carries pare succession, storents have re | sector the following featuring results | | |
| Knowledge | The students will be exposed to up-to-date research topics focused on soil, water and climate related challenges with a particular focus on the effects of microplastics in environment. Data analysis, data measurement, curation and presentation will be other skills that the students will develop in this module. | | | |
| Skills | Students' research skills will be improved in this module. How to prepare and deliver an effective presentation, how to write an abstract, research paper and proposal will be discussed in this module. Moreover, through Research-Based Learning approaches, the students will be exposed to current research trends in environmental engineering. | | | |
| Personal Competence | | | | |
| Social Competence | P Developing teamwork and problem solving skills through Research-Based Teaching approaches will be at the core of this module. | | | |
| Autonomy | The students will be involved in writing individual reports and presentation. This will contribute to the students' ability and willingness to work independently and responsibly. | | | |
| Workload in Hours | Independent Study Time 110, Study Time in Lecture 70 | | | |
| Credit points | 6 | | | |
| Course achievement | None | | | |
| Examination | Subject theoretical and practical work | | | |
| Examination duration and | Report and Presentation | | | |
| scale | | | | |
| Assignment for the | Civil Engineering: Specialisation Water and Traffic: Elective Compulsory | | | |
| Following Curricula | culaEnvironmental Engineering: Specialisation Environment and Climate: Elective CompulsoryWater and Environmental Engineering: Specialisation Cities: Elective CompulsoryWater and Environmental Engineering: Specialisation Environment: Elective Compulsory | | | |
| | | | | |
| | | | | |
| | Water and Environmental Engineering: Special | isation Water: Elective Compulsory | | |
| Seminar |
|--|
| 2 |
| 2 |
| Independent Study Time 32, Study Time in Lecture 28 |
| Dr. Salome Shokri-Kuehni |
| EN |
| WiSe |
| Introduction - course objectives, expectations and format |
| Analyzing the Audience, purpose and occasion |
| Constructing and delivering effective technical presentations |
| How to write an abstract |
| How to write a scientific paper |
| Developing competitive and persuasive research proposals |
| Databases and resources available for water and environmental research |
| Individual proposal on water and environmental research |
| Individual project on water and environmental research |
| Presentation on water and environmental research |
| The Craft of Scientific Writing Fourth edition Author: Michael Alley Springer-Verlag New York, Copyright 2018, DOI 10.1007/978-1-4419-8288-9 Supplemental materials and web links which will be available to registered students. |
| |

| Course L2750: Microplastics | in Environment |
|-----------------------------|---|
| Тур | Lecture |
| Hrs/wk | 2 |
| СР | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Prof. Nima Shokri |
| Language | EN |
| Cycle | WiSe |
| Content | - Introduction, objectives, expectations, format, importance |
| | - Sources of microplastics in environment |
| | - Microplastics sampling; Characterization of microplastics |
| | - Distribution of microplastics in terrestrial environments |
| | - Fate of microplastics in terrestrial environments |
| | - Project discussion |
| | - Effects of microplastics on terrestrial environments |
| | - Health risks of microplastics in environments |
| | - Project presentations by all students |
| Literature | - Microplastics in Terrestrial Environments (2021), Edited by Defu He and Yongming Luo |
| | - Particulate Plastics in Terrestrial and Aquatic Environments (2020), Edited by Nanthi S. Bolan et al. |
| | - Microplastic Pollutants (2017), by Christopher B. Crawford and Brian Quinn |

| Course L2751: Scientific Com | nmunication and Methods |
|------------------------------|--|
| Тур | Lecture |
| Hrs/wk | 1 |
| СР | 2 |
| Workload in Hours | Independent Study Time 46, Study Time in Lecture 14 |
| Lecturer | Prof. Nima Shokri |
| Language | EN |
| Cycle | WiSe |
| Content | Introduction - course objectives, expectations and format |
| | Analyzing the Audience, purpose and occasion |
| | Constructing and delivering effective technical presentations |
| | How to write an abstract |
| | How to create a scientific poster |
| | How to write a scientific paper |
| | Developing competitive and persuasive research proposals |
| | Individual project (report and presentation) related to soil, water and environmental research |
| | |
| Literature | The Craft of Scientific Writing Fourth edition |
| | Author: Michael Alley |
| | Springer-Verlag New York, Copyright 2018, DOI 10.1007/978-1-4419-8288-9 |
| | Supplemental materials and web links which will be available to registered students. |

| Courses | | | | | | | | | | |
|------------------------------------|-------------|-------------|---------------|---------------|----------------|-------------------|----------------------|----------------|---------------|------------------|
| ïtle | | | | | | | Тур | | Hrs/wk | СР |
| ustainable Nature-based Coastal F | | | | te (SeaPiaC | :) (L2926) | | Project-/problem-b | ased Learning | 4 | 6 |
| Module Responsible | | | e | | | | | | | |
| Admission Requirements | None | | | | | | | | | |
| Recommended Previous | • | Hydraulic | Engineerin | ig | | | | | | |
| Knowledge | | | chanics, Hy | | | | | | | |
| | • | Fundame | ntals of Coa | astal Engir | neering, Coa | stal- and Floo | d Protection | | | |
| Educational Objectives | After | taking par | successful | lly, studen | ts have rea | ched the follow | ving learning result | 5 | | |
| Professional Competence | | | | | | | | | | |
| Knowledge | | | | | | | | | | |
| | | | nd Climate | | | | | | | |
| | | | | | | nd Regime and | d water Cycle | | | |
| | | | | | nd Germany | tal Processes | | | | |
| | | | ntals of Clir | | | | | | | |
| | | | | | for Coastal I | Protection | | | | |
| Skills | | | | | | | | | | |
| Skiis | • | Critical th | inking: ana | lysis of pr | ocesses and | l relations, ass | essment of needs f | or action | | |
| | | | | | | | and adaptation me | | | |
| | • | | thinking: ir | nclusion o | of restriction | ns, application | of calculation app | proaches, meth | nods, numerio | al models, planr |
| | | methods | | | | | | | | |
| | • | Considera | ation of com | nplex tasks | S | | | | | |
| Personal Competence | | | | | | | | | | |
| Social Competence | | M | | | | | | | | |
| | | | n heterogei | | | | | | | |
| | | | n internatio | | | ntific discipline | 25 | | | |
| | • | Self refle | | nic scientini | c / non-scie | | 25 | | | |
| | | | | | | | | | | |
| Autonomy | | Applicatio | on oriented | use of kno | wledge and | l skills | | | | |
| | | | ous work or | | | , orang | | | | |
| Wardland in Harris | lus el e us | and and Ch | | 0.4. Chudu - | | | | | | |
| Workload in Hours Credit points | | endent Sti | idy Time 12 | 24, Study | lime in Lect | ure 56 | | | | |
| | | | | | | | | | | |
| Examination | Writte | en elabora | ion | | | | | | | |
| Examination duration and | Prepa | ration of a | written re | port on a | complex tas | sk with a pres | entation and subse | quent discussi | on. The work | on the complex t |
| scale | happe | ens in the | course of th | e lecture. | | | | | | |
| Assignment for the | Civil E | Engineerin | g: Specialisa | ation Coas | tal Enginee | ring: Elective (| Compulsory | | | |
| Following Curricula | | - | | | | | ctive Compulsory | | | |
| | | 5 | | | 5 | eering: Electiv | 1 | | | |
| | | - | | | | c: Elective Cor | | | | |
| | | | | | | | imate: Elective Com | pulsory | | |
| | Water | r and Envii | onmental E | ngineering | g: Specialisa | ation Cities: El | ective Compulsory | | | |
| | | | | | | | ent: Elective Comp | | | |

| Course L2926: Sustainable N | lature-based Coastal Protection in a Changing Climate (SeaPiaC) |
|-----------------------------|---|
| Тур | Project-/problem-based Learning |
| Hrs/wk | 4 |
| СР | 6 |
| Workload in Hours | Independent Study Time 124, Study Time in Lecture 56 |
| Lecturer | Prof. Peter Fröhle |
| Language | EN |
| Cycle | WiSe |
| Content | Climate and Climate Change General Impacts of Climate Change on Wind Regime and Water Cycle Consequences of Climate Change for Coastal Processes Coastal Protection in Taiwan and Germany Fundamentals of Climate Adaptation Nature-Based Solutions (NBS) for Coastal Protection |
| Literature | Materials provided on eLearning Platform (HOOU Platform) Depending on the main topics of the course in the respective year, the literature (recent papers) will be provided in the course-material or via StudIP. |

| Courses | | | | |
|---|--|---|--------|----|
| Title | | Тур | Hrs/wk | СР |
| Adaptation to climate change in hy | draulic engineering (L2291) | Project-/problem-based Learning | 4 | 6 |
| Module Responsible | Prof. Peter Fröhle | | | |
| Admission Requirements | None | | | |
| Recommended Previous Knowledge | Hydrology, Hydraulic Engineering Hydromechanic, Hydraulics Fundamentals of Coastal Engineering, Coastal- and Fl Hydrological Systems | ood Protection | | |
| Educational Objectives | After taking part successfully, students have reached the fol | llowing learning results | | |
| Professional Competence <i>Knowledge</i> <i>Skills</i> | Climate protection and climate adaptation Insights into climate change and its regional characte Impacts of climate change on the components of the Fundamentals of analysis of climate data Consequences of the impact of the climate change Measures for climate adaptation Assessment, prioritization and communication of adapteriation Fundamentals of the analysis of hydrometeorological Critical thinking: analysis of processes and relations, a Creative thinking: inclusion of restrictions, application methods Consideration of complex tasks | regional hydrological cycle ptation measures and hydrological data assessment of needs for action ies and adaptation measures | | |
| Personal Competence <i>Social Competence</i> <i>Autonomy</i> | Working in heterogenous groups Working with different scientific / non-scientific discip Self reflection Application oriented use of knowledge and skills Autonomous work on complex tasks | lines | | |
| Workload in Hours | Independent Study Time 124, Study Time in Lecture 56 | | | |
| Credit points | | | | |
| Course achievement | None | | | |
| Examination | Written elaboration | | | |
| Examination duration and scale | Preparation of a written report and a presentation of a comp | olex task. | | |
| Assignment for the | Civil Engineering: Specialisation Coastal Engineering: Electiv | 1 5 | | |
| Following Curricula | Civil Engineering: Specialisation Geotechnical Engineering: E | | | |
| | Civil Engineering: Specialisation Structural Engineering: Elec Civil Engineering: Specialisation Water and Traffic: Elective (| 1 3 | | |
| | Water and Environmental Engineering: Specialisation Cities: | | | |
| | Water and Environmental Engineering: Specialisation Enviro | | | |
| | Water and Environmental Engineering: Specialisation Water | | | |

| Course L2291: Adaptation to | climate change in hydraulic engineering |
|-----------------------------|--|
| Тур | Project-/problem-based Learning |
| Hrs/wk | 4 |
| СР | 6 |
| Workload in Hours | Independent Study Time 124, Study Time in Lecture 56 |
| Lecturer | Prof. Peter Fröhle |
| Language | DE |
| Cycle | WiSe |
| Content | Climate protection and climate adaptation Findings on climate change and its regional characteristics: fundamentals of climate change, climate modelling / climate models Impacts of climate change on the components of the regional hydrological cycle(climate science view) Fundamentals of the analysis of climate data Concequences of the impacts of climate change (ingenieering science view) Measures for climate change adaptation Assessment, prioritization and communication of measures Fundamentals of analysis of hydrometeorological and hydrological data |
| Literature | Wird bereitgestellt über die HOOU - eLearning Plattform abhängig von den jeweils schwerpunktmäßig behandelten Fragestellungen wird das Schrifttum (aktuelle Paper) in der Veranstaltung bzw. über StudIP zur Verfügung gestellt. |

| Module M0859: Coast | al Hydraulic Engineering II | | | | | |
|-------------------------------------|---|--|-----------------|----------------------|--|--|
| Courses | | | | | | |
| Title | | Тур | Hrs/wk | СР | | |
| Coastal- and Flood Protection (L080 | 8) | Lecture | 2 | 3 | | |
| Coastal- and Flood Protection (L141 | .5) | Project-/problem-based Learning | 1 | 1 | | |
| Maintenance and Defence of Flood | Protection Structures (L1411) | Lecture | 2 | 2 | | |
| Module Responsible | Prof. Peter Fröhle | | | | | |
| Admission Requirements | None | | | | | |
| Recommended Previous | Coastal Engineering I | | | | | |
| Knowledge | | | | | | |
| Educational Objectives | After taking part successfully, students have | reached the following learning results | | | | |
| Professional Competence | | | | | | |
| Knowledge | The students have the capability to define a | and explain in detail the important aspects of erosi | on protection | and flood protectio | | |
| | and are able to apply the aspects to practical coastal protection problems. They are able to design and dimension impor | | | | | |
| | coastal protection measures from the functional and from the constructional point of view. | | | | | |
| <i></i> | | | <i>.</i> . | | | |
| SKIIIS | The students are able to select design approaches for the functional and constructional design of erosion and flood prote | | | | | |
| | measures and apply these approaches to pro- | actical design tasks. | | | | |
| Personal Competence | | | | | | |
| Social Competence | The students are able to deploy their gain | ed knowledge in applied problems such as the fun | ctional and co | onstructive design o | | |
| | coastal and flood protection structures. Addi | tionaly, they will be able to work in team with engine | eers of other o | lisciplines. | | |
| Autonomy | The students will be able to independently e | xtend their knowledge and apply it to new problems | | | | |
| Workload in Hours | Independent Study Time 110, Study Time in | Lecture 70 | | | | |
| Credit points | 6 | | | | | |
| Course achievement | None | | | | | |
| Examination | Written exam | | | | | |
| Examination duration and | The duration of the examination is 130 mi | n. The examination includes tasks with respect to | the general u | understanding of th | | |
| scale | lecture contents and calculations tasks. | | | | | |
| Assignment for the | Civil Engineering: Specialisation Coastal Eng | ineering: Compulsory | | | | |
| Following Curricula | Civil Engineering: Specialisation Geotechnica | al Engineering: Elective Compulsory | | | | |
| | Civil Engineering: Specialisation Structural E | ngineering: Elective Compulsory | | | | |
| | Environmental Engineering: Specialisation E | nvironment and Climate: Elective Compulsory | | | | |
| | Environmental Engineering: Specialisation W | ater Quality and Water Engineering: Elective Compu | llsory | | | |
| | Water and Environmental Engineering: Spec | ialisation Environment: Elective Compulsory | | | | |
| | Water and Environmental Engineering: Spec | ialisation Water: Elective Compulsory | | | | |

| Course L0808: Coastal- and I | Flood Protection |
|------------------------------|--|
| Тур | Lecture |
| Hrs/wk | 2 |
| CP | 3 |
| Workload in Hours | Independent Study Time 62, Study Time in Lecture 28 |
| Lecturer | Prof. Peter Fröhle |
| Language | EN |
| Cycle | WiSe |
| Content | Protection of sandy coasts |
| literature | Sediment transport Morphology Technical solution for the protection of sandy coasts Construction in direction of the coast Constructions perpendicular to the coast Other Concepst Calculation approaches and numerical models Flood Protection Classification of constructions / measures Dikes Dunes Foreland - constructions Flood-Protection Walls Drainage of the hinterland |
| Literature | Vorlesungsumdruck |
| | Coastal Engineering Manual CEM |
| | |

| Course L1415: Coastal- and I | urse L1415: Coastal- and Flood Protection | | | |
|------------------------------|---|--|--|--|
| Тур | Project-/problem-based Learning | | | |
| Hrs/wk | 1 | | | |
| СР | 1 | | | |
| Workload in Hours | Independent Study Time 16, Study Time in Lecture 14 | | | |
| Lecturer | Prof. Peter Fröhle | | | |
| Language | EN | | | |
| Cycle | WiSe | | | |
| Content | See interlocking course | | | |
| Literature | See interlocking course | | | |

| Course L1411: Maintenance | and Defence of Flood Protection Structures |
|---------------------------|--|
| Тур | Lecture |
| Hrs/wk | 2 |
| СР | 2 |
| Workload in Hours | Independent Study Time 32, Study Time in Lecture 28 |
| Lecturer | Dr. Olaf Müller |
| Language | EN |
| Cycle | WiSe |
| Content | Dike protection Maintennance of flood protection measures |
| Literature | Vorlesungsumdruck |

| Courses | | | |
|-----------------------------|---|----------------------|--------------------|
| Title | Тур | Hrs/wk | СР |
| Module Responsible | Dozenten des SD B | | |
| Admission Requirements | None | | |
| Recommended Previous | | | |
| Knowledge | | | |
| Educational Objectives | After taking part successfully, students have reached the following learning results | | |
| Professional Competence | | | |
| Knowledge | The students are able to demonstrate their detailed knowledge in the field of Water a exemplify the state of technology and application and discuss critically in the context of a science and society. | | |
| | The students can develop solving strategies and approaches for fundamental and prac Environmental Engineering. They may apply theory based procedures and integrate economic view points of science and society. | | |
| | Scientific work techniques that are used can be described and critically reviewed. | | |
| Skills | The students are able to independently select methods or planning approaches for the They can explain how these methods or approaches relate to solutions in the field of wo to be adjusted. General findings and further developments may essentially be outlined. | | |
| Personal Competence | | | |
| Social Competence | The students are able to condense the relevance and the structure of the project work, the presentation and discussion in front of a bigger group. They can lead the discussion a colleagues. | | |
| Autonomy | The students are capable of independently planning and documenting the work steps an deadlines. This includes the ability to accurately procure the newest scientific informatio from experts with regard to the progress of the work, and to accomplish results on the sta | n. Furthermore, they | can obtain feedbad |
| Workload in Hours | Independent Study Time 360, Study Time in Lecture 0 | | |
| Credit points | 12 | | |
| Course achievement | None | | |
| Examination | Study work | | |
| Examination duration and | | | |
| scale | | | |
| Assignment for the | Water and Environmental Engineering: Specialisation Water: Compulsory | | |
| Following Curricula | | | |

| ction to Climate Informed En | gineering | | |
|--|--|--|---|
| | | | |
| | - | 11 | |
| Title | | | СР 3 |
| Methods in Climate Informed Engineering (L3347) Topics in Climate Informed Engineering (L3348) | | | 3 |
| | 2000.0 | 5 | 5 |
| | | | |
| | onal understanding of environmental sci | ence, basic engineerin | g principles, and ar |
| interest in sustainability. Recommended knowledge includes climate science, data analysis, and familiarity with engineering desi | | | |
| | | | |
| fter taking part successfully, students have | reached the following learning results | | |
| | · · · · · · · · · · · · · · · · | | |
| ais module explores next-generation clima | te models and high-resolution data emp | hasizing their impact o | n environmental and |
| | | | |
| | | | |
| nalysis in climate-informed engineering. | | | |
| limate data analysis anginaaying adapt | stion strategies, problem colving, reso | arch bacad loarning | and interdisciplinary |
| | ation strategies, problem-solving, rese | arch-based learning, a | |
| | | | |
| | | | |
| ollaboration, interdisciplinary teamwork, c | ommunication skills, problem-solving, et | hical responsibility, and | d decision-making in |
| imate-resilient engineering. | | | |
| me management self-directed learning | critical thinking accountability initiative | e and the ability to c | onduct independent |
| | | | |
| | | | |
| Independent Study Time 96, Study Time in Lecture 84 | | | |
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| eport and Presentation | | | |
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| and an a summer and any incerning. Speer | Energy Control Process Control Parson y | | |
| ater and Environmental Engineering: Speci | alisation Environment: Elective Compulso | ry . | |
| | ring (L3347) ng (L3348) rof. Nima Shokri one tudents are expected to have a foundation tudents are expected to have a foundation treest in sustainability. Recommended know rocesses. Analytical and critical thinking and fter taking part successfully, students have his module explores next-generation clima ngineering products and processes. It cover ased learning activities, expert talks, and nalysis in climate-informed engineering. limate data analysis, engineering adapted ollaboration, interdisciplinary teamwork, c imate-resilient engineering. ime management, self-directed learning, esearch and make informed decisions in clirand dependent Study Time 96, Study Time in La one ubject theoretical and practical work eport and Presentation ivil Engineering: Specialisation Coastal Engi ivil Engineering: Specialisation Structural Engineering: specialisation Mater and T ivil Engineering: Specialisation Computatiors at Science: Specialisation III. Applications: nvironmental Engineering: Core Qualificatio rocess Engineering: Specialisation Process Engineering: Specialisation P | Typ ring (L3347) Lecture lg (L3348) Lecture rof. Nima Shokri | Typ Hrs/wk ring (13347) Lecture 3 rof. Nima Shokri 3 1 one 1 1 1 tudents are expected to have a foundational understanding of environmental science, basic engineerin 1 1 tudents are expected to have a foundational understanding of environmental science, basic engineerin 1 1 tudents are expected to have a foundational understanding of environmental science, basic engineerin 1 1 tudents are expected to have a foundational understanding of environmental science, basic engineerin 1 1 tudents are expected to have a foundational understanding of environmental science, basic engineerin 1 1 tudents are expected to have a foundational understanding of environmental science, basic engineerin 1 1 torocesses. Analytical and critical thinking and creative problem-solving skills are also beneficial 1 1 fitter taking part successfully, students have reached the following learning disciplines can benefit from climate inased learning activities, expert talks, and presentations will expose students to state-of-the-art modeling nalysis in climate-informed engineering. 1 limate data analysis, engineering adaptation strategies, problem-solving, ethical responsibility, and imate-resillent engineering. </td |

| Course L3347: Methods in Cl | imate Informed Engineering |
|-----------------------------|---|
| Тур | Lecture |
| Hrs/wk | 3 |
| СР | 3 |
| Workload in Hours | Independent Study Time 48, Study Time in Lecture 42 |
| Lecturer | Prof. Nima Shokri, Prof. Cathy Hohenegger, Prof. Irina Smirnova |
| Language | EN |
| Cycle | WiSe |
| Content | Students will learn techniques for incorporating climate data and environmental factors into engineering design. It covers climate modelling and the use of sensors and devices to measure climate-related parameters and engineering processes. Students will have the opportunity to conduct their own measurements, analyze the collected data, and write a report on their findings. This hands-on experience will be assessed and contribute to their final grade. |
| Literature | |

| Course L3348: Topics in Clim | ate Informed Engineering |
|------------------------------|--|
| Тур | Lecture |
| Hrs/wk | 3 |
| СР | 3 |
| Workload in Hours | Independent Study Time 48, Study Time in Lecture 42 |
| Lecturer | Prof. Irina Smirnova, Prof. Cathy Hohenegger, Prof. Nima Shokri |
| Language | EN |
| Cycle | WiSe |
| Content | Exploring specific applications of climate data in various engineering disciplines. Invited speakers will present their research and discuss the relevance of climate-informed engineering to their work. Additionally, there will be a segment on effective communication, covering how to give impactful presentations and write research papers. Students will also give presentations on their own class projects related to climate-informed engineering, applying the concepts they've learned. This hands-on experience will be assessed and contribute to their final grade. |
| Literature | |

| Courses | | | | |
|-----------------------------|---|---|----------------------|---------------------|
| ītle | | Тур | Hrs/wk | СР |
| Water Protection (L3459) | | Integrated Lecture | 6 | 6 |
| Module Responsible | Prof. Simon Michael Papalexiou | | | |
| Admission Requirements | None | | | |
| Recommended Previous | Basic knowledge in water manageme | nt- | | |
| Knowledge | Good knowledge in urban drainage; | | | |
| | Good knowledge of wastewater treatr | nent techniques; | | |
| | Good knowledge of pollutants (e.g. Cl | | | |
| | | | | |
| | After taking part successfully, students have | e reached the following learning results | | |
| Professional Competence | | | | |
| Knowledge | | es of the regulatory framework related to the i | | |
| | | substance cycles and water morphology in d | | |
| | | as ecosystem service and wastewater treatr | nent with a special | tocus on innovativ |
| | solutions, remediation measures as well as o | conceptual approaches. | | |
| Skills | Students can accurately assess current pro | blems and situations in a country-specific or lo | ocal context. They c | an suggest concre |
| | actions to contribute to the planning of to | omorrow's urban water cycle. Furthermore, t | ney can suggest ap | opropriate technica |
| | administrative and legislative solutions to so | lve these problems. | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| Personal Competence | | | | |
| Social Competence | The students can work together in internation | onal groups. | | |
| | | | | |
| | | | | |
| | | | | |
| Autonomy | Students are able to organize their work flo | w to prepare presentations and discussions. T | hey can acquire ap | propriate knowledg |
| | by making enquiries independently. | | | |
| | | | | |
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| | | | | |
| | | | | |
| Workload in Hours | Independent Study Time 96, Study Time in L | ecture 84 | | |
| Credit points | | | | |
| Course achievement | Compulsory Bonus Form | Description | | |
| | Yes 20 % Presentation | 10-minütige Präsentation von Arbeitser | gebnissen | |
| Examination | Written exam | | | |
| Examination duration and | 150 minutes | | | |
| scale | | | | |
| Assignment for the | Civil Engineering: Specialisation Coastal Eng | ineering: Elective Compulsory | | |
| Following Curricula | Civil Engineering: Specialisation Geotechnica | al Engineering: Elective Compulsory | | |
| | Civil Engineering: Specialisation Structural E | ngineering: Elective Compulsory | | |
| | Civil Engineering: Specialisation Water and | Fraffic: Elective Compulsory | | |
| | Environmental Engineering: Specialisation W | ater Quality and Water Engineering: Elective C | Compulsory | |
| | International Management and Engineering: | Specialisation II. Civil Engineering: Elective Co | mpulsory | |
| | Water and Environmental Engineering: Spec | ialisation Cities: Elective Compulsory | | |
| | Water and Environmental Engineering: Spec | ialisation Environment: Compulsory | | |
| | Water and Environmental Engineering: Spec | ialisation Water: Elective Compulsory | | |

| Course L3459: Water Protection | | |
|--------------------------------|---|--|
| Тур | Integrated Lecture | |
| Hrs/wk | 6 | |
| СР | 6 | |
| Workload in Hours | Independent Study Time 96, Study Time in Lecture 84 | |
| Lecturer | Prof. Simon Michael Papalexiou | |
| Language | EN | |
| Cycle | WiSe | |
| Content | | |
| Literature | | |

| | | g for Engineer | | | | |
|--|--|--|--|---|---|---|
| ourses | | | | | | |
| itle | | | Тур | | Hrs/wk | СР |
| ncertainty Modelling for Engineer | rs (L3458) | | Integra | ated Lecture | 6 | 6 |
| Module Responsible | Prof. Simon Michael Pap | palexiou | | | | |
| Admission Requirements | None | | | | | |
| Recommended Previous Knowledge | 1. General familiarit | | concepts. , and mathematical skills. | | | |
| | Basic computer s Interest in solving | | ta. ems using statistical and pro | babilistic methods. | | |
| Educational Objectives | After taking part succes | ssfully, students hav | e reached the following lear | ning results | | |
| Professional Competence | | | | | | |
| | introduces probability a probability distributions uncertainty in engineer decision-making and pr and disutility and learn | as a measure of un s, extreme value th ring problems. The redictive modeling. how to apply Bayes | in uncertainty, probability, certainty, covering frequen eory, joint probability distrik course also covers linear a Additionally, students will g ian Decision Theory to optim ble to apply probabilistic mo | cy-based methods butions, and stocha nd nonlinear regre ain insight into risk ize engineering so | Students will explo- astic optimization to ssion methods, essee assessment as a fu- lutions under uncerta | ore Bayes' Theore model and quan ential for data-driv inction of probabi ainty. |
| SKIIIS | problems. They will gai inference to real-world enabling them to analy | in expertise in fittin I engineering challe ze complex enginee | g probability distributions, j enges. Students will also do ring datasets and improve r thods and optimization tech | performing extrem evelop skills in lin isk predictions. The | e value analysis, an ear and nonlinear r rough hands-on com | d applying Bayes egression modeli putational exercis |
| Personal Competence | | | | | | |
| | effectively with peers, | engineers, and dec | c collaboratively on engine ision-makers. They will eng engineering analyses are | age in discussions | s on risk perception, | safety factors, a |
| Autonomy | - | ndependently analy: | ze and model engineering u | ncertainties, select | ting and applying ap | propriate probabi |
| Autonomy | Students will learn to ir distributions, regression | n methods, and sto atural and human-m | ze and model engineering u chastic techniques for varic ade hazards, ensuring they | us applications. Th | hey will also gain th | e ability to evalu |
| | Students will learn to ir distributions, regression risks associated with na | n methods, and sto atural and human-m er mitigation. | chastic techniques for varic ade hazards, ensuring they | us applications. Th | hey will also gain th | e ability to evalu |
| | Students will learn to ir distributions, regression risks associated with na assessment, and disast Independent Study Tim | n methods, and sto atural and human-m er mitigation. | chastic techniques for varic ade hazards, ensuring they | us applications. Th | hey will also gain th | e ability to evalu |
| Workload in Hours | Students will learn to ir distributions, regression risks associated with na assessment, and disast Independent Study Time 6 | n methods, and sto atural and human-m er mitigation. | chastic techniques for varic ade hazards, ensuring they | us applications. Th | hey will also gain th | e ability to evalu |
| Workload in Hours Credit points | Students will learn to ir distributions, regression risks associated with na assessment, and disast Independent Study Time 6 Compulsory Bonus | n methods, and sto atural and human-m er mitigation. e 96, Study Time in | chastic techniques for varic ade hazards, ensuring they Lecture 84 | us applications. Ti can make informe | hey will also gain th d engineering decisio | e ability to evalu |
| Workload in Hours Credit points | Students will learn to in distributions, regression risks associated with na assessment, and disast Independent Study Time 6 Compulsory Bonus Yes 20 % | n methods, and sto atural and human-m er mitigation. e 96, Study Time in Form | chastic techniques for varic ade hazards, ensuring they Lecture 84 Description | us applications. Ti can make informe | hey will also gain th d engineering decisio | e ability to evalu |
| Workload in Hours Credit points Course achievement | Students will learn to ir distributions, regression risks associated with na assessment, and disast Independent Study Time 6 Compulsory Bonus Yes 20 % Written exam | n methods, and sto atural and human-m er mitigation. e 96, Study Time in Form | chastic techniques for varic ade hazards, ensuring they Lecture 84 Description | us applications. Ti can make informe | hey will also gain th d engineering decisio | e ability to evalu |
| Workload in Hours Credit points Course achievement Examination | Students will learn to in distributions, regression risks associated with na assessment, and disast Independent Study Time 6 Compulsory Bonus Yes 20 % Written exam 150 min | n methods, and sto atural and human-m er mitigation. e 96, Study Time in Form Presentation | chastic techniques for vario ade hazards, ensuring they Lecture 84 Description 10-minütige Präsent | us applications. Ti can make informe ation von Arbeitse | hey will also gain th d engineering decisio | e ability to evalu |
| Workload in Hours Credit points Course achievement Examination Examination duration and | Students will learn to ir distributions, regression risks associated with na assessment, and disast Independent Study Time 6 Compulsory Bonus Yes 20 % Written exam 150 min Civil Engineering: Speci | n methods, and sto atural and human-m er mitigation. e 96, Study Time in Form Presentation | chastic techniques for vario ade hazards, ensuring they Lecture 84 Description 10-minütige Präsent | us applications. Ti can make informe ation von Arbeitse | hey will also gain th d engineering decisio | e ability to evalu |
| Workload in Hours Credit points Course achievement Examination Examination duration and scale | Students will learn to ir distributions, regression risks associated with na assessment, and disast Independent Study Time 6 Compulsory Bonus Yes 20 % Written exam 150 min Civil Engineering: Speci Civil Engineering: Speci | n methods, and sto atural and human-m er mitigation. e 96, Study Time in Form Presentation ialisation Coastal En ialisation Geotechnic | chastic techniques for vario ade hazards, ensuring they Lecture 84 Description 10-minütige Präsent gineering: Elective Compulse cal Engineering: Elective Cor | us applications. Ti can make informe ation von Arbeitse | hey will also gain th d engineering decisio | e ability to evalu |
| Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the | Students will learn to ir distributions, regression risks associated with na assessment, and disast Independent Study Time 6 Compulsory Bonus Yes 20 % Written exam 150 min Civil Engineering: Speci Civil Engineering: Speci Civil Engineering: Speci | n methods, and sto atural and human-m er mitigation. e 96, Study Time in Presentation Presentation ialisation Coastal En ialisation Geotechnic ialisation Structural | chastic techniques for vario ade hazards, ensuring they Lecture 84 Description 10-minütige Präsent in-minütige Präsent gineering: Elective Compulse cal Engineering: Elective Compu | us applications. Ti can make informe ation von Arbeitse pry npulsory Isory | hey will also gain th d engineering decisio | e ability to evalu |
| Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the | Students will learn to ir distributions, regression risks associated with na assessment, and disast Independent Study Time 6 Compulsory Bonus Yes 20 % Written exam 150 min Civil Engineering: Speci Civil Engineering: Speci Civil Engineering: Speci | n methods, and sto atural and human-m er mitigation. e 96, Study Time in Presentation Presentation ialisation Coastal En ialisation Geotechnia ialisation Structural ialisation Computatio | chastic techniques for vario ade hazards, ensuring they Lecture 84 Description 10-minütige Präsent in-minütige Präsent gineering: Elective Compulse cal Engineering: Elective Compu- ponal Engineering: Elective Compu- | us applications. Ti can make informe ation von Arbeitse pry npulsory lsory pmpulsory | hey will also gain th d engineering decisio | e ability to evalu |
| Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the | Students will learn to ir distributions, regression risks associated with na assessment, and disast Independent Study Time 6 Compulsory Bonus Yes 20 % Written exam 150 min Civil Engineering: Speci Civil Engineering: Speci Civil Engineering: Speci Civil Engineering: Speci Civil Engineering: Speci | n methods, and sto atural and human-m er mitigation. e 96, Study Time in Form Presentation ialisation Coastal En ialisation Geotechnic ialisation Structural ialisation Computati ialisation Water and | chastic techniques for vario ade hazards, ensuring they Lecture 84 Description 10-minütige Präsent 10-minütige Präsent seal Engineering: Elective Compulse Engineering: Elective Compu- onal Engineering: Elective Compulsory | us applications. Th can make informe ation von Arbeitse pry npulsory lsory pmpulsory | hey will also gain th d engineering decisio | e ability to evalu |
| Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the | Students will learn to ir distributions, regression risks associated with na assessment, and disast Independent Study Time 6 Compulsory Bonus Yes 20 % Written exam 150 min Civil Engineering: Speci Civil Engineering: Speci Civil Engineering: Speci Civil Engineering: Speci Civil Engineering: Speci Civil Engineering: Speci | n methods, and sto atural and human-m er mitigation. e 96, Study Time in Presentation Presentation ialisation Coastal En ialisation Geotechnic ialisation Structural ialisation Computativi ialisation Computativi ialisation Coastal En | chastic techniques for vario ade hazards, ensuring they Lecture 84 Description 10-minütige Präsent in Description 20-minütige Präsent in Description 20-minütige Präsent 20-minütige Präse | us applications. Th can make informe ation von Arbeitse pry npulsory lsory pmpulsory pry | hey will also gain th d engineering decisio | e ability to evalu |
| Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the | Students will learn to ir distributions, regression risks associated with na assessment, and disast Independent Study Tim 6 Compulsory Bonus Yes 20 % Written exam 150 min Civil Engineering: Speci Civil Engineering: Speci | n methods, and sto atural and human-m er mitigation. e 96, Study Time in Presentation Presentation alisation Coastal En ialisation Geotechnic ialisation Structural ialisation Computativi ialisation Computativi ialisation Coastal En ialisation Geotechnic | chastic techniques for vario ade hazards, ensuring they Lecture 84 Description 10-minütige Präsent al Engineering: Elective Compulse cal Engineering: Elective Compu- ponal Engineering: Elective Compulsory gineering: Elective Compulsory gineering: Elective Compulsory gineering: Elective Compulsory gineering: Elective Compulsory | us applications. Th can make informe ation von Arbeitse ory npulsory lsory ompulsory ompulsory ory oppulsory | hey will also gain th d engineering decisio | e ability to evalu |
| Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the | Students will learn to ir distributions, regression risks associated with na assessment, and disast Independent Study Tim 6 Compulsory Bonus Yes 20 % Written exam 150 min Civil Engineering: Speci Civil Engineering: Speci | n methods, and sto atural and human-m er mitigation. e 96, Study Time in Presentation alisation Coastal En ialisation Geotechnic ialisation Structural ialisation Computati ialisation Computati ialisation Coastal En ialisation Geotechnic ialisation Geotechnic ialisation Structural | chastic techniques for vario ade hazards, ensuring they Lecture 84 Description 10-minütige Präsent al Engineering: Elective Compulse cal Engineering: Elective Compu- ponal Engineering: Elective Compulsory gineering: Elective Compulsory gineering: Elective Compulsory gineering: Elective Compulsory gineering: Elective Compulsory gineering: Elective Compulsory gineering: Elective Compulsory | us applications. Ti can make informe ation von Arbeitse pry npulsory lsory pmpulsory pry pulsory pry pulsory lsory pry lsory | hey will also gain th d engineering decisio | e ability to evalu |
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| Course L3458: Uncertainty M | Iodelling for Engineers |
|-----------------------------|---|
| Тур | Integrated Lecture |
| Hrs/wk | 6 |
| СР | 6 |
| Workload in Hours | Independent Study Time 96, Study Time in Lecture 84 |
| Lecturer | Prof. Simon Michael Papalexiou |
| Language | EN |
| Cycle | SoSe |
| Content | Engineering decisions are rarely made with complete certainty—uncertainty affects material properties, environmental conditions, structural performance, and risk assessments. This course provides students with theoretical foundations and practical tools to quantify uncertainty, assess risks, and enhance decision-making in civil, structural, geotechnical, and environmental engineering applications. Students will begin with fundamental probability concepts, learning how Bayes' Theorem, probability distributions, and extreme value theory help evaluate engineering uncertainties. They will explore linear and nonlinear regression methods for analyzing complex datasets, as well as joint probability distributions and stochastic optimization to improve predictive modeling and reliability assessments. The course also introduces Bayesian Decision Theory, offering a structured approach to decision-making under uncertainty. With a focus on real-world engineering problems, students will apply probabilistic models, extreme value analysis, and stochastic techniques to assess risks in infrastructure design, system reliability, and disaster resilience. Hands-on computational exercises will reinforce key concepts, preparing students to work with data-driven models and uncertainty quantification techniques used in engineering practice. This course is ideal for students interested in engineering risk assessment, reliability analysis, and data-driven modeling. By the end of the course, students will have developed critical analytical and problem-solving skills, equipping them for careers in structural safety, geotechnical engineering, environmental risk management, and beyond. |
| Literature | |

Thesis

| Module M-002: Maste | er Thesis |
|-------------------------|---|
| | |
| Courses | |
| Title | Typ Hrs/wk CP |
| Module Responsible | Professoren der TUHH |
| Admission Requirements | According to General Regulations §21 (1): |
| | At least CO and it as into how to be a chine of in charly an encourse. The completions bound decides an exception |
| | At least 60 credit points have to be achieved in study programme. The examinations board decides on exceptions. |
| Recommended Previous | |
| Knowledge | |
| Educational Objectives | |
| Professional Competence | |
| Knowledge | • The students can use specialized knowledge (facts, theories, and methods) of their subject competently on specialized |
| | issues. |
| | • The students can explain in depth the relevant approaches and terminologies in one or more areas of their subject |
| | describing current developments and taking up a critical position on them.The students can place a research task in their subject area in its context and describe and critically assess the state |
| | research. |
| | |
| | |
| Skills | The students are able: |
| | • To select, apply and, if necessary, develop further methods that are suitable for solving the specialized problem in question |
| | To apply knowledge they have acquired and methods they have learnt in the course of their studies to complex and/ |
| | incompletely defined problems in a solution-oriented way. |
| | • To develop new scientific findings in their subject area and subject them to a critical assessment. |
| Personal Competence | |
| Social Competence | |
| , , | |
| | Both in writing and orally outline a scientific issue for an expert audience accurately, understandably and in a structure |
| | way. Deal with issues competently in an expert discussion and answer them in a manner that is appropriate to the addresser |
| | while upholding their own assessments and viewpoints convincingly. |
| | |
| | |
| Autonomy | Students are able: |
| | To structure a project of their own in work packages and to work them off accordingly. |
| | • To work their way in depth into a largely unknown subject and to access the information required for them to do so. |
| | • To apply the techniques of scientific work comprehensively in research of their own. |
| Workload in Hours | Independent Study Time 900, Study Time in Lecture 0 |
| Credit points | |
| Course achievement | |
| Examination | |
| | According to General Regulations |
| scale | |
| Assignment for the | Civil Engineering: Thesis: Compulsory |
| Following Curricula | Bioprocess Engineering: Thesis: Compulsory |
| | Chemical and Bioprocess Engineering: Thesis: Compulsory |
| | Chemical and Bioprocess Engineering: Thesis: Compulsory |
| | Computational Engineering: Thesis: Compulsory Computer Science: Thesis: Compulsory |
| | Data Science: Thesis: Compulsory |
| | Electrical Engineering and Information Technology: Thesis: Compulsory |
| | Electrical Engineering: Thesis: Compulsory |
| | Energy Systems: Thesis: Compulsory |
| | Environmental Engineering: Thesis: Compulsory |
| | Aircraft Systems Engineering: Thesis: Compulsory |
| 1 | Global Innovation Management: Thesis: Compulsory |
| | |
| | Computer Science in Engineering: Thesis: Compulsory |
| | Computer Science in Engineering: Thesis: Compulsory Information and Communication Systems: Thesis: Compulsory |
| | Computer Science in Engineering: Thesis: Compulsory |
| | Computer Science in Engineering: Thesis: Compulsory Information and Communication Systems: Thesis: Compulsory Interdisciplinary Mathematics: Thesis: Compulsory |

Module Manual M.Sc. "Water and Environmental Engineering"

| Engineering | |
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| | Joint European Master in Environmental Studies - Cities and Sustainability: Thesis: Compulsory |
| | Logistics, Infrastructure and Mobility: Thesis: Compulsory |
| | Aeronautics: Thesis: Compulsory |
| | Mechanical Engineering - Product Development and Production: Thesis: Compulsory |
| | Materials Science and Engineering: Thesis: Compulsory |
| | Materials Science: Thesis: Compulsory |
| | Mechanical Engineering and Management: Thesis: Compulsory |
| | Mechatronics: Thesis: Compulsory |
| | Biomedical Engineering: Thesis: Compulsory |
| | Microelectronics and Microsystems: Thesis: Compulsory |
| | Product Development, Materials and Production: Thesis: Compulsory |
| | Renewable Energies: Thesis: Compulsory |
| | Naval Architecture and Ocean Engineering: Thesis: Compulsory |
| | Naval Architecture and Ocean Engineering: Thesis: Compulsory |
| | Ship and Offshore Technology: Thesis: Compulsory |
| | Theoretical Mechanical Engineering: Thesis: Compulsory |
| | Process Engineering: Thesis: Compulsory |
| | Water and Environmental Engineering: Thesis: Compulsory |
| | Certification in Engineering & Advisory in Aviation: Thesis: Compulsory |