Description of the degree program

Environmental Engineering (Master)
PO 4

Date: 15.09.2026

Table of contents

Specialisation Soil and Geotechnical Engineering

Title	Fundamentals of Geotechnical Engineering and Investigation of Contaminated Sites		
Number	4399770	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration		**Institution**	
Hours per Week / ECTS	0 / 6,0	**Module owner**	
Workload (h)	180		
Class attendance (h)		**Self studying (h)**	
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 min)		
Course achievement			

Contents
Foundation and rock engineering: Understanding of foundation and rock engineering for the design and construction of works in the ground. Catch dams and marine quays, special forms of excavation enclosures, special forms of support structures (e.g. reinforced earth), special earth pressure approaches, underpinning, pipe drilling, micro-tunnelling, pile grids, combined pile-raft foundations, subsoil improvement, soil stabilization, environmental aspects in geotechnical engineering, wedge statics, legal issues in geotechnical engineering.
Objective qualification
Literature

↑

Related courses
Rules for the choice of courses
Compulsory attendance

Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture/Exercise	german

	4,0	Lecture/Exercise	german

Title	Theoretical and Applied Topics of Geomechanics and Geotechnical Engineering		
Number	4315030	**Module version**	V1
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Geomechanik und Geotechnik
Hours per Week / ECTS	6 / 6,0	**Module owner**	Prof. Dr. Marius Milatz
Workload (h)	180		
Class attendance (h)	84	**Self studying (h)**	96
Compulsory requirements			
Expected performance/ Type of examination	Exam (120 min)		
Course achievement			

Contents

[Theoretical and experimental soil and rock mechanics]
Mechanical behavior of soils and rocks; Time-dependent behavior of soils; Geomechanical testing methods; Special characteristics of cohesive soils; Partially saturated soils; Fundamentals of geology, rock mechanics, and rock hydraulics; Imaging techniques in geomechanics; Introduction to constitutive models

[Soil Mechanics Laboratory]:
Site investigation as well as laboratory and field tests for the classification of soils, their permeability, and their strength and deformation behavior depending on the soil type

Objective qualification

Students who successfully complete the course are able to better understand and describe complex behavior of soils and rock, and to plan and interpret experimental investigations.
Upon recognition of the laboratory report, students are able to perform and evaluate laboratory and field tests.

Literature

- Vorlesungsunterlagen
- Grundbautaschenbuch Teil 1 bis Teil 3, Ernst & Sohn, 8. Auflage, 2018
- Kolymbas, D. : Geotechnik – Bodenmechanik, Grundbau und Tunnelbau, Springer, 2019

↑

Related courses

Rules for the choice of courses

Compulsory attendance

Name of the course	SWS	Eventtype	Language

	2,0	Internship	german
	4,0	Lecture/Exercise	german

Title	Deep Storage		
Number	4399780	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Geomechanik und Geotechnik
Hours per Week / ECTS	6 / 6,0	**Module owner**	Prof. Dr. Marius Milatz
Workload (h)	180		
Class attendance (h)	84	**Self studying (h)**	96
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 min)		
Course achievement			
Contents			
Introduction to the disposal of hazardous waste in deep geological formations.			
Objective qualification			
Literature			
Forschungsberichte, Veröffentlichungen, aktuelle Informationen im Internet, Skript			

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	6,0	Lecture/Exercise	german

Title	Soil as an Ecosystem		
Number	3328200010	**Module version**	
Shorttext		**Language**	english german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung für Bodenwissenschaften
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Magdalena Sut-Lohmann
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements	Basic knowledge of the lecture "Bodenkunde - Einführung" is mandatory.		
Recommended requirements	Basic knowledge of soil science and biology		
Expected performance/ Type of examination	Written examination (120 min)		
Course achievement			

Contents

[Soil Ecology and Soil Use (V)]
The course focuses on the role and performance of soil fauna in regulating soil processes under different land use types
- Soil ecology and ecological classification systems of soil organisms
- Recognizing and evaluating the role and performance of soil fauna
- Habitat function of soil and adaptation mechanisms of soil organisms
- Production function of soil as an ecological stress situation with potential for regeneration

[Isotopes for Quantifying Biogeochemical Cycles (VÜ)]
- Isotope Analysis and Measurement Techniques
- Carbon (C) and Nitrogen (N) Cycles in Terrestrial Ecosystems (Vegetation, Soils)
- Organic Soil Matter and Its Transformation and Stabilization
- Isotopes as Tracers in Soil Hydrology
- Soil-Plant-Atmosphere Interactions and Global Change

[Microbial Ecosystem Processes (VÜ)]
This course covers the following themes:
- Microbial physiology, behaviour, evolution and biodiversity
- Global elemental cycles from the perspective of microbial biotransformations
- Key factors that control microbial activity in aquatic, terrestrial, engineered and host-associated environments
- Computer lab practical for investigating microbial community composition and function from environmental DNA sequencing data

Objective qualification

Students acquire knowledge about soil ecological relationships in the context of soil use, the application of isotopes in biogeochemical research, and microbial ecosystem processes. The focus is initially on teaching the fundamentals of soil ecology, the habitat function of soil, adaptation mechanisms of soil organisms, and the production function of soil. Students gain the ability to analyze and evaluate feedback mechanisms between habitat function and soil use using indicator systems for soil invertebrates. Isotopes are important tracers in soil ecological research, enabling the tracking of the transformation and fate of substances in the environment. Students learn the basics and applications of stable isotopes for researching C and N cycles through current research examples.
In the course "Microbial Ecosystem Processes" (lectures combined with exercises), students acquire knowledge about microbial activities in ecosystems, with a focus on terrestrial systems (soils, rhizospheres) but also with reference to aquatic and constructed systems. Students become familiar with important microorganisms and microbial functional groups. They gain an understanding of the interactions between environmental factors and microbial processes, leading to insights into how microbial activities can be controlled, utilized, and managed. "Microbial Ecosystem Processes" is conducted in English.

Literature

Soil Ecology and Soil Use:

- Skript zur Vorlesung wird gestellt.
- W. Amelung, H. Blume, H. Fleige et al. (2018) Scheffer/Schachtschabel Lehrbuch der Bodenkunde. 17. Aufl., Springer Spektrum, Berlin, Heidelberg.
- H.-P. Blume, R. Horn, S. Thiele-Bruhn (2011) Handbuch des Bodenschutzes. 4. Aufl., Wiley-VCH, Weinheim.
- J.K. Whalen, L. Sampedro (2010) Soil Ecology and Management. CABI International, Wallingford.
- D.H. Wall, R.D. Bardgett, V. Behan-Pelletier, J.E. Herrick, T.H. Jones, K. Ritz, J. Six, D.R. Strong, W.H. van der Putten (2012) Soil Ecology and Ecosystem Services. Oxford University Press, Oxford.
- Isotopes for Quantifying Biogeochemical Cycles:
- Krüger, N., Finn, D. R., & Don, A. (2024). Soil depth gradients of organic carbon-13–A review on drivers and processes. Plant and Soil, 495(1), 113-136.
- J.R. Ehleringer, A.E. Hall, G.D. Farquhar (1993) Stable Isotope in Plant Carbon-Water Relations, Academic Press
- Deb, S., Lewicka-Szczebak, D., & Rohe, L. (2024). Microbial nitrogen transformations tracked by natural abundance isotope studies and microbiological methods: A review. Science of The Total Environment, 172073.
- Nieder, R. and Benbi, D.K., 2008, Carbon and nitrogen in the terrestrial environment. Springer, Dordrecht.

Microbial Ecosystem Processes:

- M.T. Madigan, K.S. Bender, D.H. Buckley, W.M. Sattley, D.A. Stahl (2022) Brock Biology of Microorganisms 16th edition. Pearson Education Ltd., Harlow, UK
- E.A. Paul (ed.) (2015) Soil microbiology, ecology, and biochemistry. Elsevier, Amsterdam, NL.

↑

Related courses

Rules for the choice of courses

Compulsory attendance

Mandatory attendance for the exercise part.

Name of the course	SWS	Eventtype	Language

	1,0	Lecture/Exercise	german
Literature			
Skript zur Vorlesung als Lerngrundlage wird gestellt. Folgende Lehrbücher zum Nachschlagen und Vertiefen sind in der UB vorhanden: F. Scheffer, P. Schachtschabel (2002) Lehrbuch der Bodenkunde. 15.Aufl., Spektrum, Heidelberg. U. Gisi (1997) Bodenökologie. 2. Aufl., Thieme, Stuttgart. H.-P. Blume (2004) Handbuch des Bodenschutzes. 3. Aufl., Ecomed, Landsberg am Lech. D.C. Coleman, D.A. Crossley, P.F. Hendrix (2004) Fundamentals of Soil Ecology. 2. Aufl., Elsevier, Amsterdam. P. Lavelle, A.V. Spain (2005) Soil Ecology. Springer, Dordrecht.			

	1,0	Lecture/Exercise	german
Literature			
Isotope in der bodenökologischen Forschung: - Skript wird zur Verfügung gestellt - J.R. Ehleringer, A.E. Hall, G.D. Farquahar, Stabe Isotope in Plant Carbon-Water Relations, Academic Press 1993 R. Nieder, D.K. Benbi (2008): Carbon and Nitrogen in the Terrestrial Environment. Springer, Dordrecht			

	2,0	Lecture/Exercise	english
Literature			
Vorlesungsskript			

Specialisation Energy Technology

Title	Thermal energy Systems		
Number	2520090	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät für Maschinenbau
Module duration	1	**Institution**	Institut für Energie- und Systemverfahrenstechnik
Hours per Week / ECTS	3 / 5,0	**Module owner**	Prof. Dr. Daniel Schröder
Workload (h)	150		
Class attendance (h)	42	**Self studying (h)**	108
Compulsory requirements			
Recommended requirements	Basic knowledge in the field of thermodynamics		
Expected performance/ Type of examination	1 Examination element: Written exam, 120 minutes or oral examination 30 minutes		
Course achievement			

Contents

Lecture: Development of power plants. Steam power process. Gas turbine processes. Steam generators (advantages, disadvantages and reasons for the development of each type). Thermal calculation and design of steam generators. Materials. Function and design of auxiliary equipment such as condenser, water preheater, feedwater and circulation pump, safety valves and bypass stations, fan, air preheater, electrostatic precipitator, desulfurization, NOx reduction, stack. Steam turbine. Gas turbine. Combined cycle and multi-fuel processes.

Exercise: Consolidation of theoretical principles through application to examples from power plant engineering, design, construction of steam generator components in compliance with regulations and standards.

Objective qualification

The students acquire fundamental knowledge about the energy transformation in thermal power plants. They gain insight in composition, construction and dimensioning of thermal power plants. After participating in this module the students are able to develop concepts and solutions for thermal plants.

Literature

Brandt, F. Dampferzeuger: Kesselsysteme, Energiebilanz, Strömungstechnik. 2. Auflage. Band 3 der FDBR - Fachbuchreihe. Essen: Vulkan-Verlag Strauss,
K. Kraftwerkstechnik - zur Nutzung fossiler, regenerativer und nuklearer Energiequellen. 1998 Berlin, Heidelberg, New York: Springer Verlag
S. Kakac: Boilers, Evaporators & Condensers, Wiley-Intersciences, ISBN: 0-471-62170-6 Singer,
J. G.: Combustion, Fossil Power Systems Combustion Engineering Inc., 1981, Library of Congress Catalog Card Nr. 81-66247, ISBN: 0-960 5974

VDI: Energietechnische Arbeitsmappe, ISBN 3-540-62195-4 Cerbe/Wilhelms; Technische Thermodynamik; 18. Auflage; Hanser-Verlag

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture	german
	1,0	Exercise	german

Title	Electrical Distribution Systems Technology		
Number	2423300	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	Fakultät für Elektrotechnik, Informationstechnik, Physik
Module duration	1	**Institution**	
Hours per Week / ECTS	4 / 5,0	**Module owner**	Prof. Dr. Bernd Engel
Workload (h)	150		
Class attendance (h)	56	**Self studying (h)**	94
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 min)		
Course achievement			

Contents

- Electrical Grid and Grid structures
- Basic terms, energy history, future
- Cable and overhead line
- Transformer
- Substations and Control rooms
- Grid safety & security
- Grid planning, calculation and AI
- Grid financing and grid fees
- Innovative grid operation using the example of medium and low voltage grids
- Active power management in distribution grids

Objective qualification

After successfully completing the module, students will have basic knowledge of technologies that are relevant to the distribution of electrical energy now and in the future. They are informed about current and future developments in electrical energy distribution networks and can formulate existing challenges. They are able to analyse and assess technologies, components and systems and to design and dimension them in principle.

Literature

Elektrische Energieverteilung – Flosdorff, Hilgarth – Vieweg + Teubner
Elektrische Energieversorgung – Heuck, Dettmann, Schulz – SpringerVieweg
Taschenbuch der elektrischen Energietechnik – Schufft – Hanser
Elektrische Anlagentechnik – Knies, Schierack – Hanser
Elektroenergiesysteme – Schwab – Springer

↑

Related courses
Rules for the choice of courses
Compulsory attendance

Name of the course	SWS	Eventtype	Language
	3,0	Lecture	german
Literature			
Elektrische Energieverteilung; Flosdorff, Hilgarth; Vieweg + Teubner Elektrische Energieversorgung; Heuck, Dettmann, Schulz; SpringerVieweg Taschenbuch der elektrischen Energietechnik; Schufft; Hanser Elektrische Anlagentechnik; Knies, Schierack; Hanser Elektroenergiesysteme; Schwab; Springer			

	1,0	Exercise	german
Literature			
Elektrische Energieverteilung; Flosdorff, Hilgarth; Vieweg + Teubner Elektrische Energieversorgung; Heuck, Dettmann, Schulz; SpringerVieweg Taschenbuch der elektrischen Energietechnik; Schufft; Hanser Elektrische Anlagentechnik; Knies, Schierack; Hanser Elektroenergiesysteme; Schwab; Springer			

Title	Energy Economy and Market Integration of Renewables		
Number	2423460	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät für Elektrotechnik, Informationstechnik, Physik
Module duration	1	**Institution**	
Hours per Week / ECTS	4 / 5,0	**Module owner**	Prof. Dr. Bernd Engel
Workload (h)	150		
Class attendance (h)	56	**Self studying (h)**	94
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 min) or oral exam (30 min)		
Course achievement			

Contents

1. energy economics
2. energy policy
3. laws and subsidy systems
4. markets (electricity market 2.0, balancing power market)
5. direct marketing / balancing group management
6. virtual power plant
7. large-scale storage

Objective qualification

On completion of the module, students will have acquired knowledge of the energy industry in Germany. They will be able to evaluate and assess current developments in the markets. New technologies and research insights are integrated.

Literature

Marcel Linnemann: Energiewirtschaft für (Quer-)Einsteiger Tim Wawer: Elektrizitätswirtschaft

↑

Related courses

Rules for the choice of courses

Compulsory attendance

Name of the course	SWS	Eventtype	Language
	2,0	Lecture	german

	2,0	Exercise	german

Title	Energy Systems and Biomass Utilisation		
Number	4310330	**Module version**	
Shorttext		**Language**	german
Frequency of offer		**Teaching unit**	
Module duration		**Institution**	Institut für Siedlungswasserwirtschaft
Hours per Week / ECTS	3 / 4,0	**Module owner**	Prof. Dr. Thomas Dockhorn
Workload (h)			
Class attendance (h)	90	**Self studying (h)**	30
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			

Contents

Material flow analyses, storage, logistics, mass balances, treatment processes and technologies, anaerobic and aerobic as well as thermo-chemical treatment processes, first- to third-generation biofuels, cascading use of biomass, quality requirements, integrated energy systems, sustainability.

Objective qualification

Students will gain advanced knowledge of the utilization of various types of biomass as an energy source. They will be able to understand, discuss and evaluate advantages and opportunities as well as limitations for the utilization of biomass in a sustainable chemical industry as well as for sustainable energy and fuel production. Students will be able to design overall concepts for the utilization of biomass in the pre-planning stage and will also be able to understand and overlook the entire treatment chain, such as regional material flow cycles and potential analyses, systems for biomass supply, substance conversion, processes for product refinement and options for disposal of residues. They will acquire skills to discuss and evaluate the complexity of sustainability questions and will understand that an objective assessment of sustainability is complex and requires a differentiated approach.

Literature

↑

Related courses

Rules for the choice of courses

Compulsory attendance

Name of the course	SWS	Eventtype	Language

	3,0	Lecture/Exercise	german

Title	Innovative Energy Systems		
Number	2423340	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	Fakultät für Elektrotechnik, Informationstechnik, Physik
Module duration	1	**Institution**	
Hours per Week / ECTS	4 / 5,0	**Module owner**	Prof. Dr. Bernd Engel
Workload (h)	150		
Class attendance (h)	56	**Self studying (h)**	94
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Contents			
Objective qualification			
Literature			
Quaschning, Volker: Regenerative Energiesysteme: Technologie # Berechnung # Simulation. München 2015. Hanser Verlag. Kaltschmitt, Martin: Erneuerbare Energien: Systemtechnik, Wirtschaftlichkeit, Umweltaspekte. Berlin 2013. Springer Vieweg. Heuck, Klaus; Dettmann, Klaus-Dieter; Schulz, Detlef: Elektrische Energieversorgung: Erzeugung, Übertragung und Verteilung elektrischer Energie für Studium und Praxis. Wiesbaden 2013. Springer Vieweg. Schwab, Adolf J.: Elektroenergiesysteme: Erzeugung, Übertragung und Verteilung elektrischer Energie. Berlin 2015. Springer Vieweg.			

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture	german
Literature			
Die Energiefrage Bedarf und Potentiale, Nutzung, Risiken und Kosten, K. Heinloth, Vieweg			

	2,0	Exercise	german

Title	Renewable Energy Technology		
Number	2520170	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration	1	**Institution**	
Hours per Week / ECTS	3 / 5,0	**Module owner**	Prof. Dr. Jens Friedrichs
Workload (h)	150		
Class attendance (h)	42	**Self studying (h)**	108
Compulsory requirements			
Expected performance/ Type of examination	1 Examination element: Written exam (120 min)		
Course achievement			

Contents

Lecture:
- Overview of forms and extent of renewable energies
- Geothermal energy Biomass and fuel cells Biogas
- Thermal solar energy for space heating and hot water production
- Solar heat power stations
- Photovoltaics
- Windpower plants
- Water-power plants

Exercise:
- Calculation of examples

Objective qualification

The students can name the basic technologies for renewable energy conversion and storage and are able to draft their combination to systems. They are able to calculate the theoretical efficiencies for the most significant technologies and thus are able to compare them. They know the typical efficiencies of various systems and on this basis they are able to evaluate present systems. Further, they know the major characteristic advantages and disadvantages of the technologies and are able to develop measures for improvement on this basis. Besides, they are able to design simple systems. They can analyze the integration of renewable energy technologies into the electrical energy supply system and are able to evaluate the systems in the context of current and future challenges.

Literature

- Winter, Nitsch: Wasserstoff als Energieträger, Springer, ISBN: 3-540-15865-0
- Bührke, Wengenmayer: Erneuerbare Energie, Wiley-VCH 2007, ISBN-10: 3-527-40727-8
- Stoy: Wunschenergie Sonne, ISBN: 3-87200-611-8;
- Kaltschmitt, Hartmann: Energie aus Biomasse, Springer, ISBN: 3-540-64853-4
- Insti, W. et al.: Wasserstoff, die Energie für alle Zeiten, Udo Pfriemer Verlag 1980, ISBN: 3-7906-0092-X

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture	german
	1,0	Exercise	german

Title	Wind Energy Systems		
Number	2518290	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät für Maschinenbau
Module duration	1	**Institution**	Institut für Flugantriebe und Strömungsmaschinen
Hours per Week / ECTS	3 / 5,0	**Module owner**	Prof. Dr. Jens Friedrichs
Workload (h)	150		
Class attendance (h)	42	**Self studying (h)**	108
Compulsory requirements	none		
Expected performance/ Type of examination	1 examination element: written exam, 90 minutes or oral exam, 30 minutes		
Course achievement			

Contents

Historic development; Construction types Fluid mechanical fundamentals; Betz´s law Tip speed ratio, Coefficient of power, Modelling Laws Meteorologic fundamentals, Wind supply, Wind histograms, Wind classes, Wind atlas Wind - Measurement - Output # Forecast Drag based machines # Lift based machines; Velocity triangles; Lift and Drag coefficient, Lilienthal polar Constructive setup; Rotor # Drive train # Common auxiliaries # Tower and foundation Lift based wind turbine design; Performance map and part load behavior Wind turbine power production; Control and regulation; Construction concepts; grid-connected and wind run wind turbines Control of operations, Monitoring, Maintenance; Planning, Operation and Profitability Conducted constructions, Onshore and offshore wind farms

Objective qualification

The students are able to evaluate the functional principles and system properties of the different wind turbines (WTG) using examples and exercises and to assign them to the site question. Appropriate statistical methods are used to assess the site. They are able to participate in the planning and conceptual design of wind turbines and wind farms. They have knowledge of the different control and regulation concepts of wind and grid-operated plants and are able to assess the economic efficiency of different concepts taking into account the local wind supply.

Literature

T. Burton et. al.: Wind Energy Handbook, John Wiley & Sons; 2. Auflage, 2011. R. Gasch, J. Twele: Windkraftanlagen, 8. Aufl. Springer, 2013. J.-P. Molly: Windenergie, 2. Auflage, Verlag C.F. Müller Karlsruhe, 1990.

↑

Related courses
Rules for the choice of courses
Compulsory attendance

Name of the course	SWS	Eventtype	Language
	2,0	Lecture	german
Literature			
T. Burton et. al.: Wind Energy Handbook, John Wiley & Sons; 2. Auflage, 2011. R. Gasch, J. Twele: Windkraftanlagen, 8. Aufl. Springer, 2013. J.-P. Molly: Windenergie, 2. Auflage, Verlag C.F. Müller Karlsruhe, 1990.			

	1,0	Exercise	german
Literature			
T. Burton et. al.: Wind Energy Handbook, John Wiley & Sons; 2. Auflage, 2011. R. Gasch, J. Twele: Windkraftanlagen, 8. Aufl. Springer, 2013. J.-P. Molly: Windenergie, 2. Auflage, Verlag C.F. Müller Karlsruhe, 1990.			

Title	System Technology for Photovoltaic		
Number	2423380	**Module version**	
Shorttext		**Language**	
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät für Elektrotechnik, Informationstechnik, Physik
Module duration	1	**Institution**	
Hours per Week / ECTS	4 / 5,0	**Module owner**	Prof. Dr. Bernd Engel
Workload (h)	150		
Class attendance (h)	56	**Self studying (h)**	94
Compulsory requirements			
Expected performance/ Type of examination	oral exam (30 min) or written exam (90-120 min, in case of high number of participants)		
Course achievement			

Contents

1. introduction to the system technology of photovoltaics
2. system configurations
3. inverter topologies
4. functions of the inverters
5. other components of PV system technology
6. grid integration of PV systems
7. off-grid systems
8. grid-connected PV systems with storage
9. future developments

Objective qualification

The lecture provides an overview of the requirements for the system components of grid-connected and off-grid photovoltaic systems without and with decentralised battery storage, for example to maximise self-consumption. Due to subsidy programmes and the sharp drop in prices, photovoltaics are becoming increasingly important for the electrical energy supply in Germany (30 gigawatts installed by 2013, share of up to 30 % of the midday load). Special attention is paid to inverter technology with a comparison of the properties of different circuit topologies and their effects on PV system design. In the exercise, PC tool-based system designs and their grid integration are calculated. The lecture is rounded off with a free one-day excursion to the international market and technology leader for solar inverters in Kassel. On completion of the module, students will be able to analyse, assess, design and dimension components and PV systems and their integration into the grid.

Literature

Photovoltaik, Heinrich Häberlein, VDE-Verlag, ISBN 978-3-8007-3205-0
Photovoltaik für Profis, Falk Antony et. al., Verlag Solarpraxis, ISBN 978-3-934595-38-5
Lecture notes

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture	german
Literature			
Photovoltaik, Heinrich Häberlein, VDE-Verlag, ISBN 978-3-8007-3205-0 Photovoltaik für Profis, Falk Antony et. al., Verlag Solarpraxis, ISBN 978-3-934595-38-5 Skript			
	2,0	Exercise	german
Literature			
Photovoltaik, Heinrich Häberlein, VDE-Verlag, ISBN 978-3-8007-3205-0 Photovoltaik für Profis, Falk Antony et. al., Verlag Solarpraxis, ISBN 978-3-934595-38-5 Skript			

Title	electrotechnical laboratory practical course specialization battery technologies		
Number	2423000000	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät für Elektrotechnik, Informationstechnik, Physik
Module duration	1	**Institution**	elenia Institut für Hochspannungstechnik und Energiesysteme
Hours per Week / ECTS	4 / 5,0	**Module owner**	Prof. Dr. Michael Kurrat
Workload (h)	150		
Class attendance (h)	42	**Self studying (h)**	108
Compulsory requirements			
Expected performance/ Type of examination	For the seminar: portfolio in addition to passed lab work		
Course achievement	Lab work: successful participation in four lab experiments incl. written report		

Contents

Practical experiments in the areas of:
- Formation and post-mortem analysis
- Electrochemical characterizations
- Pressure analysis
- Simulation and modeling

The practical experiments include preparation, experimental work, colloquium and written elaboration. This knowledge will be deepened during the seminar.

Objective qualification

Students know and understand in-depth methods of battery technology, including the characterization, analysis and simulation of batteries. Students will be able to apply the basic knowledge they have already acquired in other modules, e.g. the structure and function of storage systems. They have the ability to collect, document and evaluate experimental data from various battery test cells and to cooperate successfully with fellow students. Students are able to make scientifically sound judgments in the context of battery technologies. Draw new conclusions from their own results and the state of knowledge in the literature. This scientific work must be presented orally and in writing.

Literature

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
seminar - electrotechnical laboratory practical course specialization battery technologies	2,0	Seminar	german
laboratory - electrotechnical laboratory practical course specialization battery technologies	2,0	Laboratory	german

Title	Hydropower Plants		
Number	4310320	**Module version**	
Shorttext		**Language**	german
Frequency of offer		**Teaching unit**	
Module duration		**Institution**	Abteilung Wasserbau und Gewässermorphologie
Hours per Week / ECTS	3 / 5,0	**Module owner**	Prof. Dr. Jochen Aberle
Workload (h)			
Class attendance (h)	42	**Self studying (h)**	108
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Contents			
Objective qualification			
Literature			

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	3,0	Lecture/Exercise	german

Title	Building Simulation and Modelling		
Number	3307000000	**Module version**	
Shorttext		**Language**	
Frequency of offer		**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration		**Institution**	
Hours per Week / ECTS	/ 6,0	**Module owner**	
Workload (h)	180		
Class attendance (h)		**Self studying (h)**	
Compulsory requirements			
Expected performance/ Type of examination	Presentation		
Course achievement			

Contents

Interdisciplinary design has long been a reality and a necessary basis for innovative ideas and strategies. The desire for the greatest possible transparency in today's buildings can stand in the way of thermal and visual comfort or require avoidable building technology and high energy consumption. With the help of building simulations and modelling, design-relevant decisions are reviewed, and optimized variants are derived. The aim is to verify a comfortable and energy-efficient operation of buildings in suitable simulation and modelling environments.

Objective qualification

Students learn the interrelationships of technical systems of buildings and building envelopes and are able to design the necessary components. Scientific approaches for the development and presentation of complex problems are demonstrated. The students can communicate the acquired knowledge and discuss it in an interdisciplinary context. They master the necessary basics of the vocabulary and gain insight into common simulation programs and tools as a key qualification for future work in this subject area.

Literature

↑

Related courses

Rules for the choice of courses

Compulsory attendance

Name of the course	SWS	Eventtype	Language

	4,0	Seminar	german

Title	Sustainable Building Stock		
Number	4310340	**Module version**	V1
Shorttext		**Language**	german
Frequency of offer		**Teaching unit**	
Module duration		**Institution**	Institut für Bauklimatik und Energie der Architektur
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Elisabeth Endres
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			

Contents

The seminar considers current issues in the building sector for dealing with existing buildings, as these represent a significant proportion of the total building stock. The focus is on questions concerning structural or technical renovation concepts, demolition and new-build replacements or energy supply systems. Based on an example, different approaches are developed in group work and evaluated. If possible, hands-on tasks such as building surveys and measurements are done in the building and complemented using theoretical aspects.

Objective qualification

Students learn the interrelationships of technical systems of buildings and building envelopes and are able to design the necessary components. Scientific approaches for the development and presentation of complex problems are demonstrated. The students can communicate the acquired knowledge and discuss it in an interdisciplinary context. They master the necessary basics of the vocabulary and gain insight into common simulation programs and tools as a key qualification for future work in this subject area.

Literature

↑

Related courses

Rules for the choice of courses

Compulsory attendance

Name of the course	SWS	Eventtype	Language

	4,0	Seminar	german

Title	Sustainable Waste Heat Utilization		
Number	2519150	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	Fakultät für Maschinenbau
Module duration	1	**Institution**	Institut für Thermodynamik
Hours per Week / ECTS	3 / 5,0	**Module owner**	Prof. Dr. Thomas Koller
Workload (h)	150		
Class attendance (h)	42	**Self studying (h)**	108
Compulsory requirements			
Expected performance/ Type of examination	1 examination element: oral exam of (30 min)		
Course achievement			

Contents

In almost all technical and biological processes, surplus heat occurs at different temperature levels. This heat is often emitted as waste heat to the environment. In the sense of a sustainable and economical use of resources, it is desirable to recycle the unavoidable waste heat as far as possible and to return it to the original or other processes.

1. Basics
2. Heat sources (industry, transport, natural sources)
3. Heat storage and heat transport
4. Processes for heat utilization (e.g., heat pumps, ORC, stirling, sorption, thermoelectric)
5. Systems and operating strategies (e.g., energetic analysis of a supermarket)

Objective qualification

After completing this course, the students are able to analyze and evaluate existing processes regarding the waste heat. Furthermore, they are given a variety of technical processes, with the help of which waste heat flows can be made use of. With the gained knowledge, the students are able to understand and to optimize even more complex systems. This can also be applied in a student's thesis.

Literature

1. Vorlesungsfolien als Umdruck
2. B. Weigand, J. Köhler: #Thermodynamik kompakt#; Springer Vieweg; Auflage: 4 (20. September 2016)
3. M. Sterner, I. Stadler: #Energiespeicher - Bedarf, Technologien, Integration; Springer Vieweg; Auflage: 2014 (22. Oktober 2014)
4. H.-M. Henning et al.: #Kühlen und Klimatisieren mit Wärme (BINE-Fachbuch)#; Fraunhofer IRB Verlag; Auflage: 2., Aufl. (29. April 2015)

↑

Related courses			
Rules for the choice of courses			
Lecture and exercise have to be attended.			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture	german
	1,0	Exercise	german

Specialisation Environmental Sustainability and Life Cycle Engineering

Title	Energy Efficiency in Production Engineering		
Number	2522930	**Module version**	v2
Shorttext		**Language**	english
Frequency of offer	only in the summer term	**Teaching unit**	Fakultät für Maschinenbau
Module duration	1	**Institution**	Institut für Werkzeugmaschinen und Fertigungstechnik
Hours per Week / ECTS	3 / 5,0	**Module owner**	Prof. Dr. Christoph Herrmann
Workload (h)	150		
Class attendance (h)	42	**Self studying (h)**	108
Compulsory requirements			
Expected performance/ Type of examination	written exam+ (120 min) or oral exam+ (30 min)		
Course achievement	presentation and/or written report in the context of a teamproject (On application, the result of the course achievement is taken into account in the assessment of the written examination+ or of the oral examination+, respectively, and can account maximum 20% of the respective grade.)		

Contents

- Background and methods for the holistic planning, design and development of sustainable production systems
- Definition of the term and origin of sustainability in production
- Technologies and procedures for industrial data acquisition
- Energetic evaluation of production processes on the basis of various key figures
- Data analysis of production processes using Sankey diagrams in theory and practice
- Analysis of production processes based on an (energy) value stream analysis
- Analysis of the different levels of consideration of factories (production processes, technical building equipment, building envelope) and relevant material, energy and information flows
- Guest lectures from industry on relevant topics of sustainable production systems
- Gaining knowledge about energy flexibility in production
- Practice-oriented application of various methods to increase energy efficiency in the IWF's learning factory

Objective qualification

The students...

- ... explain the planning, design and development of sustainability-oriented production systems in different contexts
- ... assess different strategies (e.g. efficiency strategy) and principles (e.g. avoidance principle) of sustainable development in defined use cases on a laboratory scale
- ... evaluate existing production systems in economic, ecological and social dimensions
- ... are able to illustrate the results of various efficiency strategies to non-experts and to apply relevant assumptions, restrictions and framework conditions correctly
- ... design their own research questions within the team project, evaluate experiments and derive a presentation of the results of the research

- ... organize themselves in a team project and gain experience in relevant soft skills such as teamwork, communication and presentation skills
- ... analyze sustainability-oriented production systems within a given topic
- ... are able to select relevant fields of action and measures for sustainable production

Literature

Vorlesungsskript "Energy Efficiency in Production Engineering" mit ausführlichen Quellenangaben für das Selbstudium

Herrmann, Christoph: Ganzheitliches Life Cycle Management, Berlin 2009

Dyckhoff, H. (2000): Umweltmanagement # Zehn Lektionen in umweltorientierter Unternehmensführung, Berlin: Springer-Verlag Berlin Heidelberg, 2000.

Günther, H.-O.; Tempelmeier, H. (2005): Produktion und Logistik. 6., verb. Aufl., [Hauptbd.], Berlin: Springer-Verlag Berlin Heidelberg, 2005.

Eversheim, W.; Schuh, G. (1999): Gestaltung von Produktionssystemen, VDI-Buch Nr. 3, Berlin: Springer-Verlag Berlin Heidelberg, 1999.

Remark

The course "Energy Efficiency in Production Engineering" is targeted in particular at students of mechanical engineering, industrial engineering, sustainable energy engineering, technology-oriented management, environmental engineering and other related courses.
This lecture is held in English.

↑

Related courses

Rules for the choice of courses

Both courses have to be attended.

Compulsory attendance

Name of the course	SWS	Eventtype	Language
	2,0	Lecture	english
	1,0	Team Project	english

Title	Energy Efficiency in Production Engineering with Laboratory		
Number	2522940	**Module version**	v2
Shorttext		**Language**	english
Frequency of offer	only in the summer term	**Teaching unit**	Fakultät für Maschinenbau
Module duration	1	**Institution**	Institut für Werkzeugmaschinen und Fertigungstechnik
Hours per Week / ECTS	4 / 7,0	**Module owner**	Prof. Dr. Christoph Herrmann
Workload (h)	210		
Class attendance (h)	56	**Self studying (h)**	154
Compulsory requirements			
Expected performance/ Type of examination	written exam+ (120 min) or oral exam+ (30 min)		
Course achievement	2 course achievements: 1. presentation and/or written report in the context of a teamproject (On application, the result of the course achievement is taken into account in the assessment of the written examination+ or of the oral examination+, respectively, and can account maximum 20% of the respective grade.) 2. protocol and presentation of the laboratory experiments		

Contents

- Background and methods for the holistic planning, design and development of sustainable production systems
- Definition of the term and origin of sustainability in production
- Technologies and procedures for industrial data acquisition
- Energetic evaluation of production processes on the basis of various key figures
- Data analysis of production processes using Sankey diagrams in theory and practice
- Analysis of production processes based on an (energy) value stream analysis
- Analysis of the different levels of consideration of factories (production processes, technical building equipment, building envelope) and relevant material, energy and information flows
- Guest lectures from industry on relevant topics of sustainable production systems
- Gaining knowledge about energy flexibility in production
- Practice-oriented application of various methods to increase energy efficiency in the IWF's learning factory
- Evaluation of measures to increase energy flexibility through e.g. load profile analysis and energy portfolio

Objective qualification

The students...
- ... explain the planning, design and development of sustainability-oriented production systems in different contexts
- ... assess different strategies (e.g. efficiency strategy) and principles (e.g. avoidance principle) of sustainable development in defined use cases on a laboratory scale
- ... evaluate existing production systems in economic, ecological and social dimensions
- ... are able to illustrate the results of various efficiency strategies to non-experts and to apply relevant assumptions, restrictions and framework conditions correctly
- ... design their own research questions within the team project, evaluate experiments and derive a presentation of the results of the research

- ... organize themselves in a team project and gain experience in relevant soft skills such as teamwork, communication and presentation skills
- ... analyze sustainability-oriented production systems within a given topic
- ... are able to select relevant fields of action and measures for sustainable production

Through the lab, the students...
- ... become more confident with the topic of energy flexibility introduced in the lecture
- ... are able to use energy measuring devices independently
- ... understand the influence of volatile renewable energies and of environmental factors on production within a case study
- ... identify energy flexibilization potentials in production within a real example in the BatteryLab Factory

Literature

Vorlesungsskript "Energy Efficiency in Production Engineering" mit ausführlichen Quellenangaben für das Selbstudium

Herrmann, Christoph: Ganzheitliches Life Cycle Management, Berlin 2009

Dyckhoff, H. (2000): Umweltmanagement # Zehn Lektionen in umweltorientierter Unternehmensführung, Berlin: Springer-Verlag Berlin Heidelberg, 2000.

Günther, H.-O.; Tempelmeier, H. (2005): Produktion und Logistik. 6., verb. Aufl., [Hauptbd.], Berlin: Springer-Verlag Berlin Heidelberg, 2005.

Eversheim, W.; Schuh, G. (1999): Gestaltung von Produktionssystemen, VDI-Buch Nr. 3, Berlin: Springer-Verlag Berlin Heidelberg, 1999.

Remark

The course "Energy Efficiency in Production Engineering" is targeted in particular at students of mechanical engineering, industrial engineering, sustainable energy engineering, technology-oriented management, environmental engineering and other related courses.
This lecture is held in English.

↑

Related courses

Rules for the choice of courses

All courses have to be attended.

Compulsory attendance

Name of the course	SWS	Eventtype	Language
	2,0	Lecture	english
	1,0	Team Project	english
	1,0	Laboratory	english

Title	Environmental and Sustainability Management in Industrial Application		
Number	2522680	**Module version**	
Shorttext		**Language**	english
Frequency of offer	only in the summer term	**Teaching unit**	Fakultät für Maschinenbau
Module duration	1	**Institution**	Institut für Werkzeugmaschinen und Fertigungstechnik
Hours per Week / ECTS	3 / 5,0	**Module owner**	Prof. Dr. Christoph Herrmann
Workload (h)	150		
Class attendance (h)	42	**Self studying (h)**	108
Compulsory requirements			
Recommended requirements	It is recommended to complete the module "Total Life Cycle Management" in the previous winter semester. However, this is not a mandatory requirement for participation.		
Expected performance/ Type of examination	written examination (120 min) or oral examination (30 min)		
Course achievement	written report		

Contents

Requirements for companies from the perspective of sustainable development. Concept of Planetary Boundaries. Indicators of ecological limits, such as biodiversity loss, air pollution or the nitrogen cycle. Two central pillars for companies: Governance and leadership. Existing regulations, laws and standards such as ISO 26000 (Guide to Corporate Social Responsibility) or ISO 14001 (Environmental Management System Standard). Unique selling points to differentiate the company from its competitors. Various methods for sustainability strategies, such as materiality analysis. Indicators and measures regarding product policy, environmental communication, corporate social responsibility or external certifications.

Objective qualification

After completing the module "Environmental and Sustainability Management in Industrial Application" students are able to

- systematically analyse companies with regard to environmental and sustainability risks and to derive sustainability strategies for companies based on this analysis.
- apply suitable methods to identify the relevant environmental and sustainability aspects within the life cycle of a product and to derive requirements for companies.
- identify suitable measures to implement these requirements within a company organization.
- apply expertise on various topics of environmental and sustainability management within the framework of a case study.
- lead well-founded discussions on environmental and sustainability issues and to formulate sustainability strategies developed in a heterogeneous team.

Literature

Literature will be announced in the course.

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture	english
	1,0	Team Project	english

Title	Life Cycle Assessment for Sustainable Engineering		
Number	2522460	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät für Maschinenbau
Module duration	1	**Institution**	
Hours per Week / ECTS	3 / 5,0	**Module owner**	
Workload (h)	150		
Class attendance (h)	42	**Self studying (h)**	108
Compulsory requirements			
Expected performance/ Type of examination	1 Examination element: Written exam (120 min) or oral examination (30 min)		
Course achievement	1 Course achievement: Final Presentation and report		

Contents

Providing knowledge of the fundamentals of Life Cycle Assessment (theory and practice): - Environmental impacts in the product life cycle, ecological hotspots and optimization potential - LCA steps according to ISO 14040/44 - Learn how to conduct a Life Cycle Inventory - Learn how to conduct a Life Cycle Impact Assessment - Problem Shifting - Learn how to critically assess and review LCAs - Use of numerous examples especially from the automotive industry and on e-mobility - Critical Review

Objective qualification

The module Life Cycle Assessment for Sustainable Engineering pretends to raise awareness about the environmental impacts of products and processes. In the course the students are expected to learn how to use the ISO 14040 methodology in order to quantified environmental impacts from a life cycle perspective. By completing this module, the students will be able to analyze products from a life cycle perspective, identify environmental hot-spots and optimization potential from different products and to understand the risk of problem shifting. The student will learn not only the individual steps of a life cycle assessment, but also to analyze the different factors that have an influence on the results, and therefore the students will be able to review critically understand other life cycle assessment analysis. In addition to the application of the methodology, the students will have an insight on several practical examples generally from the automotive sector. Of particular interest is the application of the methodology to the evaluation of the environmental implication of electric vehicles. Furthermore, the following topics of interest will be presented: Environmental Product Declaration (EPD), Product Environmental Footprint Category Rules (PEFCRs), Organization Environmental Footprint Sector Rules (OEFSRs). Through the participation on the lectures team Project, the students will enhance team work skills, project management skills. The students will learn to use the software Umberto.

Literature

1. Hauschild, M., Rosenbaum, R.K. & Olsen, 2018. Life Cycle Assessment - Theory and Practice
2. ISO 14040/44
3. ILCD Handbook
4. eLCAr-Guidelines

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture	english
	1,0	Exercise	english

Title	Life Cycle Assessment for Sustainable Engineering with Laboratory		
Number	2522640	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät für Maschinenbau
Module duration	1	**Institution**	Institut für Werkzeugmaschinen und Fertigungstechnik
Hours per Week / ECTS	4 / 7,0	**Module owner**	Prof. Dr. Christoph Herrmann
Workload (h)	210		
Class attendance (h)	56	**Self studying (h)**	154
Compulsory requirements			
Expected performance/ Type of examination	1 examination element: written exam (120 min) or oral exam (30 min)		
Course achievement	2 academic achievements: a) Written elaboration of a team project b) Written elaboration of the practical laboratory work		

Contents

Providing knowledge of the fundamentals of Life Cycle Assessment (theory and practice):
- Environmental impacts in the product life cycle, ecological hotspots and optimization potential
- LCA steps according to ISO 14040/44
- Learn how to conduct a Life Cycle Inventory
- Learn how to conduct a Life Cycle Impact Assessment
- Problem Shifting
- Learn how to critically assess and review LCAs
- Use of numerous examples especially from the automotive industry and on e-mobility
- Critical review

Objective qualification

After completing the module, they will be familiar with product life cycles and environmental impacts in the product life cycle, be able to identify ecological hotspots and optimization potentials in the product life of various products and understand the problem shifting issue. They know the fields of application and methodology of life cycle assessment, its theoretical background and ISO 14040/44. They can carry out the individual steps of a life cycle assessment themselves as well as identify factors that influence the result of a life cycle assessment and thus critically evaluate the life cycle assessment studies of others. In addition to the methodological basics, a wide range of application examples from the automotive sector, in particular electromobility, are discussed. Furthermore, fields of application such as Environmental Product Declarations (EPD), Product Environmental Footprint Category Rules (PEFCRs) and Organization Environmental Footprint Sector Rules (OEFSRs) are presented. By designing the exercise as a project task, students acquire additional qualifications in terms of teamwork and project management as well as with regard to the life cycle assessment software Umberto.

Literature

1. Hauschild, M., Rosenbaum, R.K. & Olsen, 2018. Life Cycle Assessment - Theory and Practice
2. ISO 14040/44
3. ILCD Handbook
4. eLCAr-Guidelines

5. Cerdas, F., Egede, P., & Herrmann, C. (2018). LCA of Electromobility. In Life Cycle Assessment - Theory and Practice. Springer International Publishing.

↑

Related courses

Rules for the choice of courses

Only one of the two labs "Computational Modeling in Life Cycle Assessment" or "Mobile Software Applications in Sustainable Manufacturing and Life Cycle Engineering" must be taken.

Compulsory attendance

Name of the course	SWS	Eventtype	Language
	2,0	Lecture	english
	1,0	Exercise	english
	1,0	Laboratory	english
	1,0	Laboratory	english

Title	Material Resources Efficiency in Engineering		
Number	2522500	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	Fakultät für Maschinenbau
Module duration	1	**Institution**	
Hours per Week / ECTS	3 / 5,0	**Module owner**	
Workload (h)	150		
Class attendance (h)	42	**Self studying (h)**	108
Compulsory requirements			
Recommended requirements	none		
Expected performance/ Type of examination	1 Examination element: Written exam (120 min) or oral examination (30 min)		
Course achievement	1 Course achievement: Final Presentation and report.		

Contents

- Introduction to the current use of natural resources in an industrial context and presentation of related energy and material flows as well as political, social, technological and economic challenges
- Methods and tools for holistic, lifecycle assessment and increasing material efficiency in industrial value stream
- Evaluation and classification of streams under ecological and economical aspects
- Overview of measures to reduce the energy consumption in each phase (e.g. raw material provisioning) and the entire life cycle
- Measures to reduce material losses in the material supply and product creation
- Drivers and opportunities to reduce material intensity (e.g., demand reduction, material and product substitution)
- Closed-loop approaches in product and material reuse and recycling (e.g. industrial metabolism, cradle-to-cradle)
- Areas of application and case studies
- Awareness of the ecological, economic and social relevance of global material flows for technical products from raw material extraction to recycling

Objective qualification

Students
#

- ... are able to classify the material flows for technical products in a global context and question the resulting consequences for the environment, economy and society #
- ... can analyse the process of raw material supply, processing, product manufacturing and use #
- ...are able to implement methods and tools (e.g. material flow analysis, life cycle assessment, life cycle costing) that enable a holistic, life cycle-oriented evaluation of material efficiency under different target sizes (ecological, economic, social) in the industrial value stream #
- ...can identify measures and approaches to increase material efficiency under the previously defined target variables and analyze which implementation challenges exist in the socio-economic and ecological environment #
- ...can identify the challenges associated with material substitution and argue why the entire product life cycle must be considered when choosing materials #

- ...can evaluate the ecological and economic relevance of the use of materials in technical products and services, identify key levers for improvement and anticipate potential implementation challenges

Literature

- Vorlesungsfolien (Powerpoint)
- Allwood J; Cullen J.: Sustainable Materials # With both eyes open
- Ashby, M. F.: Materials and the Environment # Eco-Informed Material Choice
- Herrmann C.: Ganzheitliches Life Cycle Management

Remark

This lecture and exercise will be held in English.

↑

Related courses

Rules for the choice of courses

The lecture or the written exam is an examination element and is graded. The exercise or case study work is a course achievement and must be documented.

Compulsory attendance

Name of the course	SWS	Eventtype	Language
Production engineering for sustainable materials	1,0	Exercise	english
Production engineering for sustainable materials	2,0	Lecture	english

Title	Sustainability in Engineering and Management		
Number	2522000030	**Module version**	
Shorttext		**Language**	english
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät für Maschinenbau
Module duration	1	**Institution**	Institut für Werkzeugmaschinen und Fertigungstechnik
Hours per Week / ECTS	3 / 5,0	**Module owner**	Prof. Dr. Christoph Herrmann
Workload (h)	150		
Class attendance (h)	42	**Self studying (h)**	108
Compulsory requirements			
Expected performance/ Type of examination	1 examination element: Presentation and written paper/report		
Course achievement	1 course achivement: (optional according to availability) Participation in exchange program		

Contents

The seminar deals with topics relating to sustainability in engineering and management. Students learn theoretical knowledge, tools and methods in order to be able to derive strategic recommendations for action for sustainability-oriented product and process design. The focus is on life cycle and circular economy-oriented thinking in local and global dimensions. Examples include the design of circular value creation networks, the application of sustainability assessment methods and the development of digitalization approaches. In addition to lecture blocks, there will be accompanying group work to consolidate the learning content and to apply methods and tools in an exemplary manner. Current scenarios are analyzed and evaluated, particularly from an ecological perspective, and solution strategies for more sustainable product and process design are developed in small groups. If possible, the seminar will be linked to an exchange program, for example with the Birla Institute of Technology and Science, Delhi, India or the University of Rhode Island, USA, provided suitable funding is available

Objective qualification

The Students
- can use the methods they have learned to identify examples of challenges that exist in relation to achieving sustainability goals.
- can use a specific industrial example to identify the need for action with regard to life cycle-oriented product and/or process design and develop suitable solutions, for example in the area of Industry 4.0.
- can explain how innovative technologies and methods, e.g. from the field of Industry 4.0, can contribute to achieving sustainability goals.
- are able to independently define goals in a practice-oriented study project, divide up work packages and work on them using various methods.
- can organize themselves in teams and implement the methods they have learned in the team.
- can view and evaluate their solutions from different perspectives.
- are able to present the solutions they have developed and discuss the results, selected methods and technologies.
- learn important skills in the field of intercultural cooperation, provided that the seminar can be combined with an exchange program in the respective semester.

Literature
References will be provided in the course.

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
Sustainability in Engineering and Management	2,0	Lecture	english
Sustainability in Engineering and Management	1,0	Team Project	english

Specialisation Coastal Engineering and Ocean Engineering

Title	Coastal Engineering		
Number	4398090	**Module version**	V1
Shorttext		**Language**	english german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Hydromechanik, Küsteningenieurwesen und Seebau
Hours per Week / ECTS	5 / 6,0	**Module owner**	Prof. Dr. Nils Goseberg
Workload (h)	180		
Class attendance (h)	70	**Self studying (h)**	110
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 min.)		
Course achievement	Term paper		

Contents

- Introduction to coastal engineering (sociological and ecological significance of the coastal zone, tasks and future of the coastal engineer)
- Linear and nonlinear wave theories, including areas of validity and application
- Wave transformation in shallow water (shoaling, refraction, breaking) and in interaction with obstacles (reflection, diffraction)
- Formation mechanisms of the sea state, including procedures for its parameterization and prediction
- Formation and prediction of tides in coastal areas and estuaries, including their special forms, significance and benefits
- Formation and prediction of storm surges and design water levels

Insight into the current state of research in various fields of coastal engineering

Objective qualification

After successful completion of the module, students will have a broad and solid basic knowledge of the mechanics of water waves and hydrodynamic processes in the coastal area, which enables them to determine the load, erosion and transport parameters for the required constructive and functional planning of engineering measures.
The students are able to use the linear and nonlinear theory of water waves to calculate the total wave induced current parameters and the associated effects on sediments, structures and other obstacles. By the mediated calculation basics for wave transformation the students can calculate the effects of the bottom in shallow water (shoaling, refraction, wave breaking) as well as of buildings and other obstacles (reflection, diffraction) on the parameters (height, length, direction) of the waves and their stability (refraction criterion) at the given planning location.
On the basis of the acquired basics of the origin, parameterization, mathematical/statistical description and prediction of the sea state, the students are able to determine the design waves for the functional and constructive planning. They can determine the design water levels on the basis of the acquired knowledge on the formation and prediction of tides on open coasts and in estuaries as well as of storm surges on the Ger-

man North Sea and Baltic Sea coasts. In the seminar, students are enabled to conduct scientific research and to present research results from current publications in an appropriate manner.

Literature

unter anderem / amongst others:

- Detailed Presentation Slides of the Lecture, Exercises, Solutions (PDF)
- Teaching Platform with educational videos, interactive diagrams, screencasts and lab videos (coastal.l-wi.tu-bs.de)
- Task Library of the Institute
- EAK (2003): Empfehlungen für Küstenschutzwerke. Die Küste, Heft 65, Heide i. Holstein.
- Oumeraci, H. (2001): Küsteningenieurwesen. Kapitel 12 in: Lecher, K. et al.: Taschenbuch der Wasserwirtschaft, Berlin.
- CEM (2008): Coastal Engineering Manual. Washington, D.C: U.S. Army Corps of Engineers, Online-Ressource.
- Dean, Robert G.; Dalrymple, Robert A. (1991): Water wave mechanics for engineers and scientists. Advanced Series on Ocean Engineering, Singapore: World Scientific.
- Goda, Yoshimi (2010): Reanalysis of regular and random breaking wave statistics. Coastal Engineering Journal, vol. 52, no.1, JSCE.

Remark

In the Seminar in Coastal Engineering on the topic Data Science & Coastal Engineering, an introduction is given to the use of Python as a universal tool for the evaluation and presentation of data; students will implement and evaluate data and methods from the lecture. The successful completion and submission of code implementations will be credited as study achievement (Studienleistung).

↑

Related courses

Rules for the choice of courses

Compulsory attendance

Name of the course	SWS	Eventtype	Language
	4,0	Lecture/Exercise	english german
	1,0	Lecture/Exercise	english german

Title	Coastal Dynamics and Engineering Design		
Number	4398100	**Module version**	
Shorttext		**Language**	english german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Hydromechanik, Küsteningenieurwesen und Seebau
Hours per Week / ECTS	5 / 6,0	**Module owner**	Prof. Dr. Nils Goseberg
Workload (h)	180		
Class attendance (h)	70	**Self studying (h)**	110
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.)		
Course achievement	Presentation (20 Min.)		

Contents

-Sedimentological and coastal morphological basics (coastal shapes and formations, initiation of motion, suspension and transport of sediments).
-Longitudinal and transverse coastal transport by sea state (significance, calculation methods, applications and limitations).
-Local morphological processes (processes of interaction between sea state, structure and sediment, calculation of scour, windward landfall and leeward erosion)

-Wave protection structures and offshore structures (structure types, operation, loading, design, and construction).
-Innovative structures (development process based on examples)
-Hydraulic laboratory practice as a planning tool

-Insight into the current state of research in diverse fields of coastal engineering

Objective qualification

After completing the module, students will be able to use hydraulic fundamentals to determine the loading and transport variables for sediments and other substances in the coastal zone as well as the effects on coastal structures and other marine engineering facilities.
The fundamentals of sediment transport enable students to calculate natural and structure-induced coastal morphological changes. Determination of longitudinal and transverse coastal transport makes it possible to predict and justify changes in coastal profile and shoreline caused by storm surges and other nearshore currents.
Understanding local morphological processes and qualitatively recording them will enable students to predict the effects and impacts of engineering activities (scour, landfall, coastal erosion, and coastal recession).

With the acquired knowledge of coastal and flood protection structures, their mode of operation and the procedures for their hydraulic loading by sea states as well as their design and construction, the students are able to prepare themselves for the special features of the constructive tasks of the coastal engineer. Since these tasks do not stop in the coastal area, they will likewise learn the specifics of offshore structures in terms of loading and design. An overview of innovative wave protection structures and offshore structures

as well as their development enables the students to apply the acquired knowledge of the processes involved in the interaction between sea state, structure and sediment to the development of innovative designs.

Through the introduction to the basics of hydraulic laboratory practice and the practical application using some examples, students have sufficient knowledge to optimize functional and structural design.

In the seminar, students will be able to conduct scientific research and present research results from current publications in an appropriate manner.

Literature

unter anderem / amongst others:
- Detailed Presentation Slides of the Lecture, Exercises, Solutions (PDF)
- Teaching Platform with educational videos, interactive diagrams, screencasts and lab videos (coastal.lwi.tu-bs.de)
- Task Library of the Institute
- EAK (2003): Empfehlungen für Küstenschutzwerke. Die Küste, Heft 65, Heide i. Holstein.
- Oumeraci, H. (2001): Küsteningenieurwesen. Kapitel 12 in: Lecher, K. et al.: Taschenbuch der Wasserwirtschaft, Berlin.
- CEM (2008): Coastal Engineering Manual. Washington, D.C: U.S. Army Corps of Engineers, Online-Ressource.
- Dean, Robert G.; Dalrymple, Robert A. (1991): Water wave mechanics for engineers and scientists. Advanced Series on Ocean Engineering, Singapore: World Scientific.
- Goda, Yoshimi (2010): Reanalysis of regular and random breaking wave statistics. Coastal Engineering Journal, vol. 52, no.1, JSCE.

Remark

In the Seminar in Coastal Engineering, students should get an insight into research-oriented studies by working out and discussing presentations of publications. During the discussion, both students and staff members will give advice on how students can further improve their skills in scientific research and their presentation skills. The Seminar in Coastal Engineering is therefore compulsory, since the qualification goals for all students can only be achieved if the students actively participate in the presentation and discussion phase. The presentation will be held in English.

↑

Related courses

Rules for the choice of courses

Compulsory attendance

Name of the course	SWS	Eventtype	Language
	4,0	Lecture/Exercise	english german
	1,0	Seminar	english

Title	Sustainable Ocean Engineering		
Number	3321400000	**Module version**	
Shorttext		**Language**	english
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Hydromechanik, Küsteningenieurwesen und Seebau
Hours per Week / ECTS	5 / 6,0	**Module owner**	Prof. Dr. Nils Goseberg
Workload (h)	180		
Class attendance (h)	70	**Self studying (h)**	110
Compulsory requirements			
Expected performance/ Type of examination	Written Exam+ (90min)		
Course achievement	Home Assignment A term paper is completed as coursework, which can count for 20% of the final grade for the module. The application for an exam+ must be submitted by the student at the start of the examination. You will receive more detailed information on the term paper in the courses of the module.		

Contents

- Introduction to ocean engineering and offshore structures (classification, definitions), as well as aspects of sustainability in ocean engineering
- Fundamental of loading on fixed offshore structures (example system, loads on a monopile for wind energy conversion, definition of relevant parameters, Morison equation, design load cases)
- Calculation of scour (analytical, experimental and numerical methods) and scour-induced failure (using the example of a founded pile)
- Seabed liquefaction around marine structures (fundamentals and calculation methods)
- Fundamentals of loading on and movement of floating offshore structures (example systems, definition of relevant parameters, loads on a floating structure for renewable energy generation, linear potential theory, equation of motion and Cummins equation, modelling in the frequency and time domain)
- Mooring and anchor systems (load calculation, mooring design and dynamics)
- Life-cycle assessment and environmental impact
- Sustainable research aspects and innovative offshore structures

Objective qualification

After completing the module, students will have a broad and solid knowledge of the design, loading, and dynamics of offshore structures, as well as aspects of sustainability in the field of offshore engineering.
The basics of calculating loads on fixed offshore structures enables students to perform initial designs of such structures. Using the example of offshore wind, the basic parameters are taught and relevant calculation methods are derived.
Also using the example of offshore wind, students are taught the aspect of scour formation and the relevant calculation principles. Particular attention is paid to the various analysis methods. The consideration of morphodynamic processes is extended by teaching the fundamentals of seabed

liquefaction around marine structures. This content enables students to make basic predictions of failures and morphodynamic processes.
In addition to fixed offshore structures, students are taught the basics on loads and motion of floating offshore structures. Using examples of floating structures for marine renewable energy generation (e.g. ocean wave energy or floating photovoltaics), the basics of linear potential theory, equation of motion and Cummins equation are explained. The additional knowledge on the application of the governing equations and modelling of motions of simple floating structures enables students to design simple, floating systems in the offshore environment.
As part of the fundamentals of floating offshore structures, the module also addresses the mooring and anchoring of such systems and provides students with basic knowledge of load calculation, mooring design and dynamics.
Finally, the module specifically covers aspect of sustainability of systems in offshore engineering and the basics of life-cycle assessment and environmental impact, in order to enable students to make assessments regarding the sustainability of offshore structures.

Literature

unter anderem / amongst others:
- Detailed Presentation Slides of the Lecture, Exercises, Solutions (PDF)
- O.M. Faltinsen (1993): Sea loads on ships and offshore structures
- J. Falnes (2010): Ocean Waves and Oscillating Systems

↑

Related courses

Rules for the choice of courses

Compulsory attendance

Name of the course	SWS	Eventtype	Language
Sustainable Ocean Engineering	5,0	Lecture/Exercise	english

Title	Advanced Coastal Engineering 1		
Number	4398110	**Module version**	V1
Shorttext		**Language**	english german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Hydromechanik, Küsteningenieurwesen und Seebau
Hours per Week / ECTS	6 / 6,0	**Module owner**	Prof. Dr. Nils Goseberg
Workload (h)	180		
Class attendance (h)	84	**Self studying (h)**	96
Compulsory requirements			
Expected performance/ Type of examination	oral exam (approx. 60 Min.) or 2 oral exams (30 Min. each)		
Course achievement			

Contents

[Practical Course in Coastal Engineering (P)]
EIntroduction to measurement and experimental techniques in coastal hydraulic engineering, planning and execution of model tests (standard tests and current projects), acquisition and analysis of measurement data, evaluation of model tests.

[Ecohydraulic Processes from Field to Laboratory (P)]
Ecosystems and coastal ecohydraulic processes, stages of the research cycle with individual work steps, basics of literature research, development of research questions, introduction to measurement and experimental techniques for ecohydraulic field measurements in coastal hydraulic engineering, basics of field study planning, planning and conducting a field study, acquisition and analysis of measurement data, Analysis and evaluation of a field study, scientific elaboration and presentation of research results, peer review of scientific papers, scale laws, introduction to measurement and experimental techniques for ecohydraulic laboratory measurements in coastal hydraulic engineering, basics of laboratory study planning, planning of laboratory experiments by transfer field observations.

[Harbour Planning and Maritime Waterways Engineering (B)]
Characteristics, tasks and importance of waterways, tidal dynamics, hydraulic engineering system analysis, river engineering measures and concepts for estuaries, maintenance of waterways as well as interactions between seagoing vessels and shipping lanes.
Planning, management and operation of seaports, problems and future perspectives of a port location, Dimensioning of a container terminal

[Coastal Engineering and Coastal Protection at the North Sea and the Baltic Sea (B)]
Historical development of coastal protection, special features of coastal protection in the North Sea and Baltic Sea regions, strategies and official organization of coastal protection, current projects of island and coastal protection.

[Spectral Analysis of nonlinear Waves in the Coastal Area (VÜ)]
Linear and nonlinear wave theories, cnoidal waves and theta functions, basics of Fourier and Hilbert-Huang transforms, basics and algorithms of direct and inverse nonlinear Fourier transformation, advantages and disadvantages of the different analysis methods, application of the methods to different examples

of surface waves and different problems from coastal engineering, interpretation of the obtained spectra, comparative analyses, discussion and evaluation of the result.

[Tsunami engineering (V)]
Tsunami hazard and risk, tsunami phenomena (definition, main tsunami characteristics compared to wind-induced waves, tsunami classification, intensity scales), tsunami generation mechanisms, tsunami propagation and inundation (tsunami characteristics in deep and shallow water, coastal manifestations, tsunami runup), tsunami impact on the coast (tsunamigenerated forces, impact on buildings, environment and society), historical tsunami events, tsunami coastal protection measures (structural, non-structural protection measures, hybrid protection systems), disaster management and land use planning, visions of tsunami-resilient cities, tsunami generation in the laboratory, numerical modeling of tsunamis, tsunami research at LWI.

[Numerical Modeling of Coastal Processes (VÜ)]
Overview of current modeling methods (SPH, Reef3D, Delft3D, Mike, Telemac, SMS, Untrim) their applications, limitations and recent developments. Fundamentals of numerical modeling, numerical modeling of sea state, wave action equation, mild slope equation, phase-averaged and phase-resolved wave modeling, tidal flow, transport processes of sediments and salt, modeling of erosion processes and coastal barrier failure due to storm surges, applications of open source and internationally accepted numerical models for modeling with e.g. Delft3D, SWAN and XBeach.

Objective qualification

Upon completion of the module, students will have the knowledge of how to apply the course contents from the modules Basic Coastal Engineering and Coastal Dynamics and Engineering Design in practice. They are able to carry out the planning, execution and evaluation of hydraulic model tests as a tool for planning tasks. Based on the internship they have carried out themselves, they can develop appropriate solutions, propose them appropriately and evaluate and assess the results professionally based on their knowledge of the hydrodynamic and morphological processes in coastal areas.
Students will know the principles of construction and operation of ports, harbor facilities, and marine waterways. Due to the excursions in the different areas, the students have the knowledge of how complex problems are optimally solved in practice. The students know the similarities and special features of coastal and flood protection on the German North Sea and Baltic Sea coasts. Due to the excursions in the different areas, the students have the knowledge of how complex problems are optimally solved in practice.
Students will know advanced fundamentals as well as practical examples of theory and application of new nonlinear analysis methods of waves in coastal areas and will be able to interpret obtained analysis results.
The students know the physical processes underlying the interactions between the fluid, the structure and the seabed. They will know the main approaches to numerical modeling of these processes and the coupling of different models. Students will be able to apply different open source tools for fluid-structure-seabed modeling.
Students will know the characteristics of tsunamis in the phases from tsunami generation to coastal inundation. They can define tsunami hazards and risks and classify the damage caused and failure mechanisms of structures based on the forces exerted. Based on examples of implemented protection strategies in tsunami-prone countries, they have the knowledge of available protection measures and their advantages and disadvantages. The students know the laboratory methods and
numerical tools for the simulation of tsunamis.

Literature

unter anderem/amongst others:
- Skripte und Vortragspräsentationen zu den einzelnen Lehrveranstaltungen
- NLWKN (2010): Generalplan Küstenschutz Niedersachsen - Ostfriesische Inseln-. Niedersächsisches Landesamt für Wasserwirtschaft, Küsten- und Naturschutz, Norden.
- LU (2009): Regelwerk Küstenschutz Mecklenburg-Vorpommern. Ministerium für Landwirtschaft, Umwelt und
Verbraucherschutz, Rostock.

- EAU (2012): Empfehlungen des Arbeitsausschusses Ufereinfassungen, Häfen und Wasserstraßen. Hafenbautechnische Gesellschaft, Deutsche Gesellschaft für Erd- und Grundbau,11. Auflage, Berlin.
- EAK (2002): Empfehlungen für Küstenschutzwerke. Die Küste, Heft 65, Heide i. Holstein.
- Kuratorium für Forschung im Küsteningenieurwesen (2008): Archiv für Forschung und Technik an der Nord- und Ostsee. Die Küste, Heft 74, Heide i. Holstein.
- Kahlfeld, A., Schüttrumpf, H. (2006): Auswirkungen des JadeWeserPorts auf die Tide- und Morphodynamik der Jade, PIANC Kongress, Estoril
- Kondziella, B., Uliczka, K. (2006): Dynamisches Fahrverhalten sehr großer Containerschiffe unter extremen
Flachwasserbedingungen, PIANC Kongress, Estoril
- Brühl, M. (2014): Direct and inverse nonlinear Fourier transform based on the Korteweg-deVries equation (KdV-NLFT) - A spectral analysis of nonlinear surface waves in shallow water. Dissertation.
- Dean, R.G.; Dalrymple, R.A. (1991): Water Wave Mechanics for Engineers and Scientists. Advanced Series on Ocean Engineering - Volume 2, Singapore: World Scientific, 353 pp.
- Huang, N.E.;Shen, Z.;Long, S.R.;Wu, M.C.;Shih, H.H.;Zheng, Q.;Yen, N.-C.;Tung, C.C.; Liu, H.H. (1998): The empirical mode decomposition and the Hilbert spectrum for nonlinear and non-stationary time series analysis. London: Proceedings of the Royal Society of London A, vol. 454, pp. 903-995.
- Osborne, A. (2010): Nonlinear ocean waves and the inverse scattering transform. Amsterdam: Elsevier, 977 pp.
-Bernard, E.N., Robinson, A.R. (2009): Tsunamis. The sea, Vol. 15. Harvard Univ. Press.
-Camfield, F. (1980): Tsunami engineering. Fort Belvoir.
-Santiago-Fadiño, V., Kontar, Y.A., Kaneda, Y. (2015): Post-tsunami hazard. Reconstruction and restoration. Advances in Natural and Technological Hazards Research.
-Holthuijsen, L.H. (2010): Waves in Oceanic and Coastal Waters. Cambridge University Press; 1 edition, 404 pp.
-Roelvink, D., and Reniers, A. (2012). A guide to modelling coastal morphology. World Scientific, 292pp.

Remark

↑

Related courses

Rules for the choice of courses

Taking the Practical Course in Coastal Engineering (Studienleistung) is mandatory. From the other six courses, either Ecohydraulic Processes from Field to Laboratory or two of the other courses must be selected and taken

Compulsory attendance

Name of the course	SWS	Eventtype	Language
	2,0	Internship	english german
	2,0	Block course	german
	3,0	Block course	german
	2,0	Block course	german
	2,0	Lecture	english
	2,0	Lecture/Exercise	english
	4,0	Internship	german

Title	Advanced Coastal Engineering 2		
Number	4398120	**Module version**	V1
Shorttext		**Language**	english german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Hydromechanik, Küsteningenieurwesen und Seebau
Hours per Week / ECTS	6 / 6,0	**Module owner**	Prof. Dr. Nils Goseberg
Workload (h)			
Class attendance (h)	84	**Self studying (h)**	96
Compulsory requirements			
Expected performance/ Type of examination	Oral exam (approx. 60 Min.) or 2 oral exams (approx. 30 Min. each)		
Course achievement			

Contents

[Harbour Planning and Maritime Waterways Engineering (B)]
Characteristics, tasks and importance of waterways, tidal dynamics, hydraulic engineering system analysis, river engineering measures and concepts for estuaries, maintenance of waterways as well as interactions between seagoing vessels and shipping lanes.
Planning, management and operation of seaports, problems and future perspectives of a port location, Dimensioning of a container terminal

[Coastal Engineering and Coastal Protection at the North Sea and the Baltic Sea (B)]
Historical development of coastal protection, special features of coastal protection in the North Sea and Baltic Sea regions, strategies and official organization of coastal protection, current projects of island and coastal protection.

[Spectral Analysis of nonlinear Waves in the Coastal Area (VÜ)]
Linear and nonlinear wave theories, cnoidal waves and theta functions, basics of Fourier and Hilbert-Huang transforms, basics and algorithms of direct and inverse nonlinear Fourier transformation, advantages and disadvantages of the different analysis methods, application of the methods to different examples of surface waves and different problems from coastal engineering, interpretation of the obtained spectra, comparative analyses, discussion and evaluation of the result.

[Tsunami engineering (V)]
Tsunami hazard and risk, tsunami phenomena (definition, main tsunami characteristics compared to wind-induced waves, tsunami classification, intensity scales), tsunami generation mechanisms, tsunami propagation and inundation (tsunami characteristics in deep and shallow water, coastal manifestations, tsunami runup), tsunami impact on the coast (tsunamigenerated forces, impact on buildings, environment and society), historical tsunami events, tsunami coastal protection measures (structural, non-structural protection measures, hybrid protection systems), disaster management and land use planning, visions of tsunami-resilient cities, tsunami generation in the laboratory, numerical modeling of tsunamis, tsunami research at LWI.
[Numerical Modeling of Coastal Processes (VÜ)]
Overview of current modeling methods (SPH, Reef3D, Delft3D, Mike, Telemac, SMS, Untrim) their applications, limitations and recent developments. Fundamentals of numerical modeling, numerical modeling of sea state, wave action equation, mild slope equation, phase-averaged and phase-resolved wave modeling, tidal

flow, transport processes of sediments and salt, modeling of erosion processes and coastal barrier failure due to storm surges, applications of open source and internationally accepted numerical models for modeling with e.g. Delft3D, SWAN and XBeach.

Objective qualification

Upon completion of the module, students will have the knowledge of how to apply the course contents from the modules Basic Coastal Engineering and Coastal Dynamics and Engineering Design in practice. They are able to carry out the planning, execution and evaluation of hydraulic model tests as a tool for planning tasks. Based on the internship they have carried out themselves, they can develop appropriate solutions, propose them appropriately and evaluate and assess the results professionally based on their knowledge of the hydrodynamic and morphological processes in coastal areas.
Students will know the principles of construction and operation of ports, harbor facilities, and marine waterways. Due to the excursions in the different areas, the students have the knowledge of how complex problems are optimally solved in practice. The students know the similarities and special features of coastal and flood protection on the German North Sea and Baltic Sea coasts. Due to the excursions in the different areas, the students have the knowledge of how complex problems are optimally solved in practice.
Students will know advanced fundamentals as well as practical examples of theory and application of new nonlinear analysis methods of waves in coastal areas and will be able to interpret obtained analysis results.
The students know the physical processes underlying the interactions between the fluid, the structure and the seabed. They will know the main approaches to numerical modeling of these processes and the coupling of different models. Students will be able to apply different open source tools for fluid-structure-seabed modeling.
Students will know the characteristics of tsunamis in the phases from tsunami generation to coastal inundation. They can define tsunami hazards and risks and classify the damage caused and failure mechanisms of structures based on the forces exerted. Based on examples of implemented protection strategies in tsunami-prone countries, they have the knowledge of available protection measures and their advantages and disadvantages. The students know the laboratory methods and
numerical tools for the simulation of tsunamis.

Literature

unter anderem/amongst others:

- Skripte und Vortragspräsentationen zu den einzelnen Lehrveranstaltungen
- NLWKN (2010): Generalplan Küstenschutz Niedersachsen - Ostfriesische Inseln-. Niedersächsisches Landesamt für Wasserwirtschaft, Küsten- und Naturschutz, Norden.
- LU (2009): Regelwerk Küstenschutz Mecklenburg-Vorpommern. Ministerium für Landwirtschaft, Umwelt und Verbraucherschutz, Rostock.
- EAU (2012): Empfehlungen des Arbeitsausschusses Ufereinfassungen, Häfen und Wasserstraßen. Hafenbautechnische Gesellschaft, Deutsche Gesellschaft für Erd- und Grundbau,11. Auflage, Berlin.
- EAK (2002): Empfehlungen für Küstenschutzwerke. Die Küste, Heft 65, Heide i. Holstein.
- Kuratorium für Forschung im Küsteningenieurwesen (2008): Archiv für Forschung und Technik an der Nord- und Ostsee. Die Küste, Heft 74, Heide i. Holstein.
- Kahlfeld, A., Schüttrumpf, H. (2006): Auswirkungen des JadeWeserPorts auf die Tide- und Morphodynamik der Jade, PIANC Kongress, Estoril
- Kondziella, B., Uliczka, K. (2006): Dynamisches Fahrverhalten sehr großer Containerschiffe unter extremen Flachwasserbedingungen, PIANC Kongress, Estoril
- Brühl, M. (2014): Direct and inverse nonlinear Fourier transform based on the Korteweg-deVries equation (KdV-NLFT) - A spectral analysis of nonlinear surface waves in shallow water. Dissertation.
- Dean, R.G.; Dalrymple, R.A. (1991): Water Wave Mechanics for Engineers and Scientists. Advanced Series on Ocean Engineering - Volume 2, Singapore: World Scientific, 353 pp.
- Huang, N.E.;Shen, Z.;Long, S.R.;Wu, M.C.;Shih, H.H.;Zheng, Q.;Yen, N.-C.;Tung, C.C.; Liu, H.H. (1998): The empirical mode decomposition and the Hilbert spectrum for nonlinear and non-stationary time series analysis. London: Proceedings of the Royal Society of London A, vol. 454, pp. 903-995.
- Osborne, A. (2010): Nonlinear ocean waves and the inverse scattering transform. Amsterdam: Elsevier, 977 pp.
- Bernard, E.N., Robinson, A.R. (2009): Tsunamis. The sea, Vol. 15. Harvard Univ. Press.

- Camfield, F. (1980): Tsunami engineering. Fort Belvoir.
- Santiago-Fadiño, V., Kontar, Y.A., Kaneda, Y. (2015): Post-tsunami hazard. Reconstruction and restoration. Advances in Natural and Technological Hazards Research.
- Holthuijsen, L.H. (2010): Waves in Oceanic and Coastal Waters. Cambridge University Press; 1 edition, 404 pp.
- Roelvink, D., and Reniers, A. (2012). A guide to modelling coastal morphology. World Scientific, 292pp.

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Block course	german
	3,0	Block course	german
	2,0	Block course	german
	2,0	Lecture	english
	2,0	Lecture/Exercise	english

Specialisation Geodetic Monitoring and Geoinformation

Title	Photogrammetry		
Number	4310690	**Module version**	V1
Shorttext		**Language**	english german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Geodäsie und Photogrammetrie
Hours per Week / ECTS	4 / 6,0	**Module owner**	
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	written exam+ (90 min) or oral exam+ (30 min)		
Course achievement	term paper During the lecture period, several term papers are offered, which are graded. The average grade counts for 50% of the final grade for the module. The application for an exam+ must be submitted by the student at the end of the lecture period. Further information on deadlines for the submission of assignments is provided in the courses of the module.		

Contents

- the geometry of the perspective image
- projection from 3D space into the image
- image orientation and bundle block adjustment
- dense point matching and derived products
- ortho projection
- UAV (drone)-based photogrammetry
- practical examples and (programming) exercises in which typical fields of application are addressed.

Objective qualification

Photogrammetry is the science that derives geometric and semantic information from images. In this course, basic knowledge and methods are taught so that the participating students are able to independently capture, evaluate and analyze data. Commercial products are used in the exercise to demonstrate the processing steps. To reinforce the methodological understanding, individual tasks are also solved as part of small programming tasks. Some tasks are defined mandatory (*Studienleistung*)

Literature

Wird während der Vorlesung bekanntgegeben

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
Photogrammetry	4,0	Lecture/Exercise	english german

Title	Remote Sensing		
Number	3324000000	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Geodäsie und Photogrammetrie
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Markus Gerke
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Portfolio		
Course achievement			

Contents

-physical principles
-selected sensors of multispectral remote sensing
-backscatter values and indices
-Classification methods
-Change detection
-Terrestrial microwave interferometry
-Radar remote sensing and SAR interferometry
-Intensity and coherence analysis of radar data
-Multi-temporal evaluation processing of radar interferometry

Objective qualification

Students are taught basic theoretical knowledge, acquisition and analysis methods of multispectral and radar remote sensing. Through the combination of lectures and application-related exercises in the PC pool, students acquire the competence to independently derive selected questions regarding the determination of basic states and changes of the earth's surface on the basis of multispectral satellite data. The evaluation and analysis of radar data extends their skills to the area of geometric monitoring of changes in the earth's surface and infra-structural objects.

Literature

Wird während der Vorlesung bekanntgegeben.

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Engineering surveying		
Number	3324000010	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Geodäsie und Photogrammetrie
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Markus Gerke
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Portfolio		
Course achievement			

Contents

Geodetic Sensors:
- Automated total stations for monitoring tasks
- Basics of laser scanning: methodology, technology, systems
- Use of GNSS for monitoring tasks
- Sensor networks
- Typical fields of application, practical examples and exercises

Evaluation Methods:
- Coordinate calculation
- Variance propagation
- Introduction to the adjustment theory
- Analysis of epochal solutions
- Basics of time series analysis

Objective qualification

Geodetic Sensors:
- Automated total stations for monitoring tasks
- Basics of laser scanning: methodology, technology, systems
- Use of GNSS for monitoring tasks
- Sensor networks
- Typical fields of application, practical examples and exercises

Evaluation Methods:
- Coordinate calculation
- Variance propagation
- Introduction to the adjustment theory
- Analysis of epochal solutions
- Basics of time series analysis

Literature

Literature will be announced and provided during lectures

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
Geodetic Sensors	2,0	Lecture/Exercise	german
	2,0	Lecture/Exercise	german

Title	Image Processing and Interpretation		
Number	3324000030	**Module version**	
Shorttext		**Language**	english
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Geodäsie und Photogrammetrie
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Markus Gerke
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	written exam (90 min) or oral exam (30 min)		
Course achievement	term paper		

Contents

[Image Processing]
- image formation
- pixel operations
- linear and non-linear filters
- image segmentation
- morphology
- Typical fields of application, practical examples and exercises

[Image Interpretation]
-Supervised classification
-Unsupervised classification
-dimensionality reduction
-pixel-based and object-based approaches
- Typical fields of application, practical examples and exercises

Objective qualification

[Image Processing]
In this lecture/excercise, students are introduced to digital image processing, including the application of filters or operators that improve the image or represent a pre-processing step for image interpretation. Basic knowledge and methods are taught in the courses so that the participating students are able to independently record, evaluate and analyze data.

[Image Interpretation]
This course provides basic knowledge of methods for extracting information from images. It deals with supervised and unsupervised classification, as well as techniques for dimension reduction. Furthermore, a distinction is made between approaches that classify individual pixels and those that generate an object-based description. Basic knowledge and methods are taught in the courses so that the participating students are able to collect, evaluate and analyze data independently.

To reinforce the methodological understanding, individual tasks are also solved as part of small programming tasks. Some tasks are defined mandatory (*Studienleistung*)
Literature
Literature will be provided during lectures

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture/Exercise	english
	2,0	Lecture/Exercise	english

Title	Geoinformatics		
Number	3324000020	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Geodäsie und Photogrammetrie
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Markus Gerke
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Portfolio		
Course achievement			

Contents

- Web technologies (HTML, CSS, JavaScript)
- WebGIS frameworks (e.g. Leaflet)
- Geodata formats (GeoJSON)
- Working with map services (WMS / WFS)
- Practical experience with geodatabases
- Publishing, integrating and editing geodata in web-based systems
- Creation of REST APIs
- Development of mobile, map-based web applications

Objective qualification

In this module, theoretical and practical fundamental skills for the creation of web-based applications for the visualization and analysis of geodata are taught. In addition to the general technologies/frameworks that can be used to create a web application (HTML, CSS, Ja-vaScript), the course focuses on WebGIS components that can be used to implement map-centered web applications. In addition, server-side components such as geodatabases, map services and REST APIs are covered. Students gain a comprehensive overview of distributed systems for the visualization, collection and storage of geoinformation. In a final project, students apply the skills they have learned independently and implement a web application in the group based on predefined criteria.

Literature

Scott, A. D., MacDonald, M., & Powers, S. (2021). JavaScript cookbook (Third edition.). O'Reilly

Weitere Literatur und ein Vorlesungsskript werden zu Beginn der Veranstaltung bekannt gegeben bzw. bereitgestellt.

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Specialisation Modelling Flow and Transport in the Critical Zone

Title	Transport Processes in the Environment: Fundamentals and Modelling		
Number	3328200040	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung für Bodenwissenschaften
Hours per Week / ECTS	4 / 6,0	**Module owner**	Dr. Sascha Iden
Workload (h)	180		
Class attendance (h)	40	**Self studying (h)**	140
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Contents			
Objective qualification			
Literature			

Imboden & Koch (2003): Systemanalyse – Eine Einführung in die mathematische Modellierung natürlicher Systeme, Springer.

Jury & Horton (2004): Soil Physics, John Wiley & Sons, 384 Seiten. [Lehrbuchsammlung]

Munz & Westermann (2019): Numerische Behandlung gewöhnlicher und partieller Differenzialgleichungen, ein anwendungsorientiertes Lehrbuch für Ingenieure, Springer.

Press, Flannery, Teukolsky & Vetterling (1992): Numerical Recipes, Cambrige University Press.

D. E. Radcliffe und J. Simunek (2010): Soil Physics with Hydrus. Modeling and Applications. CRC Press

Richter, Diekkrüger und Nörteshäuser (2007): Environmental Fate of Pesticides: From the Laboratory to the Field Scale. Wiley Interscience und VCH, Weinheim.

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Inverse Modelling and Model Calibration		
Number	3328200050	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung für Bodenwissenschaften
Hours per Week / ECTS	4 / 6,0	**Module owner**	Dr. Sascha Iden
Workload (h)	180		
Class attendance (h)	40	**Self studying (h)**	140
Compulsory requirements			
Expected performance/ Type of examination	Written examination (120 min) or oral examination (30 min)		
Course achievement			

Contents

Linear regression in matrix notation
- Residual analysis, goodness-of-fit measures and model selection
- Calculation and interpretation of confidence and prediction intervals
- Collinearity analysis and parameter correlation
- Weighting of data points with different error variance
- Non-linear minimization in one and more dimensions
- Identifiability, stability and uniqueness of inverse problems
- Optimization of experimental designs
- Application of the methods to the following problems: Determination of sorption isotherms, degradation parame-ters and sorption kinetics, estimation of soil hydraulic properties, estimation of transport parameters from transport experiments in the laboratory and in the field

Objective qualification

The students...
- are able to independently apply methods of linear and non-linear regression to estimate parameters of water and mass transport and to implement them in the programming language PYTHON
- know the most important methods of iterative minimization of functions of several variables and are able to use them to solve practical problems, taking into account their advantages and disadvantages.
- are able to formulate and solve inverse problems for arbitrary problems and model types (linear and non-linear compartment models, transport models in the form of partial differential equations).
- can quantify the uncertainties of model parameters and model predictions in the form of confidence and predic-tion intervals, present them appropriately and interpret them statistically.
- are able to plan experiments to investigate the behavior of substances in the environment and optimize them with regard to their information content.
- can present, explain and interpret the results of independently conducted projects.

Literature

Draper und Smith (1998): Applied Regression Analysis, 3rd Ed., Wiley.
Fahrmeir, Kneib und Lang (2009): Regression. Modelle, Methoden und Anwendungen, Springer Verlag.

Hill und Tiedemann (2007): Effective groundwater model calibration. With analysis of data, sensitivities, predictions and uncertainty. Wiley-Interscience.
Press, Teukolsky, Vetterling und Flannery (1992): Numerical Recipes. The Art of Scientific Computing, Cambridge University Press.
Richter, Diekkrüger und Nörteshäuser (1996): Environmental Fate of Pesticides: From the Laboratory to the Field Scale. Wiley Interscience und VCH, Weinheim.

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Modelling of Water and Energy Fluxes in the Critical Zone		
Number	3328200060	**Module version**	
Shorttext		**Language**	english
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung für Bodenwissenschaften
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Ilhan Özgen
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90min) or oral exam (20min)		
Course achievement			

Contents

- Soil water budget
- Richardson-Richards equation
- Root water uptake
- Plant physiology, photosynthesis
- Plant hydraulics, van den Honert equation
- Evapotranspiration
- Water stress, vulnerability curves, hydraulic redistribution

Objective qualification

Upon completing this module, students will be able to quantitatively describe and predict the water flow through the soil-plant-atmosphere continuum and to model research questions in the field of plant hydraulics.

Literature

Baird & Wilby (2000) Eco-Hydrology, Routledge, Oxfordshire, UK.
Yin & Porporato (2021) Ecohydrology: Dynamics of Life and Water in the Critical Zone, Cambridge University Press, Cambridge, UK.

↑

Related courses

Rules for the choice of courses

Compulsory attendance

Name of the course	SWS	Eventtype	Language

	4,0	Lecture/Exercise	english

Title	Soil Water Assessment in the Field		
Number	3328200070	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung für Bodenwissenschaften
Hours per Week / ECTS	4 / 6,0	**Module owner**	Dr. Sascha Iden
Workload (h)	180		
Class attendance (h)	60	**Self studying (h)**	120
Compulsory requirements			
Expected performance/ Type of examination	Portfolio		
Course achievement			

Contents

1 Soil hydrology: basics, measurement techniques, modeling (V)
- The soil as a three-phase system, phase saturations, phase relationships
- Solid phase: mineralogy. Grain size distribution
- Water in the soil: Water content, water potential
- Measurement technology for recording water content and water potential
- Modeling water flow in the soil with the Richards equation
- Atmospheric boundary conditions and calculation of evapotranspiration

2 Soil hydrology field exercise (exercise)

Design and construction of a soil hydrological measuring station to record water dynamics in the unsaturated zone (tensiometry, water content sensors, soil temperature, soil water sampling devices, automatic data recording and data transmission).

Objective qualification

The students ...
- know the most important hydrological processes in soils and their model-based description using the laws of Buckingham-Darcy and Richards.
- know the physical principles of measuring water potential and water content in soil.
- are able to operate a meteorological measuring station and process the resulting data and convert it into atmos-pheric boundary condition for modeling and assessing the soil water balance.
- are able to independently design a measurement campaign in the field to record the soil water balance in the unsaturated soil zone and use suitable measuring instruments for the problem.
- are able to record and present the measurement results in the field, check the plausibility of the data and evalu-ate them using numerical simulation.
- can apply important soil hydrological measurement techniques in the laboratory and field and evaluate the result-ing data appropriately, e.g. HYPROP, PARIO, KSAT, infiltration measurements in the field, penetrometer meas-urements in the field, root analysis
- can compile and present the results of a measurement campaign in the field in the form of a presentation and a report.

Literature
Jury & Horton (2004): Soil Physics, John Wiley & Sons, 384 Seiten. [Lehrbuchsammlung] J.L. Monteith, M. Unsworth (2013): Principles of environmental Physics, 2nd Ed., Academic Press D. E. Radcliffe und J. Simunek (2010): Soil Physics with Hydrus. Modeling and Applications. CRC Press J.A. Tindall, J.R. Kunkel (1999): Unsaturated Zone Hydrology for Scientists and Engineers. Prentice-Hall Wessel-Bothe & Weihermüller (2020): Field Measurement Methods in Soil Science, Borntraeger

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	3,0	Exercise	german
	1,0	Lecture	german

Title	Urban Ecohydrology		
Number	1514300	**Module version**	
Shorttext		**Language**	english
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration	1	**Institution**	Abteilung für Bodenwissenschaften
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Ilhan Özgen
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.) or oral exam (20 Min.)		
Course achievement			

Contents

[Urban Ecohydrology (V)]
The lecture presents topics of ecohydrology in the urban area: urban groundwater, measurement and modelling techniques, decentralised stormwater management and green-blue infrastructure

[Urban Ecohydrology (Ü)]
The exercise consists of calculation exercises that are based on the lecture's topics. Part of the exercise is carried out using the programming language "R".

Objective qualification

Upon completing this module, students will be able to:

- apply theoretical knowledge of the effect of ecosystem services on the urban water cycle
- quantitatively solve ecohydrological problems in the urban area
- apply urban ecohydrological methods

Literature

Baird & Wilby (2000) Eco-Hydrology, Routledge, Oxfordshire, UK.

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**

	4,0	Lecture/Exercise	english
Literature			
Baird & Wilby (2000) Eco-Hydrology, Routledge, Oxfordshire, UK			

Specialisation Track-Guided Transportation Systems

Title	Planning a Construction Site on Railway Infrastructure		
Number	4398840	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Planung des öffentlichen Verkehrs
Hours per Week / ECTS	4 / 6,0	**Module owner**	Alejandro Tirachini Hernández
Workload (h)	180		
Class attendance (h)	54	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	2 Examinations: • Written exam (60 Min.) • Presentation		
Course achievement			

Contents

Railway construction in the conflict field of driving and building (V)
The students are taught the requirements for construction process planning. Each focal point is worked out using concrete projects as examples.

Planning a construction site on railway infrastructure (Ü)
Students learn how to use the SOG software to plan the construction process. The acquired skills are applied to an example within the framework of group work. For this purpose, a written copy is to be prepared and the results are to be presented in the context of a lecture.

Objective qualification

The students acquire a basic understanding of the boundary conditions from spatial planning and environmental protection, for the requirements of the different types of railway traffic and stakeholders, for the service phases in railway construction and for the interaction of the trades on a railway construction site. In addition, they gain an overview of the BIM method and its possible application in railway projects.
They acquire knowledge about maintenance strategies and the service life of superstructure components and can transfer these appropriately to new situations.
The students are able to draw up the necessary specifications for simple construction planning for individual trades, taking into account LCC considerations, and to carry out quantity and cost calculations for this. The necessary construction sequence planning and construction site logistics can be developed taking into account the standard timetable in the conflict field of driving and construction.

Literature

Scripts

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
Railway construction within the conflict between maintenance and traffic	2,0	Lecture	german
Planning a Construction Site on Railway Infrastructure	2,0	Exercise	german

Title	Railway Operation		
Number	4310610	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Eisenbahnwesen und Verkehrssicherung
Hours per Week / ECTS	5 / 6,0	**Module owner**	Prof. Dr. Lars Schnieder
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (60 Min.) or oral exam (approx. 30 Min.)		
Course achievement	Termpaper (approx. 30 h workload)		

Contents

- Basic operating terms and definitions
- Capacity research (capacity evaluation, analytical methods, simulation)
- Timetabling (traffic diagrams, time elements, running time calculation, planning of conflict-free train paths, cyclic timetables)
- Train path management (market structure, train path pricing, facility prices, station stop prices, train path requesting and assigning procedure)
- Traffic control (employees in traffic control, train movements in normal and degraded mode operations, shunting)
- Marshalling yards (purpose and structure of a marshalling yard, sorting procedure, hump dynamics, retarders)

Objective qualification

The students get profound knowledge on planning, management and control of train traffic. As employees of railway infrastructure companies or consulting firms, they are able to evaluate the operational capacity of the railway infrastructure, to select appropriate operational procedures, and to develop timetable concepts. They can take job positions in timetabling train path management and in supervision of train traffic control. They can also work in teams for the operational planning of construction and maintenance works. The students are familiar with the application of IT tools for capacity research and timetabling. They have the ability to evaluate the operational performance of railway lines and nodes under consideration of the constraints resulting from the infrastructure, and from signalling and vehicle constraints.

Literature

- Pachl, J.: Systemtechnik des Schienenverkehrs. 9. Aufl.,
- Vieweg Springer, Wiesbaden 2018, in der LV verteilte Materialien

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	5,0	Lecture/Exercise	german

Title	Railway Signalling		
Number	4310630	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Eisenbahnwesen und Verkehrssicherung
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Jörn Pachl
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (60 Min.) or oral exam (approx. 30 Min.)		
Course achievement	Term paper (approx. 30 h workload)		

Contents

- Relevant operational terms and definitions
- Systems safety criteria (classification of failures, human factors, safety strategies)
- Trackside elements controlled by signalling systems (lineside signals, points and crossings, line clear detection)
- Block systems (manual block systems, automatic block systems)
- Interlocking (route locking and release, flank protection, overlaps, interlocking systems)
- Automatic train protection (intermittent and continuous ATP, PZB 90, LZB , ETCS)
- Level crossings

Objective qualification

The students get a profound understanding of the fundamental elements and principles of railway signalling systems. As employees of railway infrastructure companies or engineering firms, they can select appropriate signalling technologies for a given use case and support the signal planning. As employees of a signalling manufacturing company, they can give advice to customers of how to apply signalling technology on their lines. Together with engineers of other trades, they can work in research & development teams of the signalling industry

Literature

- Maschek, U.: Sicherung des Schienenverkehrs - Grundlagen und Planung der Leit- und Sicherungstechnik, Springer Vieweg, Wiesbaden 2012
- Pachl, J.: Systemtechnik des Schienenverkehrs, 9. Aufl., Vieweg Springer, Wiesbaden 2018
- Theeg, G.; Vlasenko, S. (Hrsg).: Railway Signalling & Interlocking - International Compendium, Eurailpress, Hamburg 2009
- Naumann, P.; Pachl, J.: Leit- und Sicherungstechnik - Fachlexikon, 2. Aufl., Tetzlaff Verlag, Hamburg 2004

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	5,0	Lecture/Exercise	german

Title	Railway Signalling and Automation		
Number	4310630	**Module version**	V1
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Eisenbahnwesen und Verkehrssicherung
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Lars Schnieder
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (60 Min.) or oral exam (approx. 30 Min.)		
Course achievement	Term paper (approx. 30 h workload)		

Contents

The module provides fundamental and advanced knowledge of railway safety and automation with the aim of enabling safe, efficient, and increasingly automated rail operations. The starting point of the analysis is a systematic hazard prevention approach, from which the necessary functions and technical solutions for railway operations are derived. In the first part of the module, the functions of train operations across different grades of automation are examined. These functions include protection of train movements, driving the train, monitoring of the track ahead of the train, supervision of passenger exchange, operating the train, and ensuring the detection and management of emergency situations. Building on this, the second part of the module addresses higher-level functions for the control and supervision of railway operations. The focus is particularly on operational control and dispatching tasks, as well as the technical systems supporting them. Special emphasis is placed on understanding the interactions between technical systems, operational processes, and human actors in the context of controlling and monitoring train operations.

Objective qualification

Students acquire in-depth knowledge of the functionality of railway signalling and control systems across different grades of automation. They are able, as employees of a railway transport company or a design and engineering firm, to select suitable technologies and methods for railway operations for a planned application scenario and to contribute to the planning of safety-related railway applications. As employees in the railway industry, they are capable of advising customers on the selection of appropriate technologies and of working in development teams together with engineers from other disciplines.

Literature

-Maschek, U.: Sicherung des Schienenverkehrs - Grundlagen und Planung der Leit- und Sicherungstechnik, Springer
Vieweg, Wiesbaden 2012
-Pachl, J.: Systemtechnik des Schienenverkehrs, 9. Aufl., Vieweg Springer, Wiesbaden 2018
-Schnieder, L.: Communications-Based Train Control (CBTC) - Komponenten, Funktionen und Betrieb. 4. Auflage. Springer (Berlin) 2024
-Schnieder, L.: Einführung in das einheitliche europäische Zugbeeinflussungssystem. 4. Auflage. Springer (Berlin) 2024
-Theeg, G.; Vlasenko, S. (Hrsg).: Railway Signalling & Interlocking - International Compendium, Eurailpress, Hamburg
2009

-Naumann, P.; Pachl, J.: Leit- und Sicherungstechnik - Fachlexikon, 2. Aufl., Tetzlaff Verlag, Hamburg 2004

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Railway Operation Research and Traffic Management		
Number	4398070	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Planung des öffentlichen Verkehrs
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Thomas Siefer
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	oral exam (approx. 30 Min.) and term paper		
Course achievement			

Contents

- Timetable design and path management
- Investigation methods for railway installations
- Basics of modern operational investigations
- Determination of the performance of railway lines
- Determination of the performance of route nodes
- Macroscopic models
- Calculation of running time
- Railway operation simulation basics
- Vehicle scheduling/Vehicle circulation planning

Objective qualification

Students will be able to construct a timetable and apply performance investigation methods. Students will be able to build railway operational simulation models and distinguish disposition methods. The handling of the programme system RailSys® is mastered by the students.

Literature

-Radtke: EDV-Verfahren zur Modellierung des Eisenbahnbetriebs
-Pachl: Railway Operation and Control
-Hansen, Pachl et. al.: Railway Timetable and Traffic

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Engineering Process for Railway Signaling Systems		
Number	4310620	**Module version**	V1
Shorttext		**Language**	german
Frequency of offer		**Teaching unit**	
Module duration	1	**Institution**	Institut für Eisenbahnwesen und Verkehrssicherung
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Lars Schnieder
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (60 min.) or oral exam (approx. 30 min.)		
Course achievement			

Contents

The module provides fundamental and advanced knowledge of the development process of railway signalling systems in the context of safety-critical railway systems. Students gain a structured understanding of the regulatory, methodological, and technical foundations required for the development, testing, and approval of signalling systems. A particular focus is placed on distinguishing between the development of generic applications and the development of specific applications, taking into account the applicable standards and regulations in railway signalling engineering. In this context, fundamental methods and processes are taught, including:
- legal foundations and standardisation in the field of railway signalling systems
- concepts of risk and safety in safety-critical systems
- application of the V-model in the development process of both generic and specific applications
- methods of risk and hazard analysis
- requirements definition, system definition, and functional allocation within the system
- verification and validation of safety-related systems
- safety cases for generic and specific applications
- approval and certification processes for generic and specific applications

Objective qualification

Students are able to explain the legal foundations, standards, and regulations of railway signalling technology and to classify their relevance for the development of safety-critical systems. Students are able to describe the development process of railway signalling systems based on the V-model and transfer it to both generic and specific applications. Students are able to perform risk and hazard analyses using appropriate methods and to evaluate their results for system development purposes. Students understand the structure and composition of safety cases for both generic and specific applications, taking into account relevant normative requirements. Students are able to explain and classify the fundamental steps and requirements of approval and certification processes in the field of railway signalling systems.

Literature

- Braband, J. et al.: Die CENELEC-Normen zur Funktionalen Sicherheit. Eurailpress (Hamburg) 2006.
- Braband, J.: Risikoanalysen in der Eisenbahn-Automatisierung. Eurailpress (Hamburg) 2005.

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Design of Railway Infrastructure		
Number	4310600	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Eisenbahnwesen und Verkehrssicherung
Hours per Week / ECTS	7 / 6,0	**Module owner**	Prof. Dr. Lars Schnieder
Workload (h)			
Class attendance (h)	70	**Self studying (h)**	110
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Contents			
Objective qualification			
Literature			
Wird in der Lehrveranstaltung bekanntgegeben.			

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	5,0	Lecture/Exercise	german
	2,0	Exercise	german

Title	Digital Planning, Construction and Operation of Rail Systems		
Number	3318000000	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration	1	**Institution**	
Hours per Week / ECTS	4 / 6,0	**Module owner**	
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Recommended requirements	Knowledge from the Railway Construction module or comparable content is recommended		
Expected performance/ Type of examination	Written exam (60 min.) or oral exam (approx. 30 min.)		
Course achievement			

Contents

The course provides fundamental and advanced knowledge on the digital support of the entire life cycle of railway systems. It begins with the digital capture of the as-built condition of rail infrastructure using modern surveying and measurement techniques. Building on this, digital methods and tools for the planning and modelling of rail infrastructure are introduced, particularly Building Information Modeling (BIM). A special focus is placed on the integration of different disciplines (e.g. alignment design, structural engineering, and signalling and control systems) as well as on consistent data management throughout the entire planning process. Subsequently, the course addresses digital processes for coordinating and executing planning tasks, as well as for supporting approval and authorization procedures in the railway sector. Regulatory requirements and the specific framework conditions of railway infrastructure are also taken into account. Finally, the module covers the digital support of construction and operation of railway systems. This includes, among other aspects, construction scheduling under ongoing railway operations, digital monitoring, maintenance management, and data-driven operation and asset management strategies. Particular emphasis is placed on the continuous use of digital models and data in the sense of a digital twin

Objective qualification

Students are able to understand the significance of digitalization for the life cycle of railway systems and to evaluate it in the context of the specific requirements of the railway sector. Students understand methods for the digital capture of the as-built condition of railway infrastructure and are able to assess their fields of application. Students are able to apply digital planning methods for railway systems, in particular model-based approaches (e.g. BIM for linear infrastructure), and to critically evaluate them. Students are able to purposefully use digital tools for the interdisciplinary coordination of complex planning processes in the railway domain. Students understand the fundamental processes of digitally supported approval and authorization procedures for railway infrastructure. Students are able to describe digital technologies used in the construction and operation of railway systems and to assess their benefits.

Literature

Jochen Holzfeind, Jia Liu, Ferdinand Pospischil: Handbuch Eisenbahninfrastruktur. Springer (Berlin 2025)

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
		Lecture/Exercise	german

Specialisation Environmentally-compliant and Resource-saving Construction

Title	Energy-efficient and Comfort-compliant Building Design		
Number	4399730	**Module version**	V1
Shorttext		**Language**	german
Frequency of offer		**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration		**Institution**	Institut für Bauklimatik und Energie der Architektur
Hours per Week / ECTS	0 / 6,0	**Module owner**	Prof. Elisabeth Endres
Workload (h)			
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Contents			
Objective qualification			
Literature			

↑

Related courses
Rules for the choice of courses
Compulsory attendance

Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Seminar	german
	4,0	Seminar	german

	4,0	Seminar	german
	4,0	Seminar	german
	4,0	Seminar	german

Title	Structural Repair		
Number	4398210	**Module version**	V1
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Fachgebiet Baustoffe
Hours per Week / ECTS	6 / 6,0	**Module owner**	Dr. Thorsten Leusmann
Workload (h)	180		
Class attendance (h)	84	**Self studying (h)**	96
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.)		
Course achievement			

Contents

In the course Building Damages, knowledge is given on the durability of structures made of mineral building materials, on origins and mechanisms of damage, on models for the description of damage and on strategies for the prevention of structural damage. Based on this, concepts for repair and strengthening of reinforced and prestressed concrete structures as well as masonry, plasters and screeds are discussed in the context of current standardization.
Furthermore, tasks, objectives and methods of structural investigation and material testing will be addressed. In addition, the topics of planning, organization and evaluation of measurement and testing tasks, safety, reliability, standardization and approval, application of methods and instruments for experimental investigation and monitoring of reinforced concrete structures are discussed. Case studies are presented and analysed in the course, which train interdisciplinary problem-solving skills. Moreover, a practical course on the use of investigative methods is offered.
The topics discussed are based on the fundamentals of the bachelor's subject Building Materials Science.

Objective qualification

After completing the course Building Damages, the students will be able to describe, explain and differentiate the causes as well as the mechanical, chemical and physical mechanisms of damage to structures made of mineral building materials. Based on this, the students will be able to design strategies for the prevention of damage, assess structural damage, design target-oriented repair strategies, develop suitable repair concepts and carry out a success control.
After successful participation in the course Building Investigation, students are able to describe methods for damage analysis of reinforced and pre-stressed concrete structures and to define building inspection strategies depending on the condition of the structures and the building materials used. In addition, they will be able to understand how current non-destructive testing methods for quality control, inspection and long-term monitoring of structural components, facilities and structures work, apply them practically and assess their fields of application and limitations.
Targeted case studies are designed to give students the ability to abstract and to transfer what they have learned to a new problem area and to develop their own investigation concepts.

Literature

Remark
The module can only be included in one specialisation. Please ensure the correct assignment when registering.

↑

Related courses			
Rules for the choice of courses			
Building Damages and Building Investigation must be documented. Furthermore, either the Building Maintenance Adventure or Sealing of Buildings adventure can be taken. The Building Maintenance Adventure can be taken by a maximum of 20 people.			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	1,0	Exercise	german
	3,0	Lecture/Exercise	german
	2,0	Lecture	german
	1,0	Lecture/Exercise	german

Title	Additive Manufacturing in Construction		
Number	4398700	**Module version**	
Shorttext		**Language**	english german
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Fachgebiet Baustoffe
Hours per Week / ECTS	6 / 6,0	**Module owner**	Dr. Thorsten Leusmann
Workload (h)	180		
Class attendance (h)	91	**Self studying (h)**	89
Compulsory requirements			
Expected performance/ Type of examination	Written exam (60 Minuten) and laboratory experiment		
Course achievement			
Module grade composition	The grade is made up of half of the grades for each of the two examinations.		

Contents

In the course Materials and Processes in Additive Manufacturing, basic knowledge of the various additive manufacturing processes in the construction industry is first obtained across all materials. Subsequently, a special focus is set on 3D concrete printing. The main topics are 3D concrete printing processes (Selective Cement Activation, Selective Paste Intrusion, Large Particle 3D Concrete Printing, Concrete Extrusion, Shotcrete 3D Printing, Injection 3D Concrete Printing), material development (concrete technology, composition, use of additives), testing of additively manufactured objects (rheology, mechanics), quality control and application in practice.
In the course Methods of Digital Construction the basic knowledge of programming in Rhino Grasshopper and Python is taught. Based on the lecture, students learn in practical exercises to create printable geometries parametrically, to prepare them for 3D printing and to generate robot paths. Robot simulation is also taught to test the manufacturability of designed objects.
In the collaborative exercise Applied Additive Manufacturing, the acquired knowledge is applied to implement physical objects by means of a selected additive manufacturing process.

Objective qualification

After completing the module, the students will be able to make an application-oriented choice of additive manufacturing methods in the construction industry and to characterize and evaluate the material technology, process technology and robotic aspects.
Students will be able to recognize important material-process interactions and evaluate them on the basis of learned relationships. Basic design methods for material and structural behavior are learned and applied to various applications. In addition, knowledge of the composition of materials for additive manufacturing is available, which can be further developed and subsequently manufactured using the knowledge obtained. The students also know relevant investigation methods for evaluating an additive manufacturing process, can apply them and evaluate the data obtained.
In addition, students will be able to design 3D objects using computer-aided design and prepare the data appropriately for the additive manufacturing process. In addition, students will be able to perform robot path planning and control the robot in a simple process.
By participating in the exercise, students will also be able to apply specific additive manufacturing processes and produce physical objects.

Literature
Remark
The module can only be included in one specialisation. Please ensure the correct assignment when registering. Methods of Digital Construction Fabrication and Applied Additive Manufacturing can be attended by a maximum of 20 participants.

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture	german
	2,0	Lecture/Exercise	german
	2,0	Practical exercise	german

Title	Organic Materials in Construction		
Number	4310670	**Module version**	V1
Shorttext		**Language**	english german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Fachgebiet Organische Baustoffe und Holzwerkstoffe
Hours per Week / ECTS	6 / 6,0	**Module owner**	Dr. Thorsten Leusmann
Workload (h)	180		
Class attendance (h)	84	**Self studying (h)**	96
Compulsory requirements			
Expected performance/ Type of examination	2 Written exams (each 45min) The module examination comprises 2 x 45 min., as each of the courses offered in the module deals with different aspects of organic materials. The wood-based materials are natural renewable raw materials, while the plastics are synthetically produced organic polymers. The materials differ significantly in their structure and in their mechanical		
Course achievement			

Contents

General: location determination and introduction
Structure of polymers: chemical structure, formation reactions, macromolecules (shape, size and arrangement), bonding forces, classification of plastics
Processing of polymers: pressing, injection molding, extrusion, blow molding, calendering, foaming, forming, machining, welding, bonding, mechanical joining
Properties of polymers: strength and deformation behavior, temperature influence, loading influence, influence of molecular orientations, stress cracking, physical properties, thermal properties, electrical properties, density, weathering behavior and chemical resistance, important standard plastics
Application of polymers: Site aids, construction aids and binders (polymer impregnated concrete [PIC], polymer modified cement-bound concrete [PCC], reaction resin bound concrete [PC], rigid foam lightweight concrete, joint sealants and joint profiles); polymers in building construction (thermal and acoustic insulation, light elements, windows, facades, installation materials, roofing membranes); polymers in civil engineering (sealing membranes, supply and disposal systems, frost protection layers); polymer structures (structures made of fiber-reinforced composites, textile structures); structural repair, damage to polymers in civil engineering.

[Plant-based Natural Fibre Reinforcements in Construction (VÜ)] :
Natural fibres as construction materials. Fibre structure and properties.
Properties of natural fibre reinforced polymer (NFRP) composites. Natural fibre reinforced cementitious (NFRC) materials in construction. NFRP materials in construction.
NFRP tube encased NFRC hybrid structure. NFRP and NFRC for Structure Strengthening. Durability of NFRP and NFRC in construction. Degradation mechanism.
Fibre modifications.

Objective qualification

Students acquire the essential anatomical, morphological, physical and chemical properties of organic building materials (wood-based materials and polymers) and acquire in-depth knowledge of raw materials, properties, manufacture and application of organic building materials and wood-based materials. The materials science aspects of organic materials such as constitutive laws, creep, mechanosorptive creep, etc. are emphasized.
Students will also acquire the essential non-destructive and semi-destructive methods for the in-situ evaluation of wood in structures and acquire in-depth knowledge of principles, procedures, and limitations of various methods. Practical knowledge is reinforced through laboratory exercises and "in-field" (field) exercises.
With reference to polymers, the influence of macromolecular structure on the properties of polymers is considered in detail. Another important aspect is the long-term behavior of polymers under the influence of loads, media and weathering. Furthermore, the students learn methods of plastics analysis.
By achieving the qualification objectives, the students will be able to select wood materials and polymers in civil engineering for the respective application purpose and to carry out evaluations on existing buildings and structures properly during the planning phase, not only in the event of damage.

Literature

- Forest Products Laboratory. Wood handbook - Wood as an engineering material. General Technical Report FPL-GTR- 190. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory: 508 p. 2010. Free download http://www.fpl.fs.fed.us/products/publications/specific_pub.php?posting_id=18102
- Niemz, P., and W. U. Soderegger. 2017. Holzphysik. Physik des Holzes und der Holzwerkstoffe. Hanser-Verlag Leipzig, 580 p. ISBN 978-3-446-44526-0.
- Holzmann, G., Wangelin, M., and R. Bruns. 2012. Natürliche und pflanzliche Baustoffe. 2. Auflage. Springer-Vieweg. 394 p. ISBN 978-3-8348-1321-3.
- Folien in PDF-Format, vom Dozenten benannte Veröffentlichungen aus dem Fachbereich
- Menges / Schmachtenberg / Michaeli / Haberstroh: Werkstoffkunde Kunststoffe, ISBN 3-446-21257-4, Carl Hanser Verlag 2002
- Oberbach: Saechtling Kunststoff Taschenbuch, ISBN: 3-446-22670-2, Carl Hanser Verlag 2004
- Frank: Kunststoff-Kompendium, ISBN: 3-8023-1589-8, Vogel Fachbbuchverlag 2000
- Braun: Kunststofftechnik für Einsteiger, ISBN 3-446-22273-1, Carl Hanser Verlag 2003
- Braun: Erkennen von Kunststoffen, Qualitative Kunststoffanalyse mit einfachen Mitteln, Carl Hanser Verlag 2003
- Gächter / Müller: Kunststoff-Additive, ISBN: 3-446-15627-5, Carl Hanser Verlag 1989
- Bargel / Schulze: Werkstoffkunde, Springer Verlag 2004
- Potente: Fügen von Kunststoffen, Grundlagen, Verfahren, Anwendung, ISBN: 3-446-22755-5, Carl Hanser Verlag 2004

↑

Related courses

Rules for the choice of courses

Compulsory attendance

Name of the course	SWS	Eventtype	Language
	3,0	Lecture/Exercise	german
	3,0	Lecture/Exercise	english

Title	Procedures for Preservation and Restoration		
Number	4310780	**Module version**	V1
Shorttext		**Language**	english german
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Fachgebiet Organische Baustoffe und Holzwerkstoffe
Hours per Week / ECTS	6 / 6,0	**Module owner**	Prof. Dr. Bohumil Kasal
Workload (h)	180		
Class attendance (h)	84	**Self studying (h)**	96
Compulsory requirements			
Expected performance/ Type of examination	2 Written exams (45min)		
Course achievement			

Contents

[Bautenschutz und Bauwerkssanierung (V+Ü)]
(Building restoration) Damage to concrete and reinforced concrete devices, building inspectorate treatment of repair measures, repair of cracked reinforced and prestressed concrete structures, replacement of structural concrete and surface protection on concrete and reinforced concrete structures, chloride removal of reinforced concrete structures contaminated with de-icing salt and hydrogen chloride, basics on fibrous hazardous substances including asbestos, Asbestos inventory, restructuring urgency, asbestos abatement and protective measures (building protection). Building physics and materials with regard to thermal and moisture protection, basics of the Energy Conservation Act and the Energy Conservation Ordinance, construction, materials, advantages and disadvantages of various wall constructions and roof constructions as well as roof sealing, landfill base sealing.

This course is designed for Bachelor and Master students in architecture and civil engineering and will be held in English. Advanced composite materials made of glass and carbon fibers have been used for infrastructure globally for many years. The course will focus on use and design of structures with fiber reinforced polymer (FRP) composite materials.
Material properties of FRP composites, Manufacturing of composite structures, Mechanics and failure analysis of FRP, Flexural and Shear strengthening of RC structures with externally bonded FRP reinforcement, Concrete column confinement, FRP strengthening of masonry and timber structures, Design of FRP profile and all FRP structures, Monitoring and testing methods of FRP will be taught. Students will learn about relevant physical and mechanical properties of advanced composite materials and acquire in-depth knowledge about raw materials, properties, manufacturing, and design of composite materials as well as their hybrid structures for structural engineering.

Objective qualification

Students learn essential aspects of thermal and moisture protection based on building physics and material technology, as well as fundamentals of roof constructions, roof sealing, and landfill base sealing, each with an emphasis on plastic-based materials and structures. Relevant standards and regulations are consulted in relation to the application.

This will enable you to prevent damage caused by building physics in execution and planning, to carry out an initial analysis of damage that has occurred and damage in this respect, to commission in-depth investigations in a targeted manner and to draw up suitable repair concepts.
The students acquire knowledge of the main physical, chemical and electrochemical damage mechanisms in concrete structures and acquire in-depth knowledge of damage analysis, repair construction materials and their practical application in construction. The focus is on plastic-based repair building materials. Furthermore, the fundamentals of fibrous hazardous materials including asbestos, assessment of urgency for asbestos abatement and its implementation are learned. Practical demonstrations of analytical methods will supplement the lecture. This will enable you to assess existing damage, establish and implement an appropriate repair conception.
Students will acquire the essential non-destructive and semi-destructive methods for in-situ assessment of wood in structures and acquire in-depth knowledge of principles, procedures and limitations of various methods. Practical knowledge is deepened by laboratory and "in-field" (field) exercises.

Advance Composite Materials in Construction (VÜ)
Students acquire knowledge of the properties of fiber-reinforced composite materials and their use in construction. This will enable them to use such materials in a targeted manner in planning, construction and building reinforcement.

Literature

ausführliches Vorlesungsmanuskript, Handouts

Kasal, B., Tannert, T. (Editors). 2011. In-situ assessment of timber. RILEM State of the Art Reports, Vol. 7. Springer
Verlag. ISBN: 978-94-007-0559-3. 150 p.

Forest Products Laboratory. Wood handbook - Wood as an engineering material. General Technical Report FPL-GTR- 190. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory: 508 p. 2010. Free download http://www.fpl.fs.fed.us/products/publications/specific_pub.php?posting_id=18102

↑

Related courses

Rules for the choice of courses

Compulsory attendance

Name of the course	SWS	Eventtype	Language
	4,0	Lecture/Exercise	german
	2,0	Lecture/Exercise	english

Specialisation Traffic and Infrastructure

Title	Transport Planning		
Number	4318020	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Verkehr und Stadtbauwesen
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Bernhard Friedrich
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.) or oral exam (30 Min.)		
Course achievement	Homework assignment		

Contents

[Verkehrsplanung (VÜ)]
- Introduction to transport planning
- Planning Methodology
- Behavioural traffic surveys
- Planning of transport networks
- Planning of measures in public transport (external lecturer from the field)
- Decision models
- Traffic models (traffic generation, traffic distribution, traffic allocation)
- Impact models and evaluation procedures
- Traffic safety

Objective qualification

The students gain an overview of the characteristics of mobility, the socio-economic significance of transport that can be derived from this and the resulting legal anchoring of spatial and transport planning. Based on the understanding of the problems and tasks of transport planning, the planning methodology and the instruments of transport network planning in public transport and individual transport are introduced. In this context, the students get to know the requirements of the German guidelines in transport planning and can apply them to planning tasks. Through the in-depth examination of the theory and practice of transport demand modelling, the students are enabled to carry out own planning studies and to quantitatively evaluate planning alternatives. They are thus qualified to make reliable recommendations for the development of the transport infrastructure.

Literature

vgl. Vorlesung

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Research Seminar Traffic Planning and Traffic Engineering		
Number	4398080	**Module version**	
Shorttext		**Language**	english german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Verkehr und Stadtbauwesen
Hours per Week / ECTS	2 / 6,0	**Module owner**	Prof. Dr. Bernhard Friedrich
Workload (h)	180		
Class attendance (h)	28	**Self studying (h)**	152
Compulsory requirements			
Expected performance/ Type of examination	Presentation		
Course achievement			

Contents

In this seminar, specific questions from the research fields of traffic planning and traffic engineering are dealt with on changing topics. The seminar topics are embedded in the current research work or research content of the Institute of Transport and Urban Engineering. The students gain an insight into current research topics in traffic planning and traffic engineering and have the opportunity to actively participate and shape them.

- introduction, discussion of research topics
- presentation and discussion of first ideas for individual research questions
- literature review methods -overview to methods
- literature review methods -exercise
- intro on how to write a scientific paper
- development and formulation of own, individual research questions
- preparation of a short scientific paper on the individual research topic
- presentation and discussion of individual research questions

Objective qualification

The seminar imparts knowledge in the planning and implementation of research projects and gives an in-depth insight into scientific working methods. The students independently work out a partial question within one of the research topics by studying sources, write a short paper on it and present it in a short presentation. The students are thus guided to in-depth scientific work and acquire essential core competences for a goal-oriented, methodically clean and comprehensible preparation and summary of selected research topics

Literature

Die Recherche der maßgebenden aktuellen Literatur und deren Erfassung ist Bestandteil des Forschungsseminars

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
Research Seminar Traffic Planning and Traffic Engineering	2,0	Seminar	english german

Title	Local Public Transport - Supply Planning		
Number	4310770	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Verkehr und Stadtbauwesen
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Bernhard Friedrich
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.) or oral exam (approx. 30 Min.) (in the Master's programme in Social Sciences as a course achievement)		
Course achievement	Term paper		

Contents

Public transport - service planning (VÜ)
- organizational and legal basics of the public transport system
- network planning in the context of settlement development
- public transport systems and their performance capabilities
- overview of circulation, vehicle and personnel planning
- distribution of tickets, the organization in transport associations and tariffing
- financing of public transport,
- marketing strategies in public transport
- differentiated modes of operation in public transport
- acceleration of public transport in urban road networks

Objective qualification

Students will gain knowledge of the interrelationships, systems and laws that must be taken into account when planning public transport services. They will be able to design or further develop and implement public transport services for urban and rural public transport, with the respective boundary conditions and systems to be taken into account. Public transport services are differentiated for road (IVS – Prof. Friedrich) and rail transport (IVE – Prof. Siefer).

Literature

-Differenzierte Bedienung im ÖPNV - Flexible Bedienungsweisen als Baustein eines markorientierten Leistungsangebotes,
-Blaue Buchreihe des VDV, Heft 15, DVV Media Group GmbH, April 2009.
-Stadtbahnsysteme Light Rail Systems. Grundlagen, Technik, Betrieb und Finanzierung. Blaue Buchreiche des VDV,
DVV Media Group GmbH, Juni 2014
-Richtlinien, Hinweise und Merkblätter der Forschungsgesellschaft für Straßen- und Verkehrswesen (www.fgsv-verlag.de).
-Reinhardt, W. Öffentlicher Personennahverkehr. Vieweg + Teubner Verlag. Springer Fachmedien Wiesbaden GmbH,
2012.

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Local Public Transport - Planning and Infrastructure		
Number	4398060	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Planung des öffentlichen Verkehrs
Hours per Week / ECTS	4 / 6,0	**Module owner**	Alejandro Tirachini Hernández
Workload (h)	₁₈₀		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.) or oral exam (approx. 30 Min.)		
Course achievement			

Contents

[Public Transport - Infrastructure Planning (V/Ü)]
- Definition of lane-guided systems in urban transport
- Development of light rail systems
- Planning approaches/ responsibilities
- Legal basis
- Financing
- Planning approval and project sequence
- System design
- Planning principles for alignment and routes
- Construction and maintenance of infrastructure
- stations
- Energy supply (trackside)
- Current developments in Germany and worldwide
- Overview of safety systems for railways in urban traffic
- Train protection
- Route protection
- Train control and driverless operation
- Route protection in areas with road traffic participation

Objective qualification

The students are able to plan infrastructure facilities for public transport (rail and road) in Germany according to the relevant procedures and rules for a specific application and to accompany the construction. The knowledge of these basics is necessary for economic and ecological operation. As employees of a local transport operator or a planning office for a planned application, they are able to select suitable safety systems and dimension them operationally. They are able, under the guidance of experienced planning engineers in the planning of safety equipment.

Literature

- Reinhardt: Öffentlicher Personennahverkehr
- Pachl: Systemtechnik des Schienenverkehrs

- Naumann: Leit- und Sicherungstechnik im Bahnbetrieb

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title			
Number	3320000020	**Module version**	
Shorttext		**Language**	
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Straßenwesen
Hours per Week / ECTS	6 / 6,0	**Module owner**	Prof. Dr. Michael Wistuba
Workload (h)	180		
Class attendance (h)	84	**Self studying (h)**	96
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			

Contents

[Road construction materials (VÜ)]

The course begins with the question of the requirements for road construction materials (skid resistance, crack resistance, ageing resistance) and then explains how these can be met through the targeted selection, formulation and mix design of construction materials. The quality of aggregates, binders and construction material mixtures, binder modification, reuse of construction materials, determination of the layer structure and prediction of the service life of road pavements are discussed in more detail.

[Road construction technology (VÜ)]

The course deals with the technical handling and implementation of road construction projects. The transportation, paving and quality assurance of road pavements are dealt with in a practical manner. Road maintenance is then discussed. The methods for recording and assessing the condition of surface and layer properties, structural and operational road maintenance (especially winter road maintenance) and the recovery and reuse of road construction materials are explained in detail. Numerous application examples are used to prepare students for construction site-related and operational issues in road construction.

[Road construction technology in practice VÜ)]

Using selected examples from the design and production of building materials and building material components, from road construction and from the testing of new/innovative construction equipment or construction methods, the course offers an insight into the current and future practice of road construction technology. This is supported by excursions and specialist lectures by people from the construction industry.

Objective qualification

Students learn that the sustainability of road constructions depends largely on the formulation of the construction material mixtures and their composition to form a layered load-bearing system. They will be able to assess the basic suitability of building materials for road construction, for example, to recognize rocks for road construction or to interpret the quality of bituminous binders on the basis of results from laboratory tests. Students learn how to produce and test typical road construction specimens. They will be able to estimate the costs and benefits of standard test methods and correctly evaluate and interpret test results. They will acquire in-depth theoretical and practical knowledge of the methods used to test the suitability and quality of raw materials, construction material mixtures and additives as well as the technical implementation of

asphalt recycling. Students also gain in-depth knowledge of the life cycle of road constructions, starting with the delivery of construction materials, through installation and use, to reuse.

Literature

Richtlinien und Empfehlungen

Vorlesungsskripte

↑

Related courses

Rules for the choice of courses

Compulsory attendance

Name of the course	SWS	Eventtype	Language
Road Construction Materials	2,0	Lecture/Exercise	german
Road Construction Technology	2,0	Lecture/Exercise	german
Road Construction Technology in Practice	2,0	Lecture/Exercise	german

Title	Road Planning and Dimensioning		
Number	3320000030	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Straßenwesen
Hours per Week / ECTS	6 / 6,0	**Module owner**	Prof. Dr. Michael Wistuba
Workload (h)	180		
Class attendance (h)	84	**Self studying (h)**	96
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			

Contents

[Road planning and design (VÜ)

In this course, road planning is presented from the determination of the need for the construction of a road to its implementation. The planning process, the planning levels with their different levels of detail, environmental concerns, public participation, legal issues, the financing of public roads, the planning design of junctions and intersections, proof of traffic quality as well as economic efficiency and life cycle analysis are discussed.

[Computer-supported dimensioning and design of roads (VÜ)]

This course teaches the fundamentals of the structural design of road pavements and the computational dimensioning. The main focus is on highly loaded roads and flexible (asphalt) and rigid construction methods (cement concrete). The model representation of the layer structure, the time and load-dependent behavior of the construction material, the bonding of the layers and the load-bearing behavior of the subsoil are explained. The course also demonstrates practical planning and design work on a specific road construction project using the VESTRA CAD road planning program. It begins with the three-dimensional site survey, after which all planning tasks relating to the alignment, gradient and cross-section design are processed and solved with computer support.

[Digitalization in the road sector (VÜ)]

The course "Digitalization in the road sector" provides basic knowledge and practical methods for digital transformation in the field of road infrastructure. The focus is on current technologies and strategies that are used to optimize the planning, construction, operation and maintenance of roads. Students are introduced to the challenges and potentials of digitalization and learn how digital systems and smart technology approaches can change traditional work processes in the transport and road sector in the long term. This includes, for example, sensor technologies for condition monitoring (Pavement Monitoring System) or the methods of Building Information Modeling (BIM) in the planning of infrastructure projects.

Objective qualification

The qualification objective is the independent planning of road projects from project initiation, variant planning, dimensioning of the road structure, structural design through to the preparation of tender documents including the documentation of technical and economic decisions. Students understand the holistic plan-

ning process in its individual planning stages (preliminary planning, design planning, approval planning) and recognize the legal, financial and environmental framework conditions of public road projects. On the basis of a realistic example of a road project, students combine their specialist knowledge with application, creating specifications, cost and schedule plans, variant studies and tender documents. They take into account economic, ecological and social criteria as well as the contents of a life cycle analysis. In the area of structural design and computational dimensioning, they are proficient in the modeling and dimensioning of multi-layer road structures, can apply building material and load-bearing behavior models and are proficient in the use of planning software (e.g. VESTRA CAD). They can create terrain models, develop route variants and optimize gradient and cross-section constructions with the aid of computers. The project-oriented group work sharpens their team and communication skills and prepares them to work on road projects independently and in a solution-oriented manner.

Literature

Richtlinien und Empfehlungen

Vorlesungsskripte

↑

Related courses

Rules for the choice of courses

Compulsory attendance

Name of the course	SWS	Eventtype	Language
	2,0	Lecture/Exercise	german
	2,0	Lecture/Exercise	german
	2,0	Exercise	german

Title			
Number	3329000000	**Module version**	
Shorttext		**Language**	english
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration		**Institution**	Institut für Planung des öffentlichen Verkehrs
Hours per Week / ECTS	4 / 6,0	**Module owner**	Alejandro Tirachini Hernández
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Exam (120 Min.)		
Course achievement			

Contents

- Motivation: why public transport and history of public transport

- Public transport planning: strategic, tactical and operational decisions

- User costs and values of time in public transport

- Single line design: Determination of frequency of service, type of vehicle

- Single line design: stop/station design and density

- Network design: general rules, simple models, complex models

- Waiting time modelling and timetabling

- Pricing and financing

- Public transport ownership and regulation

- Demand modelling, quality of service and user satisfaction

- Future public transport

Objective qualification

The students acquire an in-depth understanding of planning processes in public transport systems. Upon successful completion, students will be able to: (1) apply methods for designing single public transport lines (including route alignment, stop location, frequency, and vehicle size determination), considering the concepts of value of time, user cost components (access, waiting, in-vehicle time, transfers), and operator cost, informed by empirical data; (2) formulate and solve fundamental frequency setting and optimal stop spacing problems; (3) evaluate public transport network structures based on density principles and solve basic network design problems under constraints; (4) analyse public transport timetabling problems using different objective functions; (5) critically assess fare systems and pricing principles using welfare economics and practical fare setting rules; (6) compare models of public transport organization and ownership including regulation; (7) utilize fundamental concepts of public transport demand modelling including mode choice,

and (8) discuss topics pertaining to future developments such as automation and sustainability challenges in the public transport industry.
Literature
Präsentation, Artikel, Buchkapitel

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title			
Number	3329000000	**Module version**	V1
Shorttext		**Language**	english
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration		**Institution**	Institut für Planung des öffentlichen Verkehrs
Hours per Week / ECTS	4 / 6,0	**Module owner**	Alejandro Tirachini Hernández
Workload (h)	180h		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Exam (120 Min.)		
Course achievement			

Contents

- Motivation: why public transport and history of public transport
- Public transport planning: strategic, tactical and operational decisions
- User costs and values of time in public transport
- Single line design: Determination of frequency of service, type of vehicle
- Single line design: stop/station design and density
- Network design: general rules, simple models, complex models
- Waiting time modelling and timetabling
- Pricing and financing
- Public transport ownership and regulation
- Demand modelling, quality of service and user satisfaction
- Future public transport

Objective qualification

The students acquire an in-depth understanding of planning processes in public transport systems. Upon successful completion, students will be able to: (1) apply methods for designing single public transport lines (including route alignment, stop location, frequency, and vehicle size determination), considering the concepts of value of time, user cost components (access, waiting, in-vehicle time, transfers), and operator cost, informed by empirical data; (2) formulate and solve fundamental frequency setting and optimal stop spacing problems; (3) evaluate public transport network structures based on density principles and solve basic network design problems under constraints; (4) analyse public transport timetabling problems using different objective functions; (5) critically assess fare systems and pricing principles using welfare economics and practical fare setting rules; (6) compare models of public transport organization and ownership including regulation; (7) utilize fundamental concepts of public transport demand modelling including mode choice,

and (8) discuss topics pertaining to future developments such as automation and sustainability challenges in the public transport industry.
Literature
Präsentation, Artikel, Buchkapitel

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Urban Road Design		
Number	3319000000	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Verkehr und Stadtbauwesen
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Bernhard Friedrich
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Portfolio		
Course achievement			

Contents

- Requirements for a sustainable and climate-friendly design of urban roads
- Design principles and utilisation requirements for urban roads
- Guidelines and recommendations for the design and layout of urban roads
- User and mode of transport-specific design elements for road sections and junctions
- Design and layout of facilities for motorised private transport
- Design and layout of facilities for pedestrian traffic
- Design and layout of facilities for bicycle traffic
- Design and layout of facilities for local public transport
- Accessibility
- Project study in collaboration with the city of Braunschweig

Objective qualification

(E) The planning and design of sustainable urban streets is based on objectives derived from the quality of sojourn and functionality. To this end, the existing road users' requirements, aspects of accessibility, traffic safety and ecological compatibility are considered. Students are given a systematic overview of these requirements for a sustainable street space and learn how to take them into account in the design process. They will also be able to apply the state of the art of the relevant recommendations and guidelines. Students acquire practical skills as part of a project study in which they design a real street space, taking appropriate account of all user requirements and boundary conditions. In cooperation with the city of Braunschweig, exemplary streetscapes are selected and worked on in small groups in order to implement, coordinate and finally present what has been learnt in the lecture in a practical exercise.

Literature

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
Urban Road Design	4,0	Lecture/Exercise	german

Title	Traffic Management		
Number	3319000010	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Verkehr und Stadtbauwesen
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Bernhard Friedrich
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam+ (90 Min.) or oral examination (ca. 30 Min.) Two assignments can be completed in advance which, if passed, count for 25% of the final grade for the module. The application for an written exam+ must be submitted by the student at the start of the examination. Further information on deadlines for the submission of term papers is provided in the courses of the module.		
Course achievement			

Contents

- Functional and organisational system architectures for the management of road traffic facilities
- Traffic flow theory as the basis for determining the traffic situation and evaluating measures
- Recording, processing and analysing traffic data (practical course)
- Design and traffic engineering dimensioning of road traffic facilities
- Procedures and methods of traffic control for road network, road sections and junctions within (urban roads) and outside built-up areas (motorways)
- Procedures for determining the traffic situation and quality management
- Insights into practice through guest lectures and excursions

Objective qualification

Students gain a comprehensive overview of the responsibilities, tasks and objectives of the management of road traffic facilities inside and outside built-up areas. In this context, system architectures for traffic management in Germany are introduced in their functional and organisational forms. Students learn the basics of traffic data analysis and traffic flow theory in order to be able to competently deal with the tasks of traffic management and, building on this, to apply state-of-the art methods for the dimensioning of road traffic facilities and the various methods of traffic control in accordance with the regulations applicable in Germany. This gives students the skills to develop and evaluate measures that make sense from a traffic flow perspective and are ecologically and economically suitable. Taking into account the existing traffic infrastructure, they will be able to dimension road traffic systems on urban roads and motorways that meet the standards of German guidelines and equip them with the necessary traffic engineering systems (operation).

Literature

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
Traffic Management	4,0	Lecture/Exercise	german

Title	Transport Policy		
Number	3329000010	**Module version**	
Shorttext		**Language**	english
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Planung des öffentlichen Verkehrs
Hours per Week / ECTS	4 / 6,0	**Module owner**	Alejandro Tirachini Hernández
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam+ (120 Min.)		
Course achievement			

Contents

- Motivation: why transport policy

- Reasons for public sector intervention on the transport sector

- Transport externalities

- Transport policy instruments:

•Supply side: provision of infrastructure and services

•Supply side: pricing (taxes, subsidies, fare setting)

•Demand side: demand management tools

•Policy packages

- Social effects of transport policy (e.g., social inclusion, transport poverty)

- Regional perspectives on transport policy

Objective qualification

The students acquire an in-depth understanding of the guiding principles behind transport policy decisions. Upon successful completion, students will be able to: (1) understand the reasons behind transport policy and the need for policy interventions on the transport sector, (2) analyse transport externalities as a reason for policy intervention, (3) examine the main types of transport policy instruments that are applied in different parts of the world, (4) predict the effects of specific transport policies in future scenarios.

Literature

Presentation, article, book chapter (See lecture)

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	english

Specialisation Sanitary and Environmental Engineering

Title	Waste and Resource Management		
Number	4398320	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration	1	**Institution**	Abteilung Abfall- und Ressourcenwirtschaft
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Julia Gebert
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.) or oral exam (approx. 30 Min.) (in the Master's programme in Social Sciences as a course achievement)		
Course achievement			

Contents

Waste management concepts; acquisition logistics; plant and process technology (with focus on biological processes; methods for process control and monitoring; emission control; product development; secondary raw materials; methods for quality control of secondary raw materials; design principles, plant planning and design, and waste analytics.

Objective qualification

Students acquire in-depth knowledge of tasks and solution methods of municipal and industrial waste and resource management as well as material flow-related recycling management. The special focus is on biological treatment and recycling processes for municipal waste. Here, required work steps and methods for the implementation of management measures and plant technologies are learned.
Evaluation methods for describing and assessing economic, ecological and social impacts are taught and applied. Special knowledge in the field of the use of regenerative energies from municipal waste is acquired. In this lecture, students will be able to use their acquired knowledge to evaluate waste management concepts and to perform rough measurements of selected process steps/aggregates

Literature

ausführliches Skript, PowerPoint Folien, Literaturempfehlungen

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Landfill Technology and Remediation of Contaminated Sites		
Number	4398330	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Abfall- und Ressourcenwirtschaft
Hours per Week / ECTS	4 / 6,0	**Module owner**	Dr. Kai Münnich
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 Min.) or oral exam (approx. 30 Min.)		
Course achievement			

Contents

[Landfill Mining, Landfill Construction and Geotechnique of Wastes (VÜ)}
Fundamentals of waste mechanics und the hydarulic behaviour of wastes; interaction between the different parameters; constructive elements of landfills; emissions from landfills and their monitoring; longterm behaviour of landfills; position and after-use of landfills; Landfills in emerging and developing countries; legal basis.

[Investigation and Remediation of Contaminated Sites (VÜ)]
Contaminants in soil and groundwater; procedures for exploration; control of soil air; sampling of soil, soil air and groundwater; evaluation and assessment of analytical results; techniques for in-site and on-/off-sites remediation; procedures for groundwater treatment; biological, thermal and physical treatment of soils; after-use of contaminated sites; landfill mining.

Objective qualification

Students acquire in-depth knowledge of the construction and operation of landfills for municipal solid waste (MSW). The aspects of the position of the landfill in the waste management, the legal framework, the site search, the technical installations up to the aftercare, the monitoring and the landfill mining are considered. Furthermore, they gain detailed knowledge about the mechanical properties of waste as well as the long-term behavior in terms of water and gas emissions. Overall, there is a focus on the situation in emerging and developing countries. This will enable students to understand and evaluate the major dynamic processes of a landfill and to size the required structural components.

Students gain in-depth knowledge of the identification and remediation of contaminated sites. The basic aspects concerning possible pollutants, sources of input and exploration of the soil and groundwater are considered. The possible techniques for remediation of contaminated sites (biological, chemical and physical) are learned. The special case of remediation of old MSW dumps is elaborated in detail. This will enable students to assess a suspected contaminated site and select an appropriate remediation technique for the specific case.

Literature

PowerPoint Folien, Literaturempfehlungen
Remark

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture/Exercise	german
	2,0	Lecture/Exercise	german

Title	International Wastewater and Waste Management		
Number	4398310	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Siedlungswasserwirtschaft
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Thomas Dockhorn
Workload (h)	180		
Class attendance (h)	50	**Self studying (h)**	130
Compulsory requirements			
Recommended requirements	Prior successful completion of the module ‘Wastewater and Sludge Treatment’ or the module ‘Waste and Ressource Management’ is strongly recommended.		
Expected performance/ Type of examination	Portfolio and presentation		
Course achievement	Students will prepare a 30-minute presentation in teams. The information given in the lectures and in the student presentations are the basis for developing disposal concepts in team work at the end of the class. The portfolio covers a structured presentation of the team results for the developed disposal concepts. Portfolios are created by the teams under supervision of the institute’s assistants. It is possible to drop the class up to two weeks before the final group project. Organization of groups and assignment of research topics takes place in the first class meeting. This class has a compulsory attendance of 50 hours (first class meeting, student presentations, final group project). If students are absent with valid excuse (e.g. illness, child care etc.) individual solutions can be found for being able to complete the class successfully and still reach educational objectives of the class. Periods of absence may not exceed 15% of compulsory attendance, in order to reach educational objectives of the class.		

Contents

[International Wastewater and Waste Management (V)]
The class introduces the topic of waste and wastewater treatment in an international context by presenting various problems and solutions from developing and emerging countries. These lectures are the introduction, basis and preparation for the team work of the following seminar ‘Waste, Wastewater and Resource Management for Developing and Emerging Countries’.

[Waste, Wastewater and Resource Management for Developing and Emerging Countries (S)]
Participants will work independently in student teams and will develop a concept for the disposal of municipal waste and wastewater. Two locations in different parts of the world will be chosen each semester and students will establish a disposal concept for these locations taking into consideration specific legal, geographical, political and social conditions.
As preparatory work, teams of two students each will prepare a 30-minute presentation dealing with basic questions such as processes of wastewater and waste treatment, costs and planning of treatment plants, economy, infrastructure, culture and religion in the area and present their results to the class.

With this information, two teams (one for each location) will then develop a complete disposal concept as a group project during the 2-day block seminar at the end of the course. Finally, the developed concepts will be introduced to the class in a 30-minute presentation and will be discussed with the participants. A written report is required to complete the class.

Objective qualification

Students are able to understand and solve problems in the field of international wastewater and waste management. They will acquire fundamental knowledge for solving problems concerning waste and wastewater in developing and emerging countries taking into special consideration country-specific aspects. They will have the ability to adapt suitable concepts and technologies to given locations with special reference to globalization. Understanding material flow management and resource protection in a global context are a further teaching objective. Students are able to scientifically discuss engineering problems in a team and to acquire additional required knowledge independently. They are able to analyse and evaluate existing problems under consideration of country-specific aspects and are able to find and realize strategies for solving these problems under given local conditions (regional governance). They are able to skillfully present their solutions to the public. A special focus in this seminar is on practicing teamwork, acquiring debate techniques and rhetorical skills and learning how to discuss controversial questions in a scientific setting.

Literature

Die relevante Fachliteratur kann je nach Aufgabenstellung variieren. Die erforderliche Literatur steht den Studierenden in der Institutsbibliothek zur Verfügung.

↑

Related courses

Rules for the choice of courses

Prior successful completion of the module ‘Wastewater and Sludge Treatment’ or the module ‘Waste and Ressource Management’ is strongly recommended.
This module is only availabe to students specializing in Sanitary and Environmental Engineering or Waste Management. Number of participants is limited to max. 40 participants.

Compulsory attendance

This class has a compulsory attendance of 50 hours (first class meeting, student presentations, final group project). If students are absent with valid excuse (e.g. illness, child care etc.) individual solutions can be found for being able to complete the class successfully and still reach educational objectives of the class. Periods of absence may not exceed 15% of compulsory attendance, in order to reach educational objectives of the class.

Name of the course	SWS	Eventtype	Language
	1,0	Lecture	german
	3,0	Seminar	german

Title	Mechanical and Thermal Waste Treatment and Air Pollution Control		
Number	4398340	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Abfall- und Ressourcenwirtschaft
Hours per Week / ECTS	4 / 6,0	**Module owner**	Dr. Kai Münnich
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 Min.) or oral exam (approx. 30 Min.)		
Course achievement			

Contents

[Mechanical and Thermal Treatment of Waste (VÜ)]
The lecture "Mechanical and Thermal Treatment of Waste" imparts knowledge on the thermo-chemical conversion of municipal waste. It focuses on household waste, commercial waste, sewage sludge and hazardous waste. The route from mechanical preparation to conversion and gas purification is described; design principles, planning and design of plants. In addition to technical aspects, legal and licensing aspects are covered.

[Technologies and Concepts for Air Pollution Control and Climate Protection (VÜ)]
Knowledge of legal regulations relevant to exhaust air, of construction and operational requirements, of different technologies for air purification; methods for monitoring and analyses and teaching the ability to design and plan individual components.

Objective qualification

Students gain in-depth knowledge of processes for the mechanical and thermal treatment of waste. The relevant basics of the waste law, in particular with the legal regulations for thermal waste treatment, are taken into account here. Furthermore, detailed knowledge about waste incineration plants, the thermal use of waste in industrial processes as well as in biomass power plants with the respective upstream treatment chains is imparted. The course enables the students to calculate performance data of incineration plants as well as to perform the rough design of plants.

Students acquire basic knowledge of technologies and concepts for emission prevention and reduction as well as air pollution control with a focus on the sectors of waste, wastewater and energy production. Students will be able to develop, plan, implement/execute and operate total solutions. Furthermore, they are able to recognize, analyze and evaluate regional and supra-regional ecological contexts in order to take these findings into account in planning tasks.

Literature

PowerPoint Folien, Literaturempfehlungen.

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture/Exercise	german
	2,0	Lecture/Exercise	german

Title	Waste-Analytical Practical Course for Environmental Engineering		
Number	4398350	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Abfall- und Ressourcenwirtschaft
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Andreas Haarstrick
Workload (h)			
Class attendance (h)		**Self studying (h)**	
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Contents			
Objective qualification			
Literature			
Die erforderliche Literatur wird mit dem Praktikumsskript bekannt gegeben.			

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Internship	german

Title	Wastewater and Sludge Treatment		
Number	4398270	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Siedlungswasserwirtschaft
Hours per Week / ECTS	5 / 6,0	**Module owner**	Prof. Dr. Thomas Dockhorn
Workload (h)	180		
Class attendance (h)	70	**Self studying (h)**	110
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 Min.) or oral exam (approx. 60 Min.)		
Course achievement			

Contents

[Processes of Wastewater Treatment (VÜ)]
The class gives a comprehensive overview of wastewater treatment an introduces wastewater parameters (organic carbon compounds, nitrogen, phosphorus compounds, relevant toxic substances) and all major processes of wastewater treatment (mechanical wastewater treatment, biological wastewater treatment, activated sludge process, special treatment procedures e.g. biofiltration, membrane processes, SBR-reactors, chemical treatment processes e.g. precipitation and flocculation as well as aeration and gas exchange).
An additional tutorial discusses special topics in detail and presents calculation and dimensioning examples.

[Sewage Sludge Treatment and Disposal (VÜ)]
The class presents the entire process of sewage sludge treatment, starting with sludge production, sludge characteristics (physical, chemical, biological), various types of sludge stabilisation (aerobic/anaerobic), biogas utilization and sludge disinfection up to sludge disposal options, legal regulations and disposal costs. Special importance is given to questions of sludge reuse and nutrient recovery

Objective qualification

Students will gain detailed and comprehensive understanding of processes and objectives of municipal wastewater and sludge treatment. On the basis of their fundamental knowledge in sanitary engineering from prior studies, students acquire advanced engineering qualifications and scientific skills to understand, design and operate wastewater and sludge treatment plants. They will be able to dimension all treatment processes independently and will be able to carry out research and practical projects in the field of wastewater and sludge treatment. They will be able to critically discuss various process options and find adequate solutions taking into consideration environmental, social, scientific and ethical concerns

Literature

Es stehen ausführliche Skripte zu den Veranstaltungen [Verfahrenstechnik der Abwasserreinigung] und [Klärschlammbehandlung] zur Verfügung.

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture/Exercise	german
	3,0	Lecture/Exercise	german

Title	Practical Lab Training and Dimensioning of Treatment Plants		
Number	4398280	**Module version**	4398280-E-FK3
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Siedlungswasserwirtschaft
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Thomas Dockhorn
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements	Prerequisite is prior participation in the module "Wastewater and Sludge Treatment"		
Recommended requirements	Students are expected to have a thorough knowledge of treatment processes for wastewater and sludge treatment in order to participate in this class.		
Expected performance/ Type of examination	The portfolio covers a detailed handout for each class, showing lab results and scientific discussion of the results or dimensioning drafts and scientific evaluation of the draft. Portfolios are design in independent teams under tuition of the lecturer. Lab results and scientific background will be presented to the class participants and the lab tutors in a final 30-minute seminar presentation. Grading will be based on participation during the lab days and on the quality of the presentation and on the corresponding student handout. Deregistration from the exam is possible up to wo weeks before the scheduled class participation. Dates for class presentations are scheduled in the first class meeting. The class Dimensioning and Design of Treatment Plants has a compulsory attendance of 16 hours (first class meeting, final class meeting). If students are absent with valid excuse (e.g. illness, child care etc.) individual solutions can be found for being able to complete the class successfully and still reach educational objectives of the class. Periods of absence may not exceed 15% of compulsory attendance, in order to reach educational objectives of the class. Practical Lab Training has a compulsory attendance of 40 hours (first class meeting, lab days, final class meeting). If students are absent with valid excuse (e.g. illness, child care etc.) individual solutions can be found for being able to complete the class successfully and still reach educational objectives of the class. Periods of absence may not exceed 15% of compulsory attendance, in order to reach educational objectives of the class.		
Course achievement			

Contents

[Dimensioning and Design of Treatment Plants (S)]
During the class, participants will work independently in student teams and will dimension the most important components of a wastewater treatment plant. Using the information and knowledge acquired in the prior classes on wastewater and sludge treatment as well as given dimensioning data, the students will design a wastewater treatment plant. Every other week meetings with the instructor and/or tutor will take place in order to discuss problems encountered during the work process. At the end of the semester each team will present its project to the class and discuss it with the participants and turn in a written report on the project work.

[Practical Lab Training on Wastewater Treatment (Ü)]
During the practical lab training, tutored lab experiments will be conducted in relation to current research projects of the institute (e.g. degradation experiments, precipitation/flocculation, respiration experiments, microscopic experiments, monitoring of experimental set-ups). Several tutored lab days will be arranged for conducting the experiments. Lab results and scientific background will be presented to the class participants in a final 30-minute seminar presentation. Grading will be based on participation during the lab days and on the quality of the presentation and on the corresponding student handout.

Objective qualification

Students are able to work independently in a research lab for wastewater and sludge treatment and discuss environmental engineering questions at a scientific level. They are able to independently acquire additional knowledge in the field of environmental engineering and can find solutions for wastewater problems at various levels. They are able to skillfully present their solutions to the public. A special focus in this seminar is on doing practical lab work, practicing teamwork, acquiring debate techniques and rhetorical skills and learning how to discuss controversial questions in a scientific setting.

Literature

Die für die einzelnen Lehrveranstaltungen relevante Fachliteratur kann je nach Aufgabenstellung variieren. Die erforderliche Literatur steht den Studierenden in der Institutsbibliothek zur Verfügung und wird jeweils zu Beginn der Veranstaltungen bekannt gegeben.

↑

Related courses

Rules for the choice of courses

Prior successful completion of the module ‘Wastewater and Sludge Treatment’ is pre-requisite for participating in this module. Students from other universities must have sufficient basic knowledge in the field of wastewater and sludge treatment.

Compulsory attendance

The class Dimensioning and Design of Treatment Plants has a compulsory attendance of 16 hours (first class meeting, final class meeting). If students are absent with valid excuse (e.g. illness, child care etc.) individual solutions can be found for being able to complete the class successfully and still reach educational objectives of the class. Periods of absence may not exceed 15% of compulsory attendance, in order to reach educational objectives of the class.

Practical Lab Training has a compulsory attendance of 40 hours (first class meeting, lab days, final class meeting). If students are absent with valid excuse (e.g. illness, child care etc.) individual solutions can be found for being able to complete the class successfully and still reach educational objectives of the class. Periods of absence may not exceed 15% of compulsory attendance, in order to reach educational objectives of the class.

Name of the course	SWS	Eventtype	Language
	2,0	Seminar	german
	2,0	Internship	german

Title	Drinking Water Treatment and Wastewater Discharge		
Number	4398300	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration		**Institution**	Institut für Siedlungswasserwirtschaft
Hours per Week / ECTS	0 / 6,0	**Module owner**	Prof. Dr. Thomas Dockhorn
Workload (h)			
Class attendance (h)		**Self studying (h)**	
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 Min.) or oral exam (approx. 60 Min.)		
Course achievement			

Contents

[Drinking Water Treatment]
The class introduces basic processes of drinking water treatment, legal regulations and drinking water standards. It presents treatment processes such as decarbonisation, flocculation, filtration, removal of iron and manganese, calcium carbonate equilibrium, processes for water softening, removal of organic compounds and water disinfection. The class also discusses world-wide problems concerning drinking water supply and treatment.

[Discharge of Municipal Wastewater (VÜ)]
The course presents a general introduction on various aspects of sewer systems. The class consists of three theoretical class meetings and two field trips. Class meetings cover the topics sewer net hydraulics, dimensioning of sewers, sewer inspection, pipes, pipe materials, separate and combined sewer systems. The field trips present the practical aspects such as manhole entry, sewer construction zones and an Oker boat tour in regard to drinking water aspects.

Objective qualification

[Drinking Water Treatment]
Students gain general knowledge of all questions concerning drinking water production, supply and treatment. They are able to dimension drinking water treatment plants. They understand world-wide concerns in regard to drinking water supply and treatment. They are able to critically discuss various treatment options and find adequate solutions taking into consideration social, scientific and ethical concerns.

[Discharge of Municipal Wastewater]
Students gain advanced knowledge of modern sewer systems and are able to analyse and understand hydraulic, topographic and operational correlations in a sewer system. They are able to design new sewer systems and evaluate existing systems. They are able to critically discuss problems of wastewater discharge and find adequate solutions taking into consideration environmental, scientific and ethical concerns.

Literature

Comprehensive lecture notes for ‘Drinking Water Treatment’ are available for download. Technical literature and additional information for the class ‘Discharge of Municipal Wastewater’ is presented during the class.

↑

Related courses
Rules for the choice of courses
Compulsory attendance
The class ‘Discharge of Municipal Wastewater’ has compulsory attendance (first class meeting, theoretical lectures, field trips). Participation in the theoretical lessons is pre-requisite to understand the problems presented in the field trips. If students are absent with valid excuse (e.g. illness, child care etc.) individual solutions can be found for being able to complete the class successfully and still reach educational objectives of the class. Periods of absence may not exceed 15% of compulsory attendance, in order to reach educational objectives of the class

Name of the course	SWS	Eventtype	Language
	2,0	Lecture/Exercise	german
Drinking Water Treatment	2,0	Lecture/Exercise	german

Specialisation Waste and Resource Management

Title	Waste and Resource Management		
Number	4398320	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration	1	**Institution**	Abteilung Abfall- und Ressourcenwirtschaft
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Julia Gebert
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.) or oral exam (approx. 30 Min.) (in the Master's programme in Social Sciences as a course achievement)		
Course achievement			

Contents

Waste management concepts; acquisition logistics; plant and process technology (with focus on biological processes; methods for process control and monitoring; emission control; product development; secondary raw materials; methods for quality control of secondary raw materials; design principles, plant planning and design, and waste analytics.

Objective qualification

Students acquire in-depth knowledge of tasks and solution methods of municipal and industrial waste and resource management as well as material flow-related recycling management. The special focus is on biological treatment and recycling processes for municipal waste. Here, required work steps and methods for the implementation of management measures and plant technologies are learned.
Evaluation methods for describing and assessing economic, ecological and social impacts are taught and applied. Special knowledge in the field of the use of regenerative energies from municipal waste is acquired. In this lecture, students will be able to use their acquired knowledge to evaluate waste management concepts and to perform rough measurements of selected process steps/aggregates

Literature

ausführliches Skript, PowerPoint Folien, Literaturempfehlungen

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Landfill Technology and Remediation of Contaminated Sites		
Number	4398330	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Abfall- und Ressourcenwirtschaft
Hours per Week / ECTS	4 / 6,0	**Module owner**	Dr. Kai Münnich
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 Min.) or oral exam (approx. 30 Min.)		
Course achievement			

Contents

[Landfill Mining, Landfill Construction and Geotechnique of Wastes (VÜ)}
Fundamentals of waste mechanics und the hydarulic behaviour of wastes; interaction between the different parameters; constructive elements of landfills; emissions from landfills and their monitoring; longterm behaviour of landfills; position and after-use of landfills; Landfills in emerging and developing countries; legal basis.

[Investigation and Remediation of Contaminated Sites (VÜ)]
Contaminants in soil and groundwater; procedures for exploration; control of soil air; sampling of soil, soil air and groundwater; evaluation and assessment of analytical results; techniques for in-site and on-/off-sites remediation; procedures for groundwater treatment; biological, thermal and physical treatment of soils; after-use of contaminated sites; landfill mining.

Objective qualification

Students acquire in-depth knowledge of the construction and operation of landfills for municipal solid waste (MSW). The aspects of the position of the landfill in the waste management, the legal framework, the site search, the technical installations up to the aftercare, the monitoring and the landfill mining are considered. Furthermore, they gain detailed knowledge about the mechanical properties of waste as well as the long-term behavior in terms of water and gas emissions. Overall, there is a focus on the situation in emerging and developing countries. This will enable students to understand and evaluate the major dynamic processes of a landfill and to size the required structural components.

Students gain in-depth knowledge of the identification and remediation of contaminated sites. The basic aspects concerning possible pollutants, sources of input and exploration of the soil and groundwater are considered. The possible techniques for remediation of contaminated sites (biological, chemical and physical) are learned. The special case of remediation of old MSW dumps is elaborated in detail. This will enable students to assess a suspected contaminated site and select an appropriate remediation technique for the specific case.

Literature

PowerPoint Folien, Literaturempfehlungen
Remark

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture/Exercise	german
	2,0	Lecture/Exercise	german

Title	International Wastewater and Waste Management		
Number	4398310	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Siedlungswasserwirtschaft
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Thomas Dockhorn
Workload (h)	180		
Class attendance (h)	50	**Self studying (h)**	130
Compulsory requirements			
Recommended requirements	Prior successful completion of the module ‘Wastewater and Sludge Treatment’ or the module ‘Waste and Ressource Management’ is strongly recommended.		
Expected performance/ Type of examination	Portfolio and presentation		
Course achievement	Students will prepare a 30-minute presentation in teams. The information given in the lectures and in the student presentations are the basis for developing disposal concepts in team work at the end of the class. The portfolio covers a structured presentation of the team results for the developed disposal concepts. Portfolios are created by the teams under supervision of the institute’s assistants. It is possible to drop the class up to two weeks before the final group project. Organization of groups and assignment of research topics takes place in the first class meeting. This class has a compulsory attendance of 50 hours (first class meeting, student presentations, final group project). If students are absent with valid excuse (e.g. illness, child care etc.) individual solutions can be found for being able to complete the class successfully and still reach educational objectives of the class. Periods of absence may not exceed 15% of compulsory attendance, in order to reach educational objectives of the class.		

Contents

[International Wastewater and Waste Management (V)]
The class introduces the topic of waste and wastewater treatment in an international context by presenting various problems and solutions from developing and emerging countries. These lectures are the introduction, basis and preparation for the team work of the following seminar ‘Waste, Wastewater and Resource Management for Developing and Emerging Countries’.

[Waste, Wastewater and Resource Management for Developing and Emerging Countries (S)]
Participants will work independently in student teams and will develop a concept for the disposal of municipal waste and wastewater. Two locations in different parts of the world will be chosen each semester and students will establish a disposal concept for these locations taking into consideration specific legal, geographical, political and social conditions.
As preparatory work, teams of two students each will prepare a 30-minute presentation dealing with basic questions such as processes of wastewater and waste treatment, costs and planning of treatment plants, economy, infrastructure, culture and religion in the area and present their results to the class.

With this information, two teams (one for each location) will then develop a complete disposal concept as a group project during the 2-day block seminar at the end of the course. Finally, the developed concepts will be introduced to the class in a 30-minute presentation and will be discussed with the participants. A written report is required to complete the class.

Objective qualification

Students are able to understand and solve problems in the field of international wastewater and waste management. They will acquire fundamental knowledge for solving problems concerning waste and wastewater in developing and emerging countries taking into special consideration country-specific aspects. They will have the ability to adapt suitable concepts and technologies to given locations with special reference to globalization. Understanding material flow management and resource protection in a global context are a further teaching objective. Students are able to scientifically discuss engineering problems in a team and to acquire additional required knowledge independently. They are able to analyse and evaluate existing problems under consideration of country-specific aspects and are able to find and realize strategies for solving these problems under given local conditions (regional governance). They are able to skillfully present their solutions to the public. A special focus in this seminar is on practicing teamwork, acquiring debate techniques and rhetorical skills and learning how to discuss controversial questions in a scientific setting.

Literature

Die relevante Fachliteratur kann je nach Aufgabenstellung variieren. Die erforderliche Literatur steht den Studierenden in der Institutsbibliothek zur Verfügung.

↑

Related courses

Rules for the choice of courses

Prior successful completion of the module ‘Wastewater and Sludge Treatment’ or the module ‘Waste and Ressource Management’ is strongly recommended.
This module is only availabe to students specializing in Sanitary and Environmental Engineering or Waste Management. Number of participants is limited to max. 40 participants.

Compulsory attendance

This class has a compulsory attendance of 50 hours (first class meeting, student presentations, final group project). If students are absent with valid excuse (e.g. illness, child care etc.) individual solutions can be found for being able to complete the class successfully and still reach educational objectives of the class. Periods of absence may not exceed 15% of compulsory attendance, in order to reach educational objectives of the class.

Name of the course	SWS	Eventtype	Language
	1,0	Lecture	german
	3,0	Seminar	german

Title	Mechanical and Thermal Waste Treatment and Air Pollution Control		
Number	4398340	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Abfall- und Ressourcenwirtschaft
Hours per Week / ECTS	4 / 6,0	**Module owner**	Dr. Kai Münnich
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 Min.) or oral exam (approx. 30 Min.)		
Course achievement			

Contents

[Mechanical and Thermal Treatment of Waste (VÜ)]
The lecture "Mechanical and Thermal Treatment of Waste" imparts knowledge on the thermo-chemical conversion of municipal waste. It focuses on household waste, commercial waste, sewage sludge and hazardous waste. The route from mechanical preparation to conversion and gas purification is described; design principles, planning and design of plants. In addition to technical aspects, legal and licensing aspects are covered.

[Technologies and Concepts for Air Pollution Control and Climate Protection (VÜ)]
Knowledge of legal regulations relevant to exhaust air, of construction and operational requirements, of different technologies for air purification; methods for monitoring and analyses and teaching the ability to design and plan individual components.

Objective qualification

Students gain in-depth knowledge of processes for the mechanical and thermal treatment of waste. The relevant basics of the waste law, in particular with the legal regulations for thermal waste treatment, are taken into account here. Furthermore, detailed knowledge about waste incineration plants, the thermal use of waste in industrial processes as well as in biomass power plants with the respective upstream treatment chains is imparted. The course enables the students to calculate performance data of incineration plants as well as to perform the rough design of plants.

Students acquire basic knowledge of technologies and concepts for emission prevention and reduction as well as air pollution control with a focus on the sectors of waste, wastewater and energy production. Students will be able to develop, plan, implement/execute and operate total solutions. Furthermore, they are able to recognize, analyze and evaluate regional and supra-regional ecological contexts in order to take these findings into account in planning tasks.

Literature

PowerPoint Folien, Literaturempfehlungen.

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture/Exercise	german
	2,0	Lecture/Exercise	german

Title	Waste-Analytical Practical Course for Environmental Engineering		
Number	4398350	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Abfall- und Ressourcenwirtschaft
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Andreas Haarstrick
Workload (h)			
Class attendance (h)		**Self studying (h)**	
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Contents			
Objective qualification			
Literature			
Die erforderliche Literatur wird mit dem Praktikumsskript bekannt gegeben.			

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Internship	german

Title	Fundamentals Waste Management Officer		
Number	3321000000	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration	1	**Institution**	Abteilung Abfall- und Ressourcenwirtschaft
Hours per Week / ECTS	3 / 4,0	**Module owner**	Prof. Dr. Julia Gebert
Workload (h)	128		
Class attendance (h)	42	**Self studying (h)**	86
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Contents			
Objective qualification			
Literature			
Folien u.a. durch die Lehrenden bereitgestelltes Material; Nagel, J. (2022): Der Abfallbeauftragte. Erich Schmidt Verlag GmbH & Co. KG Berlin. https://doi.org/10.37307/b.978-3-503-20079-5			

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	3,0	Lecture/Exercise	german

Specialisation Sanitary Engineering

Title	Wastewater and Sludge Treatment		
Number	4398270	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Siedlungswasserwirtschaft
Hours per Week / ECTS	5 / 6,0	**Module owner**	Prof. Dr. Thomas Dockhorn
Workload (h)	180		
Class attendance (h)	70	**Self studying (h)**	110
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 Min.) or oral exam (approx. 60 Min.)		
Course achievement			

Contents

[Processes of Wastewater Treatment (VÜ)]
The class gives a comprehensive overview of wastewater treatment an introduces wastewater parameters (organic carbon compounds, nitrogen, phosphorus compounds, relevant toxic substances) and all major processes of wastewater treatment (mechanical wastewater treatment, biological wastewater treatment, activated sludge process, special treatment procedures e.g. biofiltration, membrane processes, SBR-reactors, chemical treatment processes e.g. precipitation and flocculation as well as aeration and gas exchange).
An additional tutorial discusses special topics in detail and presents calculation and dimensioning examples.

[Sewage Sludge Treatment and Disposal (VÜ)]
The class presents the entire process of sewage sludge treatment, starting with sludge production, sludge characteristics (physical, chemical, biological), various types of sludge stabilisation (aerobic/anaerobic), biogas utilization and sludge disinfection up to sludge disposal options, legal regulations and disposal costs. Special importance is given to questions of sludge reuse and nutrient recovery

Objective qualification

Students will gain detailed and comprehensive understanding of processes and objectives of municipal wastewater and sludge treatment. On the basis of their fundamental knowledge in sanitary engineering from prior studies, students acquire advanced engineering qualifications and scientific skills to understand, design and operate wastewater and sludge treatment plants. They will be able to dimension all treatment processes independently and will be able to carry out research and practical projects in the field of wastewater and sludge treatment. They will be able to critically discuss various process options and find adequate solutions taking into consideration environmental, social, scientific and ethical concerns

Literature

Es stehen ausführliche Skripte zu den Veranstaltungen [Verfahrenstechnik der Abwasserreinigung] und [Klärschlammbehandlung] zur Verfügung.

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture/Exercise	german
	3,0	Lecture/Exercise	german

Title	Practical Lab Training and Dimensioning of Treatment Plants		
Number	4398280	**Module version**	4398280-E-FK3
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Siedlungswasserwirtschaft
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Thomas Dockhorn
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements	Prerequisite is prior participation in the module "Wastewater and Sludge Treatment"		
Recommended requirements	Students are expected to have a thorough knowledge of treatment processes for wastewater and sludge treatment in order to participate in this class.		
Expected performance/ Type of examination	The portfolio covers a detailed handout for each class, showing lab results and scientific discussion of the results or dimensioning drafts and scientific evaluation of the draft. Portfolios are design in independent teams under tuition of the lecturer. Lab results and scientific background will be presented to the class participants and the lab tutors in a final 30-minute seminar presentation. Grading will be based on participation during the lab days and on the quality of the presentation and on the corresponding student handout. Deregistration from the exam is possible up to wo weeks before the scheduled class participation. Dates for class presentations are scheduled in the first class meeting. The class Dimensioning and Design of Treatment Plants has a compulsory attendance of 16 hours (first class meeting, final class meeting). If students are absent with valid excuse (e.g. illness, child care etc.) individual solutions can be found for being able to complete the class successfully and still reach educational objectives of the class. Periods of absence may not exceed 15% of compulsory attendance, in order to reach educational objectives of the class. Practical Lab Training has a compulsory attendance of 40 hours (first class meeting, lab days, final class meeting). If students are absent with valid excuse (e.g. illness, child care etc.) individual solutions can be found for being able to complete the class successfully and still reach educational objectives of the class. Periods of absence may not exceed 15% of compulsory attendance, in order to reach educational objectives of the class.		
Course achievement			

Contents

[Dimensioning and Design of Treatment Plants (S)]
During the class, participants will work independently in student teams and will dimension the most important components of a wastewater treatment plant. Using the information and knowledge acquired in the prior classes on wastewater and sludge treatment as well as given dimensioning data, the students will design a wastewater treatment plant. Every other week meetings with the instructor and/or tutor will take place in order to discuss problems encountered during the work process. At the end of the semester each team will present its project to the class and discuss it with the participants and turn in a written report on the project work.

[Practical Lab Training on Wastewater Treatment (Ü)]
During the practical lab training, tutored lab experiments will be conducted in relation to current research projects of the institute (e.g. degradation experiments, precipitation/flocculation, respiration experiments, microscopic experiments, monitoring of experimental set-ups). Several tutored lab days will be arranged for conducting the experiments. Lab results and scientific background will be presented to the class participants in a final 30-minute seminar presentation. Grading will be based on participation during the lab days and on the quality of the presentation and on the corresponding student handout.

Objective qualification

Students are able to work independently in a research lab for wastewater and sludge treatment and discuss environmental engineering questions at a scientific level. They are able to independently acquire additional knowledge in the field of environmental engineering and can find solutions for wastewater problems at various levels. They are able to skillfully present their solutions to the public. A special focus in this seminar is on doing practical lab work, practicing teamwork, acquiring debate techniques and rhetorical skills and learning how to discuss controversial questions in a scientific setting.

Literature

Die für die einzelnen Lehrveranstaltungen relevante Fachliteratur kann je nach Aufgabenstellung variieren. Die erforderliche Literatur steht den Studierenden in der Institutsbibliothek zur Verfügung und wird jeweils zu Beginn der Veranstaltungen bekannt gegeben.

↑

Related courses

Rules for the choice of courses

Prior successful completion of the module ‘Wastewater and Sludge Treatment’ is pre-requisite for participating in this module. Students from other universities must have sufficient basic knowledge in the field of wastewater and sludge treatment.

Compulsory attendance

The class Dimensioning and Design of Treatment Plants has a compulsory attendance of 16 hours (first class meeting, final class meeting). If students are absent with valid excuse (e.g. illness, child care etc.) individual solutions can be found for being able to complete the class successfully and still reach educational objectives of the class. Periods of absence may not exceed 15% of compulsory attendance, in order to reach educational objectives of the class.

Practical Lab Training has a compulsory attendance of 40 hours (first class meeting, lab days, final class meeting). If students are absent with valid excuse (e.g. illness, child care etc.) individual solutions can be found for being able to complete the class successfully and still reach educational objectives of the class. Periods of absence may not exceed 15% of compulsory attendance, in order to reach educational objectives of the class.

Name of the course	SWS	Eventtype	Language
	2,0	Seminar	german
	2,0	Internship	german

Title	Drinking Water Treatment and Wastewater Discharge		
Number	4398300	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration		**Institution**	Institut für Siedlungswasserwirtschaft
Hours per Week / ECTS	0 / 6,0	**Module owner**	Prof. Dr. Thomas Dockhorn
Workload (h)			
Class attendance (h)		**Self studying (h)**	
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 Min.) or oral exam (approx. 60 Min.)		
Course achievement			

Contents

[Drinking Water Treatment]
The class introduces basic processes of drinking water treatment, legal regulations and drinking water standards. It presents treatment processes such as decarbonisation, flocculation, filtration, removal of iron and manganese, calcium carbonate equilibrium, processes for water softening, removal of organic compounds and water disinfection. The class also discusses world-wide problems concerning drinking water supply and treatment.

[Discharge of Municipal Wastewater (VÜ)]
The course presents a general introduction on various aspects of sewer systems. The class consists of three theoretical class meetings and two field trips. Class meetings cover the topics sewer net hydraulics, dimensioning of sewers, sewer inspection, pipes, pipe materials, separate and combined sewer systems. The field trips present the practical aspects such as manhole entry, sewer construction zones and an Oker boat tour in regard to drinking water aspects.

Objective qualification

[Drinking Water Treatment]
Students gain general knowledge of all questions concerning drinking water production, supply and treatment. They are able to dimension drinking water treatment plants. They understand world-wide concerns in regard to drinking water supply and treatment. They are able to critically discuss various treatment options and find adequate solutions taking into consideration social, scientific and ethical concerns.

[Discharge of Municipal Wastewater]
Students gain advanced knowledge of modern sewer systems and are able to analyse and understand hydraulic, topographic and operational correlations in a sewer system. They are able to design new sewer systems and evaluate existing systems. They are able to critically discuss problems of wastewater discharge and find adequate solutions taking into consideration environmental, scientific and ethical concerns.

Literature

Comprehensive lecture notes for ‘Drinking Water Treatment’ are available for download. Technical literature and additional information for the class ‘Discharge of Municipal Wastewater’ is presented during the class.

↑

Related courses
Rules for the choice of courses
Compulsory attendance
The class ‘Discharge of Municipal Wastewater’ has compulsory attendance (first class meeting, theoretical lectures, field trips). Participation in the theoretical lessons is pre-requisite to understand the problems presented in the field trips. If students are absent with valid excuse (e.g. illness, child care etc.) individual solutions can be found for being able to complete the class successfully and still reach educational objectives of the class. Periods of absence may not exceed 15% of compulsory attendance, in order to reach educational objectives of the class

Name of the course	SWS	Eventtype	Language
	2,0	Lecture/Exercise	german
Drinking Water Treatment	2,0	Lecture/Exercise	german

Title	International Wastewater and Waste Management		
Number	4398310	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Siedlungswasserwirtschaft
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Thomas Dockhorn
Workload (h)	180		
Class attendance (h)	50	**Self studying (h)**	130
Compulsory requirements			
Recommended requirements	Prior successful completion of the module ‘Wastewater and Sludge Treatment’ or the module ‘Waste and Ressource Management’ is strongly recommended.		
Expected performance/ Type of examination	Portfolio and presentation		
Course achievement	Students will prepare a 30-minute presentation in teams. The information given in the lectures and in the student presentations are the basis for developing disposal concepts in team work at the end of the class. The portfolio covers a structured presentation of the team results for the developed disposal concepts. Portfolios are created by the teams under supervision of the institute’s assistants. It is possible to drop the class up to two weeks before the final group project. Organization of groups and assignment of research topics takes place in the first class meeting. This class has a compulsory attendance of 50 hours (first class meeting, student presentations, final group project). If students are absent with valid excuse (e.g. illness, child care etc.) individual solutions can be found for being able to complete the class successfully and still reach educational objectives of the class. Periods of absence may not exceed 15% of compulsory attendance, in order to reach educational objectives of the class.		

Contents

[International Wastewater and Waste Management (V)]
The class introduces the topic of waste and wastewater treatment in an international context by presenting various problems and solutions from developing and emerging countries. These lectures are the introduction, basis and preparation for the team work of the following seminar ‘Waste, Wastewater and Resource Management for Developing and Emerging Countries’.

[Waste, Wastewater and Resource Management for Developing and Emerging Countries (S)]
Participants will work independently in student teams and will develop a concept for the disposal of municipal waste and wastewater. Two locations in different parts of the world will be chosen each semester and students will establish a disposal concept for these locations taking into consideration specific legal, geographical, political and social conditions.
As preparatory work, teams of two students each will prepare a 30-minute presentation dealing with basic questions such as processes of wastewater and waste treatment, costs and planning of treatment plants, economy, infrastructure, culture and religion in the area and present their results to the class.

With this information, two teams (one for each location) will then develop a complete disposal concept as a group project during the 2-day block seminar at the end of the course. Finally, the developed concepts will be introduced to the class in a 30-minute presentation and will be discussed with the participants. A written report is required to complete the class.

Objective qualification

Students are able to understand and solve problems in the field of international wastewater and waste management. They will acquire fundamental knowledge for solving problems concerning waste and wastewater in developing and emerging countries taking into special consideration country-specific aspects. They will have the ability to adapt suitable concepts and technologies to given locations with special reference to globalization. Understanding material flow management and resource protection in a global context are a further teaching objective. Students are able to scientifically discuss engineering problems in a team and to acquire additional required knowledge independently. They are able to analyse and evaluate existing problems under consideration of country-specific aspects and are able to find and realize strategies for solving these problems under given local conditions (regional governance). They are able to skillfully present their solutions to the public. A special focus in this seminar is on practicing teamwork, acquiring debate techniques and rhetorical skills and learning how to discuss controversial questions in a scientific setting.

Literature

Die relevante Fachliteratur kann je nach Aufgabenstellung variieren. Die erforderliche Literatur steht den Studierenden in der Institutsbibliothek zur Verfügung.

↑

Related courses

Rules for the choice of courses

Prior successful completion of the module ‘Wastewater and Sludge Treatment’ or the module ‘Waste and Ressource Management’ is strongly recommended.
This module is only availabe to students specializing in Sanitary and Environmental Engineering or Waste Management. Number of participants is limited to max. 40 participants.

Compulsory attendance

This class has a compulsory attendance of 50 hours (first class meeting, student presentations, final group project). If students are absent with valid excuse (e.g. illness, child care etc.) individual solutions can be found for being able to complete the class successfully and still reach educational objectives of the class. Periods of absence may not exceed 15% of compulsory attendance, in order to reach educational objectives of the class.

Name of the course	SWS	Eventtype	Language
	1,0	Lecture	german
	3,0	Seminar	german

Specialisation Water Management

Title	Hydrology and Water Resources Management		
Number	4310260	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Hydrologie und Flussgebietsmanagement
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Kai Schröter
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 Min.) or oral exam (approx. 60 Min.)		
Course achievement			

Contents

[Hydrology and water management (VÜ)]
Hydrological processes and process models for precipitation, evaporation, snow, soil moisture, runoff generation, runoff concentration and flood routing; integration of processes in catchment models for event and long-term continuous systems and determination of design values. Model applications using the PC for catchment modeling, flood protection planning and water balance studies; evaluation of the results.

Objective qualification

Students will gain knowledge of the processes of runoff formation, runoff concentration, and flood-routing and their implementation in simulation models. They will be able to apply a mesoscale rainfall-runoff model to a catchment area, to evaluate results and to carry out flood prevention planning. They acquire the basics to perform an economic evaluation of flood protection measures in terms of benefits and costs.

Literature

- Baumgartner, A., Liebscher, H.-J., & Benecke, P. (2011, February 25). Allgemeine Hydrologie. Schweizerbart'sche Verlagsbuchhandlung. https://www.schweizerbart.de/publications/detail/isbn/9783443300029
- Dyck, S., & Peschke, G. (1995). Grundlagen der Hydrologie (3., stark bearb. Aufl.). Verlag für Bauwesen.
- Maniak, U. (2016). Hydrologie und Wasserwirtschaft: Eine Einführung für Ingenieure (7., neu bearbeitete Auflage). Springer Vieweg. https://doi.org/10.1007/978-3-662-49087-7
- Fohrer, N. (Hrsg.), Bormann, H., Miegel, K., Casper, M., Bronstert, A., Schumann, A., Weiler, M. (2016): Hydrologie. utb.basics, Haupt Verlag, Bern.
- Patt, H., & Jüpner, R. (Eds.). (2020). Hochwasser-Handbuch: Auswirkungen und Schutz. Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-26743-8
- Shaw, E. M., Beven, K. J., Chappell, N. A., & Lamb, R. (2011). Hydrology in Practice, Fourth Edition. Spon Press. http://www.crcpress.com/product/isbn/9780415370417

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Hydrogeology and Groundwater Management		
Number	4310270	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Hydrologie und Flussgebietsmanagement
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Matthias Schöniger
Workload (h)			
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 Min.) or oral exam (60 Min.)		
Course achievement			

Contents

[Hydrogeology and Groundwater Management (VÜ)]
Basics of hydrogeology and groundwater management, knowledge of the tasks of hydrogeology and groundwater management for sustainable resource use, management objectives according to § 47 of WHG (national water resources act).

Presented are: numerical groundwater software for the calculation of regional groundwater movements, transport processes with simple reaction kinetics, model-based evaluation of quantitative and chemical groundwater conditions.

Objective qualification

Students will gain knowledge about the structure of regional groundwater bodies, the flow and transport processes in aquifer systems and in the vadose zone and the groundwater balance.
They acquire practical skills in the use of computer programs to simulate groundwater movement and transport processes. After successful completion of this module, students will be able to gain an overview of evaluating water management projects according to benefit-cost criteria and other criteria. Another central aspect is learn about complex hydrogeologic processes and the modeling techniques used to model these processes.

Literature

Hill, M.C. & Tiedeman, C.T. (2006): Effecvtive Groundwater Model Calibration. With Analysis of Data, Sensitivities,
Predictions, and Uncertainty.- Wiley- Interscience

Rausch, R., Schäfer, W. & Wagner, C. (2002): Einführung in die Transportmodellierung im Grundwasser.- Gebr.
Borntraeger

Mattheß, G. & Ubell, K. (2003): Allgemeine Hydrogeologie Grundwasserhaushalt.- Gebr. Borntraeger

Skriptum und Simulationsprogramme

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	River Basin Management		
Number	4320090	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Hydrologie und Flussgebietsmanagement
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Kai Schröter
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 Min.) or oral exam (approx. 60 Min.)		
Course achievement	2 Term papers		

Contents

River Basin Management (VÜ).
River basin management (RBM) for the implementation of the EU Water Framework Directive and the EU Floods Directive; International RBM; Model applications for reservoir management; Flood risk management.
[GIS - Applications in River Basin Management (RBM).
Geographic information for hydrologic and hydraulic modeling; digital maps, vector and raster data; intersection techniques; georeferencing; macro languages and programming.

Objective qualification

The students will acquire the ability to perform river basin management according to the requirements of the EU directives. Students will be familiarized with computer-based model applications for river basin management with a focus on reservoir management.
They will be able to process and analyze geographical data in raster and vector form.
They will be able to solve spatial problems and present the results in thematic maps.

Literature

Skripten und Simulationsprogramme

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture/Exercise	german
	2,0	Lecture/Exercise	german

Title	Water Protection - Measurement Technologies and Data analyses		
Number	4310970	**Module version**	V1
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Hydrologie und Flussgebietsmanagement
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Kai Schröter
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Term paper		
Course achievement			

Contents

[Measuring Techniques for Water Quantity and Water Quality (P)]
Measuring techniques for meteorological and hydrological data and their processing (surface water and groundwater); measuring of water quality parameters (physical-chemical variables, biological indicators); sampling from the water body (river, lake) and laboratory analysis; online measuring networks; analysis of measurement data

[Data Processing for Hydrologic and Hydraulic simulations (V)]
Testing, processing and analyzing of data to answer application-related questions and for subsequent usage as input data for hydrologic and hydraulic models. The relevant processes of precipitation, evapotranspiration, soil water movement and runoff transformation are covered in the lecture. Teaching content are universal applicable methods as time series analysis (homogeneity, consistency), regionalisation and extreme value analysis, as well as process-specific methods as correction of measurement errors and the usage of alternative precipitation data sets.

Objective qualification

The students gain varied and interdisciplinary knowledge in data processing and the development of own algorithms for data analysis. An understanding of data structures, data amounts and data plausibility is established. The gained knowledge can be transferred to other disciplines and model software.

Literature

Skripten und Simulationsprogramme

Remark

↑

Related courses			
Rules for the choice of courses			
maximum 12 participants			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Internship	german
	2,0	Lecture/Exercise	german

Title	Water Protection - Water Quality Modeling		
Number	4310730	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Hydrologie und Flussgebietsmanagement
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Kai Schröter
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.) or oral exam (approx. 60 Min.)		
Course achievement	Term paper		

Contents

[Water quality modeling (VÜ)]

water quality parameters and processes; methods for the analysis of measurement data; differential equations for the simulation of completely and incompletely mixed systems; analytical and numerical methods; heat balance; transport and transformation processes of pollutants (e.g. sediment, nitrogen, phosphorus) in water bodies, solving model equations in R programming

Objective qualification

The students gain in-depth knowledge of the interaction of water quantity and water quality in standing and flowing waters at the reach scale. The students will be qualified to quantify the pollution scientifically and technically and to describe it using model algorithms. Using model applications, the students get to know solutions for the improvement of water quality.

Literature

Steven C. Chapra, Surface Water-Quality Modeling, Waveland Press 2008 James L. Martin & Steven C. McCutcheon, Hydrodynamics and Transport for Water Quality Modeling, CRC Press, 1998

↑

Related courses

Rules for the choice of courses

Basic knowledge of water quality parameters and processes is required.

Compulsory attendance

Name of the course	SWS	Eventtype	Language

	4,0	Lecture/Exercise	german

Title	Ecohydrological Modelling of Catchments		
Number	4398800	**Module version**	V1
Shorttext		**Language**	english
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration	1	**Institution**	Abteilung Hydrologie und Flussgebietsmanagement
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Kai Schröter
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam+ (120min) or oral exam+ (30min)		
Course achievement			

Contents

Components of an ecohydrological model system
- Modeling of the water balance (precipitation, evapotranspiration, soil water, runoff formation, runoff concentration, flood-routing)
- Modeling of plant growth
- Modeling of transport and transformation processes of substances (e.g. sediment, nitrogen, phosphorus) in the landscape and in water bodies
- Application of an ecohydrological model on a PC to a mesoscale catchment area
- Influence of different forms of land use, land cultivation and land management on the landscape water regime and nutrient budget
- Modeling and evaluation of management measures for the reduction of emissions from the landscape (technical and nature-based)
- Solving model equations in R programming

Objective qualification

Students will gain in-depth knowledge of the transport and transformation processes of substances in a catchment that occur in the landscape and in a water body, as well as their mathematical description in an eco-hydrological model system. They will be able to set-up an ecohydrological model for a mesoscale catchment, prepare and analyze the model outputs, and evaluate the simulation results. They will acquire fundamental knowledge in modeling and evaluating management measures to reduce substance emissions within and from the catchment.

Literature

- Harper, D.M., Zalewski, M., Pacini, N., 2008. Ecohydrology: Processes, Models and Case Studies: an Approach to the Sustainable Management of Water Resources. CABL
- Haygarth, P.M., Jarvis, S.C., 2002. Agriculture, hydrology and water quality. Pers, C. 2007. HBV-NP Model Manual

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	english

Title	Urban Ecohydrology		
Number	1514300	**Module version**	
Shorttext		**Language**	english
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration	1	**Institution**	Abteilung für Bodenwissenschaften
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Ilhan Özgen
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.) or oral exam (20 Min.)		
Course achievement			

Contents

[Urban Ecohydrology (V)]
The lecture presents topics of ecohydrology in the urban area: urban groundwater, measurement and modelling techniques, decentralised stormwater management and green-blue infrastructure

[Urban Ecohydrology (Ü)]
The exercise consists of calculation exercises that are based on the lecture's topics. Part of the exercise is carried out using the programming language "R".

Objective qualification

Upon completing this module, students will be able to:

- apply theoretical knowledge of the effect of ecosystem services on the urban water cycle
- quantitatively solve ecohydrological problems in the urban area
- apply urban ecohydrological methods

Literature

Baird & Wilby (2000) Eco-Hydrology, Routledge, Oxfordshire, UK.

↑

Related courses

Rules for the choice of courses

Compulsory attendance

Name of the course	SWS	Eventtype	Language

	4,0	Lecture/Exercise	english
Literature			
Baird & Wilby (2000) Eco-Hydrology, Routledge, Oxfordshire, UK			

Title	Hydraulic Engineering		
Number	4320030	**Module version**	V2
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Wasserbau und Gewässermorphologie
Hours per Week / ECTS	6 / 6,0	**Module owner**	Prof. Dr. Jochen Aberle
Workload (h)	180		
Class attendance (h)	62	**Self studying (h)**	118
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.) and presentation and oral exam (approx. 20 Min.)		
Course achievement			

Contents

Hydraulic Engineering (VÜ)
The course deals with the design of hydraulic structures in rivers and streams such as weirs, dams, culverts, stilling basins as well as the hydraulic parts of hydroelectric power plants and hydraulic structures for restoring the longitudinal continuity for ecology and sediments in rivers.

Open Channel Hydraulics – Hydraulic Structures (Ü)
Practical exercises support the contents presented in the course Hydraulic Engineering. This is achieved through the performance of scale model experiments in the teaching and hydraulic engineering laboratory.

Dams (V)
The elective course includes in-depth and supplementary teaching content to the compulsory course "Hydraulic Engineering" with regard to dams. The design and construction principles of reservoirs, retaining walls, dams, flood relief and extraction systems are treated. In addition, the sustainable sediment management of reservoirs is discussed.

Hydraulic Steel Constructions and Offshore-wind turbines (V)
The students acquire knowledge about typical steel constructions in the field of hydraulic engineering and are able to design them. The essential standard regulations are also conveyed.

Experimental Hydraulics (V)
The students acquire in-depth knowledge of experimental hydraulics. hydraulic engineering experiments. This includes dimensional analysis, scaling laws and similarities, scale models, scale models with a movable bed; instrumentation and field measurements.

Objective qualification

The students learn get an in-depth understanding of hydraulic engineering and hydraulic structures. They will be able to explain the functionality of hydraulic structures such as weirs, dams, hydroelectric power plants, continuity structures and crossing structures and to dimension these structures hydraulically. In addi-

tion, they can independently plan and carry out hydraulic scale model tests. Thus, the students are able to develop suitable measures for solving practical problems taking into account special boundary conditions.

Literature

Vorlesungsumdrucke und Fachbücher, wie z.B.:

- Chow, V. T. (1959). Open channel hydraulics. Singapore: McGraw-Hill.
- Giesecke, J.; Heimerl, S.; Mosonyi, E. (2014). Wasserkraftanalagen. Planung, Bau und Betrieb. 6. Auflage. Berlin: Springer Vieweg
- Hager, W., Schleiss, A. J. Boes, R. M., Pfister, M. (2021). Hydraulic Engineering of Dams, CRC Press.
- Muste et al. (2017). Experimental Hydraulics: Methods, Instrumentation, Data Processing and Management, Two Volume Set; Routledge, Taylor and Francis Group
- Patt, H.; Gonsowski, P. (2011). Wasserbau. 7., aktualisierte Auflage. Heidelberg, Springer.
- Strobl, T.; Zunic, F. (2006). Wasserbau. Berlin, Heidelberg, Springer.

↑

Related courses

Rules for the choice of courses

Mandatory courses:
[Hydraulic Engineering] (4 LP), [Open Channel Hydraulics – Hydraulic Structures] (1 LP)

One of the following elective courses: [Dams] (1 LP),
[Hydraulic Steel Constructions and Offshore-Wind Turbines] (1 LP)
[Experimental Hydraulics] (1 LP)

Compulsory attendance

Name of the course	SWS	Eventtype	Language
	1,0	Lecture	german
	4,0	Lecture/Exercise	german
	1,0	Exercise	english german
	1,0	Lecture	german
	1,0	Lecture	english

Title	Eco-Hydraulics		
Number	4320020	**Module version**	V2
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Wasserbau und Gewässermorphologie
Hours per Week / ECTS	6 / 6,0	**Module owner**	Prof. Dr. Jochen Aberle
Workload (h)	180		
Class attendance (h)	66	**Self studying (h)**	114
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.) and oral exam (approx. 30 Min.)		
Course achievement			

Contents

[Near-to-Nature Hydraulic Engineering (Master) (VÜ)]
European Water Framework Directive, River Morphology, Hydraulics of nature-like rivers; Flow resistance of plain river beds composed of different bed material and form resistance of morphological structures; Roughness and resistance coefficients, Sediment transport, Morphological development of rivers, River maintenance and development measures
[Open Channel Hydraulics – Near-to-Nature (Master) (Ü)]
Practical exercises in the field are carried out so that the students learn about the effect of hydraulic, morphological and morphodynamic factors on the flow characteristics of rivers.

[Flow Resistance of Vegetation (Master) (V)]
Approaches are introduced for the determination of parameters to describe riverine vegetation characteristics (rigid, flexible, emergent, submerged) and to determine flow resistance due to vegetation. This is an elective subject serving as an in-depth supplement to the compulsory course "Near-to-Nature Hydraulic Engineering”
[Stream Ecology (Master) (V)]
Introduction into the field of stream ecology and presentation of methods for the determination of water and structural quality of streams.
[Dynamics of Cohesive Sediments (V)]
Introduction into the physical processes governing the dynamics of cohesive sediments in rivers, streams, and estuaries.

Objective qualification

The students learn the basics of essential aspects that are important for near-to-nature hydraulic engineering applications. They will have a basic understanding of flow characteristics, flow resistance and sediment transport in natural rivers and how these are interrelated, also considering the effect of further roughness such as vegetation. The students will be able to define the goals of near-natural revitalization measures, to develop appropriate measures and to evaluate the success of planned and existing revitalization measures. The practical training is underlined by exercises in the field. In addition to hydraulic engineering and environmental hydraulics applications, ecological considerations are also part of the contents to prepare the stu-

dents for the interdisciplinary cooperation with the scientific field of natural sciences that is required in professional life to implement nature-based solutions.
Literature
Literaturhinweise, Fachbücher, und Vorlesungsumdrucke

↑

Related courses
Rules for the choice of courses
Compulsory: [Near-to-Nature Hydraulic Engineering] (3 LP), [Open Channel Hydraulics – Near-to-Nature] (2 LP) One of the elective courses: [Flow Resistance of Vegetation] (1 LP) [Dynamics of Cohesive Sediments] (1 LP) [Stream Ecology] (1 LP) must be chosen.
Compulsory attendance

Name of the course	**SWS**	**Eventtype**	**Language**
	3,0	Lecture/Exercise	german
	2,0	Exercise	german
	1,0	Lecture	german
	1,0	Lecture	german

Title	Numeric Methods in Ground and Surface Waters		
Number	4320040	**Module version**	V2
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Wasserbau und Gewässermorphologie
Hours per Week / ECTS	6 / 6,0	**Module owner**	Prof. Dr. Jochen Aberle
Workload (h)	180		
Class attendance (h)	66	**Self studying (h)**	114
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.) and presentation and oral exam (30 Min.)		
Course achievement			

Contents

[Numerical Methods in Groundwater and Open Channel Flow (Master) (VÜ)]
General: Concepts of models, basics of numerical solutions; discretization of space and time; practical introduction of several hydro numerical programmes
Surface flow: basics of hydraulic modelling; modelling of turbulence; setup of computational grid; 1D to 3D computations; basics of sediment transport modelling; hydraulics of subsurface flow
Groundwater flow: fundamental terms; basic hydraulic formulas; methods for determination of conductivity; modelling of groundwater flow

[Open Channel Hydraulics - numerical (Master) (Ü)]
Introduction to several methods and programmes for numerical modelling of open channel flow; tutorials for modelling groundwater flow

[Hydraulics of Dams and Dikes (Master) (V)]
Complementary and deepening knowledge for considering water in dams and dikes construction

[Sediment Transport Modelling (Master) (V)]
Introduction to computational methods for sediment transport processes

[Numerical Computation of Groundwater Flow in Dams and Dikes (Master) (VÜ)]
Basics of the Finite Elements Method und of the differential method; development of programmes for simple 1D systems; exercises for modelling 1D and 2D systems

Objective qualification

Students gain competent knowledge of the theoretical background for calculating surface and groundwater flow. Thus, they achieve the ability for understanding implications of boundary conditions, assumptions, and simplifications required for hydraulic computational modelling. Consequently, they are able to assess which method/model is appropriate and required, resp., to numerically solve a hydraulic problem. In practical applications the students are introduced to several hydro numerical programmes with emphasizing the critical

discussion of results. The students are, finally, able to handle a hydraulic question by compiling required information, selecting an appropriate programme and analysing and discussing the results.
Literature
Skript vorhanden

↑

Related courses
Rules for the choice of courses
Mandatory: Numerical Methods in Groundwater and Open Channel Flow (3 LP), Open Channel Hydraulics-Numerical (2 LP) Obligatory choice (1 out of 3): Hydraulics of Dams and Dikes (1 LP), Sediment Transport Modelling (1 LP) or Numerical Computation of Groundwater Flow in Dams and Dikes (1 LP)
Compulsory attendance

Name of the course	**SWS**	**Eventtype**	**Language**
	3,0	Lecture/Exercise	german
	2,0	Exercise	german
	1,0	Lecture	german

Title	Project Management in Waterways Engineering		
Number	4398790	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	2	**Institution**	Abteilung Wasserbau und Gewässermorphologie
Hours per Week / ECTS	6 / 6,0	**Module owner**	Prof. Dr. Jochen Aberle
Workload (h)	180		
Class attendance (h)	72	**Self studying (h)**	108
Compulsory requirements			
Expected performance/ Type of examination	3 Examinations: 2 Written exams (each 60 Min.) or 1 Written exam (60 Min.) and 1 oral exam (15 Min.) and a presentation		
Course achievement			

Contents

[Inland Waterways Engineering (VÜ)]
Inland navigation; administration of the federal waterways; canals and inland vessels; dynamics of inland vessels; river training; sluices

[Project Management in Waterways Engineering (V)]
Planning and implementation of projects in waterways engineering; responsibilities; planning stages; scheduling and resource planning; tenders and tender models; risk management; consideration of interest groups; process optimization options

Objective qualification

Projektmanagement im Bauwesen kann entweder im Modul Realisierung und Finanzierung oder im Modul Projektmanagement im Verkehrswasserbau eingebracht werden.
The students acquire in-depth knowledge of inland navigation, the required waterway engineering infrastructure and project management for the construction, maintenance and rehabilitation of infrastructure elements from the point of view of the waterways and shipping administration. They will be able to understand the functionality of hydraulic structures used in waterways engineering and to design hydraulically these structures. They will gain in-depth insights into the methods and tools that can be used in waterways engineering projects and how such projects can be carried out in a goal-oriented manner from an organizational, legal, technical, economic and scheduling point of view.

Literature

Präsentationsfolien der Vorlesungen

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture/Exercise	german
	2,0	Seminar	german
	2,0	Lecture/Exercise	german

Specialisation Hydrology, Water Management and Water Protection

Title	Hydrology and Water Resources Management		
Number	4310260	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Hydrologie und Flussgebietsmanagement
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Kai Schröter
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 Min.) or oral exam (approx. 60 Min.)		
Course achievement			

Contents

[Hydrology and water management (VÜ)]
Hydrological processes and process models for precipitation, evaporation, snow, soil moisture, runoff generation, runoff concentration and flood routing; integration of processes in catchment models for event and long-term continuous systems and determination of design values. Model applications using the PC for catchment modeling, flood protection planning and water balance studies; evaluation of the results.

Objective qualification

Students will gain knowledge of the processes of runoff formation, runoff concentration, and flood-routing and their implementation in simulation models. They will be able to apply a mesoscale rainfall-runoff model to a catchment area, to evaluate results and to carry out flood prevention planning. They acquire the basics to perform an economic evaluation of flood protection measures in terms of benefits and costs.

Literature

- Baumgartner, A., Liebscher, H.-J., & Benecke, P. (2011, February 25). Allgemeine Hydrologie. Schweizerbart'sche Verlagsbuchhandlung. https://www.schweizerbart.de/publications/detail/isbn/9783443300029
- Dyck, S., & Peschke, G. (1995). Grundlagen der Hydrologie (3., stark bearb. Aufl.). Verlag für Bauwesen.
- Maniak, U. (2016). Hydrologie und Wasserwirtschaft: Eine Einführung für Ingenieure (7., neu bearbeitete Auflage). Springer Vieweg. https://doi.org/10.1007/978-3-662-49087-7
- Fohrer, N. (Hrsg.), Bormann, H., Miegel, K., Casper, M., Bronstert, A., Schumann, A., Weiler, M. (2016): Hydrologie. utb.basics, Haupt Verlag, Bern.
- Patt, H., & Jüpner, R. (Eds.). (2020). Hochwasser-Handbuch: Auswirkungen und Schutz. Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-26743-8
- Shaw, E. M., Beven, K. J., Chappell, N. A., & Lamb, R. (2011). Hydrology in Practice, Fourth Edition. Spon Press. http://www.crcpress.com/product/isbn/9780415370417

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Hydrogeology and Groundwater Management		
Number	4310270	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Hydrologie und Flussgebietsmanagement
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Matthias Schöniger
Workload (h)			
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 Min.) or oral exam (60 Min.)		
Course achievement			

Contents

[Hydrogeology and Groundwater Management (VÜ)]
Basics of hydrogeology and groundwater management, knowledge of the tasks of hydrogeology and groundwater management for sustainable resource use, management objectives according to § 47 of WHG (national water resources act).

Presented are: numerical groundwater software for the calculation of regional groundwater movements, transport processes with simple reaction kinetics, model-based evaluation of quantitative and chemical groundwater conditions.

Objective qualification

Students will gain knowledge about the structure of regional groundwater bodies, the flow and transport processes in aquifer systems and in the vadose zone and the groundwater balance.
They acquire practical skills in the use of computer programs to simulate groundwater movement and transport processes. After successful completion of this module, students will be able to gain an overview of evaluating water management projects according to benefit-cost criteria and other criteria. Another central aspect is learn about complex hydrogeologic processes and the modeling techniques used to model these processes.

Literature

Hill, M.C. & Tiedeman, C.T. (2006): Effecvtive Groundwater Model Calibration. With Analysis of Data, Sensitivities,
Predictions, and Uncertainty.- Wiley- Interscience

Rausch, R., Schäfer, W. & Wagner, C. (2002): Einführung in die Transportmodellierung im Grundwasser.- Gebr.
Borntraeger

Mattheß, G. & Ubell, K. (2003): Allgemeine Hydrogeologie Grundwasserhaushalt.- Gebr. Borntraeger

Skriptum und Simulationsprogramme

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	River Basin Management		
Number	4320090	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Hydrologie und Flussgebietsmanagement
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Kai Schröter
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 Min.) or oral exam (approx. 60 Min.)		
Course achievement	2 Term papers		

Contents

River Basin Management (VÜ).
River basin management (RBM) for the implementation of the EU Water Framework Directive and the EU Floods Directive; International RBM; Model applications for reservoir management; Flood risk management.
[GIS - Applications in River Basin Management (RBM).
Geographic information for hydrologic and hydraulic modeling; digital maps, vector and raster data; intersection techniques; georeferencing; macro languages and programming.

Objective qualification

The students will acquire the ability to perform river basin management according to the requirements of the EU directives. Students will be familiarized with computer-based model applications for river basin management with a focus on reservoir management.
They will be able to process and analyze geographical data in raster and vector form.
They will be able to solve spatial problems and present the results in thematic maps.

Literature

Skripten und Simulationsprogramme

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture/Exercise	german
	2,0	Lecture/Exercise	german

Title	Water Protection - Measurement Technologies and Data analyses		
Number	4310970	**Module version**	V1
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Hydrologie und Flussgebietsmanagement
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Kai Schröter
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Term paper		
Course achievement			

Contents

[Measuring Techniques for Water Quantity and Water Quality (P)]
Measuring techniques for meteorological and hydrological data and their processing (surface water and groundwater); measuring of water quality parameters (physical-chemical variables, biological indicators); sampling from the water body (river, lake) and laboratory analysis; online measuring networks; analysis of measurement data

[Data Processing for Hydrologic and Hydraulic simulations (V)]
Testing, processing and analyzing of data to answer application-related questions and for subsequent usage as input data for hydrologic and hydraulic models. The relevant processes of precipitation, evapotranspiration, soil water movement and runoff transformation are covered in the lecture. Teaching content are universal applicable methods as time series analysis (homogeneity, consistency), regionalisation and extreme value analysis, as well as process-specific methods as correction of measurement errors and the usage of alternative precipitation data sets.

Objective qualification

The students gain varied and interdisciplinary knowledge in data processing and the development of own algorithms for data analysis. An understanding of data structures, data amounts and data plausibility is established. The gained knowledge can be transferred to other disciplines and model software.

Literature

Skripten und Simulationsprogramme

Remark

↑

Related courses			
Rules for the choice of courses			
maximum 12 participants			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Internship	german
	2,0	Lecture/Exercise	german

Title	Water Protection - Water Quality Modeling		
Number	4310730	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Hydrologie und Flussgebietsmanagement
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Kai Schröter
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.) or oral exam (approx. 60 Min.)		
Course achievement	Term paper		

Contents

[Water quality modeling (VÜ)]

water quality parameters and processes; methods for the analysis of measurement data; differential equations for the simulation of completely and incompletely mixed systems; analytical and numerical methods; heat balance; transport and transformation processes of pollutants (e.g. sediment, nitrogen, phosphorus) in water bodies, solving model equations in R programming

Objective qualification

The students gain in-depth knowledge of the interaction of water quantity and water quality in standing and flowing waters at the reach scale. The students will be qualified to quantify the pollution scientifically and technically and to describe it using model algorithms. Using model applications, the students get to know solutions for the improvement of water quality.

Literature

Steven C. Chapra, Surface Water-Quality Modeling, Waveland Press 2008 James L. Martin & Steven C. McCutcheon, Hydrodynamics and Transport for Water Quality Modeling, CRC Press, 1998

↑

Related courses

Rules for the choice of courses

Basic knowledge of water quality parameters and processes is required.

Compulsory attendance

Name of the course	SWS	Eventtype	Language

	4,0	Lecture/Exercise	german

Title	Ecohydrological Modelling of Catchments		
Number	4398800	**Module version**	V1
Shorttext		**Language**	english
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration	1	**Institution**	Abteilung Hydrologie und Flussgebietsmanagement
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Kai Schröter
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam+ (120min) or oral exam+ (30min)		
Course achievement			

Contents

Components of an ecohydrological model system
- Modeling of the water balance (precipitation, evapotranspiration, soil water, runoff formation, runoff concentration, flood-routing)
- Modeling of plant growth
- Modeling of transport and transformation processes of substances (e.g. sediment, nitrogen, phosphorus) in the landscape and in water bodies
- Application of an ecohydrological model on a PC to a mesoscale catchment area
- Influence of different forms of land use, land cultivation and land management on the landscape water regime and nutrient budget
- Modeling and evaluation of management measures for the reduction of emissions from the landscape (technical and nature-based)
- Solving model equations in R programming

Objective qualification

Students will gain in-depth knowledge of the transport and transformation processes of substances in a catchment that occur in the landscape and in a water body, as well as their mathematical description in an eco-hydrological model system. They will be able to set-up an ecohydrological model for a mesoscale catchment, prepare and analyze the model outputs, and evaluate the simulation results. They will acquire fundamental knowledge in modeling and evaluating management measures to reduce substance emissions within and from the catchment.

Literature

- Harper, D.M., Zalewski, M., Pacini, N., 2008. Ecohydrology: Processes, Models and Case Studies: an Approach to the Sustainable Management of Water Resources. CABL
- Haygarth, P.M., Jarvis, S.C., 2002. Agriculture, hydrology and water quality. Pers, C. 2007. HBV-NP Model Manual

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	english

Title	Urban Ecohydrology		
Number	1514300	**Module version**	
Shorttext		**Language**	english
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration	1	**Institution**	Abteilung für Bodenwissenschaften
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Ilhan Özgen
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.) or oral exam (20 Min.)		
Course achievement			

Contents

[Urban Ecohydrology (V)]
The lecture presents topics of ecohydrology in the urban area: urban groundwater, measurement and modelling techniques, decentralised stormwater management and green-blue infrastructure

[Urban Ecohydrology (Ü)]
The exercise consists of calculation exercises that are based on the lecture's topics. Part of the exercise is carried out using the programming language "R".

Objective qualification

Upon completing this module, students will be able to:

- apply theoretical knowledge of the effect of ecosystem services on the urban water cycle
- quantitatively solve ecohydrological problems in the urban area
- apply urban ecohydrological methods

Literature

Baird & Wilby (2000) Eco-Hydrology, Routledge, Oxfordshire, UK.

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**

	4,0	Lecture/Exercise	english
Literature			
Baird & Wilby (2000) Eco-Hydrology, Routledge, Oxfordshire, UK			

Specialisation Hydraulic Engineering

Title	Hydraulic Engineering		
Number	4320030	**Module version**	V2
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Wasserbau und Gewässermorphologie
Hours per Week / ECTS	6 / 6,0	**Module owner**	Prof. Dr. Jochen Aberle
Workload (h)	180		
Class attendance (h)	62	**Self studying (h)**	118
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.) and presentation and oral exam (approx. 20 Min.)		
Course achievement			

Contents

Hydraulic Engineering (VÜ)
The course deals with the design of hydraulic structures in rivers and streams such as weirs, dams, culverts, stilling basins as well as the hydraulic parts of hydroelectric power plants and hydraulic structures for restoring the longitudinal continuity for ecology and sediments in rivers.

Open Channel Hydraulics – Hydraulic Structures (Ü)
Practical exercises support the contents presented in the course Hydraulic Engineering. This is achieved through the performance of scale model experiments in the teaching and hydraulic engineering laboratory.

Dams (V)
The elective course includes in-depth and supplementary teaching content to the compulsory course "Hydraulic Engineering" with regard to dams. The design and construction principles of reservoirs, retaining walls, dams, flood relief and extraction systems are treated. In addition, the sustainable sediment management of reservoirs is discussed.

Hydraulic Steel Constructions and Offshore-wind turbines (V)
The students acquire knowledge about typical steel constructions in the field of hydraulic engineering and are able to design them. The essential standard regulations are also conveyed.

Experimental Hydraulics (V)
The students acquire in-depth knowledge of experimental hydraulics. hydraulic engineering experiments. This includes dimensional analysis, scaling laws and similarities, scale models, scale models with a movable bed; instrumentation and field measurements.

Objective qualification

The students learn get an in-depth understanding of hydraulic engineering and hydraulic structures. They will be able to explain the functionality of hydraulic structures such as weirs, dams, hydroelectric power

plants, continuity structures and crossing structures and to dimension these structures hydraulically. In addition, they can independently plan and carry out hydraulic scale model tests. Thus, the students are able to develop suitable measures for solving practical problems taking into account special boundary conditions.

Literature

Vorlesungsumdrucke und Fachbücher, wie z.B.:

- Chow, V. T. (1959). Open channel hydraulics. Singapore: McGraw-Hill.
- Giesecke, J.; Heimerl, S.; Mosonyi, E. (2014). Wasserkraftanalagen. Planung, Bau und Betrieb. 6. Auflage. Berlin: Springer Vieweg
- Hager, W., Schleiss, A. J. Boes, R. M., Pfister, M. (2021). Hydraulic Engineering of Dams, CRC Press.
- Muste et al. (2017). Experimental Hydraulics: Methods, Instrumentation, Data Processing and Management, Two Volume Set; Routledge, Taylor and Francis Group
- Patt, H.; Gonsowski, P. (2011). Wasserbau. 7., aktualisierte Auflage. Heidelberg, Springer.
- Strobl, T.; Zunic, F. (2006). Wasserbau. Berlin, Heidelberg, Springer.

↑

Related courses

Rules for the choice of courses

Mandatory courses:
[Hydraulic Engineering] (4 LP), [Open Channel Hydraulics – Hydraulic Structures] (1 LP)

One of the following elective courses: [Dams] (1 LP),
[Hydraulic Steel Constructions and Offshore-Wind Turbines] (1 LP)
[Experimental Hydraulics] (1 LP)

Compulsory attendance

Name of the course	SWS	Eventtype	Language
	1,0	Lecture	german
	4,0	Lecture/Exercise	german
	1,0	Exercise	english german
	1,0	Lecture	german
	1,0	Lecture	english

Title	Eco-Hydraulics		
Number	4320020	**Module version**	V2
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Wasserbau und Gewässermorphologie
Hours per Week / ECTS	6 / 6,0	**Module owner**	Prof. Dr. Jochen Aberle
Workload (h)	180		
Class attendance (h)	66	**Self studying (h)**	114
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.) and oral exam (approx. 30 Min.)		
Course achievement			

Contents

[Near-to-Nature Hydraulic Engineering (Master) (VÜ)]
European Water Framework Directive, River Morphology, Hydraulics of nature-like rivers; Flow resistance of plain river beds composed of different bed material and form resistance of morphological structures; Roughness and resistance coefficients, Sediment transport, Morphological development of rivers, River maintenance and development measures
[Open Channel Hydraulics – Near-to-Nature (Master) (Ü)]
Practical exercises in the field are carried out so that the students learn about the effect of hydraulic, morphological and morphodynamic factors on the flow characteristics of rivers.

[Flow Resistance of Vegetation (Master) (V)]
Approaches are introduced for the determination of parameters to describe riverine vegetation characteristics (rigid, flexible, emergent, submerged) and to determine flow resistance due to vegetation. This is an elective subject serving as an in-depth supplement to the compulsory course "Near-to-Nature Hydraulic Engineering”
[Stream Ecology (Master) (V)]
Introduction into the field of stream ecology and presentation of methods for the determination of water and structural quality of streams.
[Dynamics of Cohesive Sediments (V)]
Introduction into the physical processes governing the dynamics of cohesive sediments in rivers, streams, and estuaries.

Objective qualification

The students learn the basics of essential aspects that are important for near-to-nature hydraulic engineering applications. They will have a basic understanding of flow characteristics, flow resistance and sediment transport in natural rivers and how these are interrelated, also considering the effect of further roughness such as vegetation. The students will be able to define the goals of near-natural revitalization measures, to develop appropriate measures and to evaluate the success of planned and existing revitalization measures. The practical training is underlined by exercises in the field. In addition to hydraulic engineering and environmental hydraulics applications, ecological considerations are also part of the contents to prepare the stu-

dents for the interdisciplinary cooperation with the scientific field of natural sciences that is required in professional life to implement nature-based solutions.
Literature
Literaturhinweise, Fachbücher, und Vorlesungsumdrucke

↑

Related courses
Rules for the choice of courses
Compulsory: [Near-to-Nature Hydraulic Engineering] (3 LP), [Open Channel Hydraulics – Near-to-Nature] (2 LP) One of the elective courses: [Flow Resistance of Vegetation] (1 LP) [Dynamics of Cohesive Sediments] (1 LP) [Stream Ecology] (1 LP) must be chosen.
Compulsory attendance

Name of the course	**SWS**	**Eventtype**	**Language**
	3,0	Lecture/Exercise	german
	2,0	Exercise	german
	1,0	Lecture	german
	1,0	Lecture	german

Title	Numeric Methods in Ground and Surface Waters		
Number	4320040	**Module version**	V2
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Wasserbau und Gewässermorphologie
Hours per Week / ECTS	6 / 6,0	**Module owner**	Prof. Dr. Jochen Aberle
Workload (h)	180		
Class attendance (h)	66	**Self studying (h)**	114
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.) and presentation and oral exam (30 Min.)		
Course achievement			

Contents

[Numerical Methods in Groundwater and Open Channel Flow (Master) (VÜ)]
General: Concepts of models, basics of numerical solutions; discretization of space and time; practical introduction of several hydro numerical programmes
Surface flow: basics of hydraulic modelling; modelling of turbulence; setup of computational grid; 1D to 3D computations; basics of sediment transport modelling; hydraulics of subsurface flow
Groundwater flow: fundamental terms; basic hydraulic formulas; methods for determination of conductivity; modelling of groundwater flow

[Open Channel Hydraulics - numerical (Master) (Ü)]
Introduction to several methods and programmes for numerical modelling of open channel flow; tutorials for modelling groundwater flow

[Hydraulics of Dams and Dikes (Master) (V)]
Complementary and deepening knowledge for considering water in dams and dikes construction

[Sediment Transport Modelling (Master) (V)]
Introduction to computational methods for sediment transport processes

[Numerical Computation of Groundwater Flow in Dams and Dikes (Master) (VÜ)]
Basics of the Finite Elements Method und of the differential method; development of programmes for simple 1D systems; exercises for modelling 1D and 2D systems

Objective qualification

Students gain competent knowledge of the theoretical background for calculating surface and groundwater flow. Thus, they achieve the ability for understanding implications of boundary conditions, assumptions, and simplifications required for hydraulic computational modelling. Consequently, they are able to assess which method/model is appropriate and required, resp., to numerically solve a hydraulic problem. In practical applications the students are introduced to several hydro numerical programmes with emphasizing the critical

discussion of results. The students are, finally, able to handle a hydraulic question by compiling required information, selecting an appropriate programme and analysing and discussing the results.
Literature
Skript vorhanden

↑

Related courses
Rules for the choice of courses
Mandatory: Numerical Methods in Groundwater and Open Channel Flow (3 LP), Open Channel Hydraulics-Numerical (2 LP) Obligatory choice (1 out of 3): Hydraulics of Dams and Dikes (1 LP), Sediment Transport Modelling (1 LP) or Numerical Computation of Groundwater Flow in Dams and Dikes (1 LP)
Compulsory attendance

Name of the course	**SWS**	**Eventtype**	**Language**
	3,0	Lecture/Exercise	german
	2,0	Exercise	german
	1,0	Lecture	german

Title	Project Management in Waterways Engineering		
Number	4398790	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	2	**Institution**	Abteilung Wasserbau und Gewässermorphologie
Hours per Week / ECTS	6 / 6,0	**Module owner**	Prof. Dr. Jochen Aberle
Workload (h)	180		
Class attendance (h)	72	**Self studying (h)**	108
Compulsory requirements			
Expected performance/ Type of examination	3 Examinations: 2 Written exams (each 60 Min.) or 1 Written exam (60 Min.) and 1 oral exam (15 Min.) and a presentation		
Course achievement			

Contents

[Inland Waterways Engineering (VÜ)]
Inland navigation; administration of the federal waterways; canals and inland vessels; dynamics of inland vessels; river training; sluices

[Project Management in Waterways Engineering (V)]
Planning and implementation of projects in waterways engineering; responsibilities; planning stages; scheduling and resource planning; tenders and tender models; risk management; consideration of interest groups; process optimization options

Objective qualification

Projektmanagement im Bauwesen kann entweder im Modul Realisierung und Finanzierung oder im Modul Projektmanagement im Verkehrswasserbau eingebracht werden.
The students acquire in-depth knowledge of inland navigation, the required waterway engineering infrastructure and project management for the construction, maintenance and rehabilitation of infrastructure elements from the point of view of the waterways and shipping administration. They will be able to understand the functionality of hydraulic structures used in waterways engineering and to design hydraulically these structures. They will gain in-depth insights into the methods and tools that can be used in waterways engineering projects and how such projects can be carried out in a goal-oriented manner from an organizational, legal, technical, economic and scheduling point of view.

Literature

Präsentationsfolien der Vorlesungen

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture/Exercise	german
	2,0	Seminar	german
	2,0	Lecture/Exercise	german

Additional modules

Title	Advanced Structural Analysis		
Number	4398770	**Module version**	
Shorttext		**Language**	english
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Statik und Dynamik
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Ursula Kowalsky
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Recommended requirements	Basic knowledge of the Module "Introduction to Finite Element Methods " is expected		
Expected performance/ Type of examination	2 examinations: 2 portfolios (each 50%)		
Course achievement			

Contents
Advanced FEM, Membrane Structures, Fluid-Structure Interaction, Particle Methods
Objective qualification
Students are able to develop complex structural mechanics models, to perform related numerical analyses and to evaluate the results.
Literature

↑

Related courses
Rules for the choice of courses
Two of the four lectures must be chosen
Compulsory attendance

Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture/Exercise	english
	2,0	Lecture/Exercise	english

	2,0	Lecture/Exercise	english
	2,0	Lecture/Exercise	english

Title	Digital Building Modeling		
Number	3325000010	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Institut für rechnergestützte Modellierung im Bauingenieurwesen
Hours per Week / ECTS	6 / 6,0	**Module owner**	Prof. Dr. Martin Geier
Workload (h)	180		
Class attendance (h)	84	**Self studying (h)**	96
Compulsory requirements			
Expected performance/ Type of examination	Written exam (60 Min.) or oral exam (approx. 30 Min.) and written exam (60 Min.) and PC-exercise A homework assignment (3 parts) is offered during the semester as voluntary coursework, which can count for 10% of the final examination grade if it is completed successfully. You will receive further information on the homework assignment in the course.		
Course achievement			

Contents

Motivation of continuous three-dimensional modeling, geometric algorithms, visualization techniques, three-dimensional design techniques, parametric modeling, introduction to product models, extension of product model data for process simulation and physical simulations, versioning. In the practical course, complex models are to be created on which the advantages of three-dimensional modeling become evident.

Objective qualification

Methodological Principles of BIM:

- Basic understanding of the structure and possibilities of modern CAD systems
- consistent three-dimensional modeling
- consistent and efficient derivation of 2D part models
- understanding of the possibilities and limitations of available product models
- Integration of CAD and product modeling
- Overcoming the idea of CAD as a tool for drawing
- Independent development and implementation of CAD software extensions

Fundamentals of geometric Algorithm:
Introduction to the object-oriented programming model using the Java programming language- This will enable students to independently implement object-oriented modeling and software engineering implementation of moderately complex simulation tasks.

Literature

Literatur zu Techniken und Aufbau moderner CAD-Systeme, multimediales Material, Beispielentwürfe

↑

Related courses			
Rules for the choice of courses			
Prerequisite for this course is a basic knowledge of object-oriented programming.			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	3,0	Lecture/Exercise	german
	3,0	Lecture/Exercise	german

Title	Fundamentals of Finite Element Methods		
Number	4312080	**Module version**	V1
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	2	**Institution**	Institut für Statik und Dynamik
Hours per Week / ECTS	6 / 6,0	**Module owner**	Prof. Dr. Ursula Kowalsky
Workload (h)	180		
Class attendance (h)	84	**Self studying (h)**	96
Compulsory requirements			
Expected performance/ Type of examination	Written exam (60 Min.)		
Course achievement	Projekt		

Contents

matrix-vector notation, numerical integration, solving systems of equations; governing differential equations, principle of virtual displacements, shape functions, criteria of convergency, element matrices for frame works, rectangular and triangular elements for heat conduction, potential and seepage flow, exercises for given examples, comparison of approximate solutions for different modelling and discretizations, lab experience with Ansys

Objective qualification

The students are able to discretize the related governing equations for a given construction, to include the boundary conditions, to interprete the results and to evaluate the convergency

Literature

Dieter Dinkler, Ursula Kowalsky, Introduction to Finite Element Methods, Springer-Verlag

↑

Related courses

Rules for the choice of courses

Compulsory attendance

Name of the course	SWS	Eventtype	Language
	2,0	Lecture/Exercise	german
LAB Fundamentals of FEM	1,0	Seminar	german

Title	Basics in Conservation of Building Stocks		
Number	4398220	**Module version**	V1
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Stahlbau
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Klaus Thiele
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (60 Min.)		
Course achievement	Presentation		

Contents

Presentation of the increasing importance of building preservation as a responsible task in the construction industry. Building preservation in the context of historical buildings, dealing with cultural high-value buildings. Building analysis methods and knowledge of historical building materials and building structures. Overview of basic damage mechanisms and causes of damage divided into the areas of steel, solid, masonry and timber construction.
Presentation of common test methods as well as measuring instruments for damage assessment or condition assessment (anamnesis and diagnosis). Demonstration of methods for damage prevention, retrofitting and strengthening of structures and constructions (therapy). Aspects of history, material science, building physics and construction are illuminated. Project-oriented exercises.

Objective qualification

Upon completion of the course, students will have knowledge of the fundamentals of preservation of buildings. They know the methodical procedure for assessing the condition of an existing structure. They have the necessary knowledge of the basic causes and consequences of damage. They have an overview of possible strategies for repair and preservation. They have gained insights into the handling of high-value architectural monuments. Students will be able to recognize problems in the preservation and/or further development of the building stock as a resource. They know methods to select suitable measures from a transdisciplinary context and to represent these in a professional discussion.

For didactic reasons, the fundamentals taught will be elaborated in small groups to an exercise example and presented in the plenary session.

Literature

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Linear Solid Mechanics		
Number	4228010	**Module version**	V1
Shorttext		**Language**	english
Frequency of offer	every term	**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration	1	**Institution**	Institut für Angewandte Mechanik
Hours per Week / ECTS	4 / 5,0	**Module owner**	Prof. Dr. Ralf Jänicke
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min)		
Course achievement			

Contents
Fundamentals of vector and tensor calculus; Linear kinematics; Stress state; Two-dimensional problems; Equilibrium conditions; Linear elasticity; Isotropic and anisotropic behavior; Thermal expansion; Introduction to boundary value problems and their numerical solution.
Objective qualification
The students are familiar with the description of stress and deformation in solids. They know linear material models, including thermal expansion. They use these basics for the solution of elementary problems, predominantly in two dimensions
Literature
Gross, Hauger, Wriggers, Technische Mechanik 4

↑

Related courses
Rules for the choice of courses
Compulsory attendance

Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	english

Title	Air Quality and Air Pollution Control		
Number	1112340	**Module version**	
Shorttext		**Language**	german
Frequency of offer		**Teaching unit**	
Module duration	1	**Institution**	Abteilung für Klimatologie und Umweltmeteorologie
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Stephan Weber
Workload (h)			
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 Min.) or oral exam (30 Min.)		
Course achievement	Portfolio		

Contents

[Air Quality in the Near-Surface Boundary Layer (S)]
- Basics of atmospheric chemistry of the near-surface boundary layer
- Principles and characteristics of urban air quality
- Procedures for the measurement and characterisation of aerosol-analysis of data sets

[Air Quality and Air Pollution Control (V)]
- Understanding of the basics of atmospheric chemistry in the near-surface boundary layer
- Knowledge of the most important impacts of tropospheric pollutants
- Legislative requirements for air pollution control
- Trends in ground-level air quality under climate change
- Understanding of the handling of air pollution data sets

Objective qualification

Students will gain a basic understanding of the fundamentals of (urban) air quality in the near-surface boundary layer as well as knowledge of the most important tropospheric pollutants. The students will be able to understand current trends air pollution research. They are trained in the handling,analysis and interpretation of air pollution data sets.

Literature

Finlayson-Pitts, B.J. and Pitts, J.N., 2000. Chemistry of the upper and lower atmosphere. Acamedic Press, San Diego,
969 pp.

Möller, D., 2003. Luft - Chemie, Physik, Biologie, Reinhaltung, Recht. de Gruyter, Berlin, NewYork, 750 pp.
Hinds, W.C., 1999. Aerosol technology - Properties, Behavior and Measurement of Airborne Particles. Wiley Interscience, New York, 483 pp.

Remark

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture	german
Literature			
Finlayson-Pitts, B.J. and Pitts, J.N., 2000. Chemistry of the upper and lower atmosphere. Acamedic Press, San Diego, 969 pp. Möller, D., 2003. Luft - Chemie, Physik, Biologie, Reinhaltung, Recht. de Gruyter, Berlin, NewYork, 750 pp. Hinds, W.C., 1999. Aerosol technology - Properties, Behavior and Measurement of Air-borne Particles. Wiley Interscience, New York, 483 pp.			
	2,0	Seminar	german

Title	Modeling and Simulation		
Number	4398780	**Module version**	
Shorttext		**Language**	english
Frequency of offer		**Teaching unit**	
Module duration	2	**Institution**	Institut für Statik und Dynamik
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Roland Wüchner
Workload (h)			
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Recommended requirements	Es werden Kenntnisse aus dem Modul "Grundlagen der Finite Elemente Methode" vorausgesetzt.		
Expected performance/ Type of examination	Portfolio		
Course achievement			

Contents

Broaden the understanding of FEM including theory and applications supported by hands on experience in creating a FEM model from scratch.

- Introduction to FEM theory with examples with increasing complexity.
- Introduction to modeling of FEM problems with hands on applications.
- Introduction to python programming for FEM with hands on application.
- Developing first FEM model from scratch in python.
- Introduction to Kratos Multiphysics python programming for FEM with hand on applications

Objective qualification

Students are able to create numerical models including programming, to analyse structures and to evaluate results.

Literature

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Project	english

Title	Modeling and Numerical Methods of Flow Problems		
Number	4306850	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für rechnergestützte Modellierung im Bauingenieurwesen
Hours per Week / ECTS	6 / 6,0	**Module owner**	Prof. Dr. Manfred Krafczyk
Workload (h)	180 h		
Class attendance (h)	84	**Self studying (h)**	96
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.) or oral exam (60 Min.)		
Course achievement			
Contents			
Objective qualification			
Literature			
-H. Kuhlmann, Strömungsmechanik, Pearson-Verlag, 2007 -J. D. Ramshaw, Elements of Computational Fluid Dynamics Vol. 2, Imperial College Press, 2011, -Skript, multimediale Demonstrationen im Virtual-Reality Labor			

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	3,0	Lecture/Exercise	german
	3,0	Lecture/Exercise	german

Title	Multivariate Statistical Methods		
Number	1116120	**Module version**	V1
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung für Landschaftsökologie und Umweltsystemanalyse
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Boris Schröder-Esselbach
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Portfolio		
Course achievement			

Contents

Introduction: Motivation, representations, multidimensional distributions
Similarity, dissimilarity.
Ordination: Principal Components, Correspondence Analysis, Multidimensional Scaling, Sammons Mapping
Canonical Ordination: Canonical Correspondence Analysis, Redundancy Analysis
Classification: Hierarchical Cluster Analysis, k-Means, Affinity Propagation, Comparison of Clusterings, Indicator Types, Mantel tests

Objective qualification

This module teaches multivariate statistical methods that are frequently used in ecological studies. In the lecture, the theoretical basics as well as the advantages and disadvantages of the individual methods are dealt with, while in the exercise, the methods are applied to concrete examples and questions from ecological research. The freely available program R is used (cran.r-project.org).

The students learn to
1. translate ecological questions into statistical models or hypotheses,
2. select suitable methods for these models or hypotheses,
3. apply the methods to the data at hand and
4. present and interpret the results scientifically.

Literature

- Borcard, Daniel, François Gillet, Pierre Legendre. 2011. Numerical Ecology with R. Springer
- Legendre, Pierre, Louis Legendre. 2012. Numerical Ecology. Third English edition. Elsevier
- Leyer, Ilona, Karsten Wesche. 2008. Multivariate Statistik in der Ökologie: eine Einführung. Springer
- Dray, Stéphane, Anne-Béatrice Dufour, Aurélie Siberchicot, Thibaut Jombart, Sandrine Pavoine. 2018. Multivariate Analysis of Ecological Data with Ade4. Springer

Remark

Restriction on participation: A maximum of 25 places are available.

↑

Related courses			
Rules for the choice of courses			
Students should know the statistical basics (e.g. distributions, density function, expected value, variance, correlation, quantiles, confidence intervals, hypothesis tests).			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Nonlinear Finite Element Method		
Number	3315000060	**Module version**	
Shorttext		**Language**	english
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Angewandte Mechanik
Hours per Week / ECTS	4 / 5,0	**Module owner**	Prof. Dr. Ralf Jänicke
Workload (h)	180 h		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Recommended requirements	Knowledge from the module Linear Solid Mechanics is recommended.		
Expected performance/ Type of examination	Writte exam (90 Min.)		
Course achievement			

Contents

The Finite Element Method for linear and nonlinear problems in solid mechanics: Heat equation, nonlinear elasticity. Variational format, weighted residuals. Numerical implementation in a Finite Element Toolbox

Objective qualification

The students learn how to employ the Finite Element Method to solve boundary value problems in solid mechanics applications. They are able to solve linear and nonlinear problems (heat equation, nonlinear elasticity). The students are able to numerically implement the methods in a Finite Element Toolbox.

Literature

(1) TJR. Hughes, The Finite Element Method: Linear Static and Dynamic Finite Element Analysis
(2) C. Johnson, Numerical Solution of Partial Differential Equations by the Finite Element Method
(3) DV. Hutton, Fundamentals of Finite Element Analysis
(4) M. Fagan, Finite Element Analysis Theory and Practice
(5) P. Steinke, Finite-Elemente-Methode - Rechnergestützte Einführung

↑

Related courses

Rules for the choice of courses

Compulsory attendance

Name of the course	SWS	Eventtype	Language
	4,0	Lecture/Exercise	english

Title	Nonlinear Solid Mechanics		
Number	3315000040	**Module version**	
Shorttext		**Language**	english
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Angewandte Mechanik
Hours per Week / ECTS	4 / 5,0	**Module owner**	Prof. Dr. Ralf Jänicke
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.)		
Course achievement			

Contents

Review of basics of vector and tensor calculus; Current and reference configuration; Non-linear kinematics (large deformations and rotations); Stress measures; Piola transform; Elasticity tensors; Non-linear constitutive relations: hyper-elasticity, visco-elasticity, plasticity; Implementation of material models in a programming language.

Objective qualification

The students are able to describe stress and deformation in presence of large deformations. They know selected non-linear material models. Using these basics, they can assess the suitability of materials with regard to mechanical loading even under non-idealized conditions.

Literature

- Gross, Hauger, Wriggers, Technische Mechanik 4
- Bonet, Nonlinear Continuum Mechanics for Finite Element Analysis
- Simo, Hughes, Computational Inelasticity
- Holzapfel, Nonlinear Solid Mechanics

↑

Related courses

Rules for the choice of courses

Compulsory attendance

Name of the course	SWS	Eventtype	Language
	4,0	Lecture/Exercise	english

Title	Public Building Law		
Number	4318260	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	2	**Institution**	Institut für Verkehr und Stadtbauwesen
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Bernhard Friedrich
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.) or oral exam (approx. 30 Min.)		
Course achievement			

Contents

[Bauplanungsrecht(VÜ)]
- Fundamentals and objectives of building planning law
- Legal bases: BauGB, BauNVO, BauPlZVO
- Urban land use planning: stages and preparation procedures
- Privatization and security instruments in urban land use planning
- Admissibility of projects
- Consideration and protection of neighbors
- Secured development

[Bauordnungsrecht(VÜ)]
- Fundamentals and goals of the building code
- Legal bases
- Landesbauordnung
- Musterbauordnung
- Implementing ordinance
- special building regulations
- ancillary building regulations
- Types of procedures and approvals
- building documents and responsibilities
- material requirements in the building code
- Regulatory content of the building permit
- protection of neighbors
- ancillary building law
- monument protection law
- immission control law
- Law governing places of assembly
- Workplace law

Objective qualification

Students receive basic knowledge of public building law. This includes the teaching of basic knowledge of building planning law as well as building regulations and ancillary building law (including special regulations). The overarching goal is to teach the relevant sources of law and how to apply them to selected

examples. The students thus acquire the competence to comprehend and understanding basic legal system interrelationships in relation to public construction.
Literature

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture/Exercise	german
	2,0	Lecture/Exercise	german

Title	Ecology and Conservation		
Number	1199950	**Module version**	
Shorttext		**Language**	german
Frequency of offer		**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration		**Institution**	
Hours per Week / ECTS	4 / 6,0	**Module owner**	
Workload (h)			
Class attendance (h)	63	**Self studying (h)**	117
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Contents			
Objective qualification			
Literature			

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	1,0	Seminar	german
	4,5	Block course	german

Title	Pollutants in the Environment		
Number	1112120	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Abteilung Geochemie
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Harald Biester
Workload (h)			
Class attendance (h)	60	**Self studying (h)**	120
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 Min.) or oral exam (60 Min.)		
Course achievement			

Contents

[Inorganic Pollutants in the Environment (V)]
The focus of the lecture Inorganic Pollutants in the Environment is the behaviour of toxic heavy metals and nutrients in the environment. In addition to the essential physical-chemical basic parameters of this group of pollutants, the binding and transport behaviour of various heavy metals in soils, aquatic systems and the atmosphere is demonstrated on the basis of case studies. The focus is on contaminated industrial sites, deposits and ore processing plants that have caused contamination of soils, groundwater, surface waters or the atmosphere on different scales. Further topics are the assessment of contaminated sites on the basis of administrative regulations and existing threshold values, considerations of the natural background of toxic heavy metals as well as strategies for remediation or risk limitation of contaminated soils and waters. In addition to heavy metals, the contamination of surface waters and groundwater by macronutrients is also addressed.

[Organic Pollutants in the Environment (V)]
The lecture Organic Pollutants in the Environment deals with the occurrence and behaviour of organic chemicals in the environment. At the beginning the principles of chemical plant protection from synthesis to application are presented. The basic prerequisite for this is the legally regulated authorisation procedure, in which, among other things, investigation strategies are used starting from laboratory and lysimeter experiments to field studies in order to assess the residue behaviour of these organic chemicals in the various environmental compartments of air, soil and water. This authorisation procedure is based on test methods that are also used as a basis for investigations under the Chemicals Act, the Biocides Directive and the authorisation of human and veterinary pharmaceuticals. In addition to the presentation of these test systems, the application of residue and radiotracer analysis is also discussed. In this methodically designed concept, direct practical relevance is achieved by including current results from research activities in the individual sub-disciplines.

Objective qualification

Knowledge of the most important inorganic pollutants and the processes and controls that govern their behaviour in the environment on different scales (local, regional, global). Learn evaluation criteria of contaminated sites (soils, groundwater and water bodies). Overview of the most important remediation concepts of contaminated soil and groundwater.

In the lecture Organic Pollutants in the Environment, students are enabled to plan and apply investigation strategies for the prospective evaluation of the behaviour of organic chemicals and their metabolites in different environmental compartments (air, water, sediment, soil, plant, waste) in order to be able to carry out and evaluate laboratory, lysimeter and field studies including basic methods of residue and radiotracer analyses.

Literature

Merian, E. et al. (2004): Elements and their Compounds in the Environment. Vol. I-III. Wiley-VCH.
Appelo and Postma (2005),Geochemistry, Groundwater and Pollution
Van Loon and Duffy (2005), Environmental Chemistry, a global perspective.
Baird and Cann (2005), Environmental Chemistry.
Förstner (2004), Umweltschutztechnik.
Bahadir, M., Klein, W., Lay, J.P., Parlar, H. und Scheunert, I. (1992): Lehrbuch der Ökologischen Chemie. Georg Thieme Verlag, Stuttgart, New York.
Haider, I. und Schäffer, A. (2000): Umwandlung und Abbau von Pflanzenschutzmitteln in Böden. Enke im Georg Thieme Verlag, Stuttgart, New York.
Kreuzig, R. (1998): Entwicklung analytischer Methoden zur Differenzierung von Abbau und Sorption als konzentrationsbestimmenden Prozessen für Pflanzenschutzmittel-Wirkstoffe in Böden. Habilitati-onsschrift, TU
Braunschweig, ISBN 3-89720-291.
Kümmerer, K. (2004): Pharmaceuticals in the Environment. Springer.

Merian, E. et al. (2004): Elements and their Compounds in the Environment. Vol. I-III. Wiley-VCH.
Appelo and Postma (2005),Geochemistry, Groundwater and Pollution
Van Loon and Duffy (2005), Environmental Chemistry, a global perspective.
Baird and Cann (2005), Environmental Chemistry.
Förstner (2004), Umweltschutztechnik.

Publikationen zur Vorlesung.

Remark

↑

Related courses

Rules for the choice of courses

Compulsory attendance

Name of the course	SWS	Eventtype	Language
	2,0	Lecture	german

Literature

Merian, E. et al. (2004): Elements and their Compounds in the Environment. Vol. I-III. Wiley-VCH. Appelo and Postma (2005),Geochemistry, Groundwater and Pollution Van Loon and Duffy (2005), Environmental Chemistry, a global perspective. Baird and Cann (2005), Environmental Chemistry. Förstner (2004), Umweltschutztechnik. Publikationen und Folien zur Vorlesung.

		Lecture	german

Title	Orientation Law		
Number	2216350	**Module version**	V3
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	Carl-Friedrich-Gauß-Fakultät
Module duration	1	**Institution**	Institut für Rechtswissenschaften
Hours per Week / ECTS	4 / 5,0	**Module owner**	Prof. Dr. Anne Paschke
Workload (h)	150		
Class attendance (h)	56	**Self studying (h)**	94
Compulsory requirements			
Recommended requirements	Basic knowledge from the module Fundamentals of Law is assumed.		
Expected performance/ Type of examination	1 exam (120 min) or 1 take-at-home exam		
Course achievement	for Organisation, Governance, Education / MA Social Sciences instead of the examination: 1 exam (120 min) or 1 take-at-home exam		

Contents

The content depends on the choice of specialisation:
In the Public Law specialisation, the basic principles of technology law and environmental law are taught. After an introduction to the historical and European and international law principles of the named areas of law, the various forms of these areas of law are examined in more detail with reference to other areas such as the natural sciences and economics. In each case, reference is made to knowledge already acquired by the students.
In the environmental law lecture, construction and immission control law, recycling management law, nature conservation law and climate protection law are examined in detail. The technical law lecture also addresses plant law, product liability law, mobility law, product and equipment safety law, patent law, technical criminal law, data protection law and the creation of technical standards.

In the civil law specialisation, students learn about IT and data law as well as the areas of law that are important for start-ups. The internet has fundamentally changed the way we communicate, analyse, work and consume information, which is why the IT and data law lecture deals with the legal requirements of the digital transformation. Students learn the legal basis for data utilisation and compliance with data protection law. They learn the basics of copyright law and learn what needs to be considered legally when creating a web presence (homepage, web shop, social media account). They are also sensitised to the risks of warnings when selling online. Finally, the lecture takes a closer look at the main features of IT security law.

The Law for Start-Ups course teaches the practical knowledge required to successfully launch a start-up company. Among other things, students learn about different types of companies. They also learn step by step what is required to found a company and what legal issues they will face when the company goes into business, e.g. in the areas of trademark and patent law, commercial and unfair competition law and labour law. In the lecture, the other economics lectures, e.g. on business models, are discussed in order to work on legal challenges.

Objective qualification

The courses teach the following theoretical legal content in order to enable graduates to independently identify the relevant legal standards in their respective specialist area and to make subject-related legal decisions taking into account the current legal situation and to present these in a scientific and practice-oriented manner in writing and orally. Only the application-orientated integrative consideration of legal requirements and technical processes enables legally compliant company/product/production design (compliance).

After completing the module in the Public Law specialisation, students will be able to independently deal with the specialist laws in environmental and technical law and identify relevant legal norms and technical standards. Here, technical examples from other lectures or from the students' internships are taken up and jointly assessed on the basis of the existing legal situation. This enables students to identify the responsible supervisory authorities and independently check whether their plant or machine requires official authorisation or whether it is subject to notification. In this context, the ‘state of the art’ as an important legal concept is also brought to life with examples from technical practice in order to sensitise students to the need to take future developments into account. Students also learn about legal issues relating to the mitigation of the consequences of climate change in order to be able to better assess and implement their significance and consequences from an economic perspective. They also learn about liability responsibilities and can identify liability and sanctioning risks in production processes.

After completing the module in the Civil Law specialisation, students will be able to independently find the specialist laws and relevant standards relevant to them and solve legal issues in IT and data law as well as in the context of company formation and management by working with the law. As regulation in this area is very fast-moving, the teaching of legal methodological skills in particular is of decisive importance in addition to the teaching of specialist skills in order to enable students to apply the law independently. After completing the module, students are sensitised to the content of the lectures in order to behave in a legally compliant manner when using the internet independently (commercially) or when founding a company. They will also have learnt how to ask the right questions to lawyers who support them in enforcing the law.

Literature

For the Public Law specialisation

- Law book
- Umweltrecht dtv. Beck, 31. Aufl. 2022
- Bundes-Immissionsschutzgesetz, dtv. Beck, 17. Aufl. 2022

For the civil law specialisation

- Textbooks

- Ensthaler, Jürgen, Technikrecht: Rechtliche Grundlagen des Technologiemanagments, 2. Aufl. 2022
- Schlacke, Umweltrecht, 8. Aufl. 2021
- Rodi, Handbuch Klimaschutzrecht, 2022

- Law book
- Datenschutzrecht, dtv Beck, 14. Aufl. 2022
- IT- und Computerrecht, dtv. Beck, 15. Aufl. 2022
- Arbeitsgesetze, dtv. Beck, 100. Aufl. 2022

- Textbooks

- Informations- und Kommunikationsrecht, 2018
- Kühling/Klar/Sackmann, Datenschutzrecht, 2021
- Schädel, Wirtschaftsrecht für Hightech-Start-ups, 2019

↑

Related courses
Rules for the choice of courses
One of the two specialisations must be chosen: Public Law: Environmental Law Technology law Civil law: IT and data law Law for StartUps Students on the Master's in Environmental Engineering can only take the Public Law specialisation.
Compulsory attendance

Name of the course	**SWS**	**Eventtype**	**Language**
Environmental Law	2,0	Lecture	german
Literature			
This will be announced during the session.			
Technology Law	2,0	Lecture	german
Literature			
This will be announced during the event.			
IT- and Data Law	2,0	Lecture	german
Literature			
This will be announced during the lecture.			
Law for StartUps	2,0	Lecture	german
Literature			
Wird in der Veranstaltung bekanntgegeben.			
Mobility Law	4,0	Lecture	english

Title	Specialisation Law		
Number	2216360	**Module version**	V3
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	Carl-Friedrich-Gauß-Fakultät
Module duration	1	**Institution**	Institut für Rechtswis-senschaften
Hours per Week / ECTS	4 / 5,0	**Module owner**	Prof. Dr. Anne Paschke
Workload (h)	150		
Class attendance (h)	56	**Self studying (h)**	94
Compulsory requirements			
Expected performance/ Type of examina-tion	1 exam (120 min) or 1 take-at-home exam		
Course achievement	for Organisation, Governance, Education / MA Social Sciences instead of the exami-nation: 1 written exam (120 min) or 1 take-at-home exam		

Contents

The content depends on the choice of specialisation:

In the Public Law specialisation, the basic principles of energy law are taught in Energy Law I and Energy Law II.
The Energy Law I course serves to present the fundamentals of energy law at European and German level. At the beginning of the course, the development of energy law in recent decades is presented. The lec-ture focuses on the regulation of grid operation and related topics such as unbundling, grid connection, grid utilisation and grid utilisation fees. The main contractual structures of energy supply relationships and the position of end consumers in the energy industry will be the subject of the course. A further focus is on the supply of end consumers, e.g. basic supply and contract adjustment options. The lecture is designed to be interactive and offers the opportunity for discussion. The topics discussed will be illustrated using numerous practical cases.

The Energy Law II lecture is primarily dedicated to the law of the ‘energy transition’. It complements the Energy Law I lecture - however, it is not essential to have attended Energy Law I beforehand. One focus of the lecture is the introduction to the law of renewable energies (EEG) including historical developments and European references, including expansion targets, connection and feed-in priority, tenders/tariffs and finan-cing, as well as an in-depth look at the specific legal situation of onshore and offshore wind turbines (includ-ing planning and approval, contract design). The event will also cover the most important legal foundati-ons for the expansion of the electricity grid (from the Energy Industry Act, EnLAG, NABEG, BBPlG). Finally, there will be an opportunity to look at current developments in energy law, e.g. with regard to sector coup-ling or green hydrogen. The lecture is designed to be interactive and offers the opportunity for discussion. The topics discussed will be illustrated using numerous practical cases.

Depending on the students' choice, the Civil Law specialisation teaches content from public procurement law, patent and trademark law and IT security law.
In the Patent and Trade Mark Law lecture, students learn the basics of German and European patent law, the relevant patenting requirements and procedures at the German Patent and Trade Mark Office (DPMA) and the European Patent Office (EPO). The requirements for patenting and the corresponding case law are then applied and analysed in particular to computer-implemented inventions, i.e. especially inventions that

contain a substantial amount of software. To a lesser extent, utility models and their differences to patents as well as registered designs and Community designs are also discussed.

The lecture on public procurement law deals with the scope and procedure of public procurement procedures as well as the legal protection options under public procurement law. It is based on the regulations of EU procurement law (cartel procurement law) in accordance with Part 4 of the GWB and the VgV. However, excursions into sub-threshold procurement law and the special procurement regimes of sector contracts, defence and security-related contracts and concessions will be made at appropriate points. An initial focus of the lecture is on the question of the cases in which public procurement law is applicable and, if applicable, which public procurement law regime is to be applied. On the basis of upper-threshold procurement law, an overview of the procedure is given, starting with the possible types of procedure, the requirements to be met by bidders and the subject matter of the contract, the necessary notices, through to the evaluation of bids and the conclusion of the award procedure. Finally, the legal protection options under public procurement law (primary and secondary legal protection) are dealt with in detail. The lecture takes into account current developments in public procurement law and deals with the respective topics using examples from public procurement law practice.

The IT security law lecture examines one of the key areas of the coming decades from a legal perspective. Students will learn about the legal framework conditions that govern the introduction and maintenance of appropriate IT protection standards. They will also learn how IT security risks are distributed at a contractual level. The unit conveys a holistic approach and enables students to independently develop scientific and practice-orientated solutions together with the relevant specialist literature in order to supervise the necessary information technology steps.

Objective qualification

The courses teach the following theoretical legal content in order to enable graduates to independently identify the relevant legal standards in their respective specialist area and to make subject-related legal decisions taking into account the current legal situation and to present these in a scientific and practice-oriented manner in writing and orally. Only the application-orientated integrative consideration of legal requirements and technical processes enables legally compliant company/product/production design (compliance).

After completing the module in the Public Law specialisation, students will be able to independently deal with the specialist laws in energy law and identify relevant legal norms. Here, technical examples from other lectures are taken up and jointly assessed on the basis of the existing legal situation. They will also learn the sector-specific "state of the art" with examples from technical practice.

After completing the module in the specialisation Civil Law, students will be able to independently find the specialist laws and relevant standards relevant to them and solve legal issues in public procurement law, patent and trademark law and/or IT security law by working with the law. After completing the module, students are sensitised to the content of the lectures in order to be able to participate in public procurement procedures and are sufficiently qualified to ask the right questions in practice in the context of patent and trademark law procedures.

Literature

For the Public Law specialisation:

Legal texts:

- Energierecht, dtv. Beck, 17. Aufl. 2022

Textbooks:

- Kühling/Rasbach/Busch, Energierecht, 5. Aufl. 2022
- Baumgart, Energierecht, 2022

For the civil law specialisation:

Legal texts:

Public procurement law, dtv. Beck, 25th ed. 2022
Patent and design law, dtv. Beck, 16th ed. 2022
Competition law, trade mark law and antitrust law, dtv. Beck, 44th ed. 2022
Textbooks:
Naumann, Public Procurement Law, 2nd ed. 2022
Burgi, Public Procurement Law, 3rd ed. 2021
Samer, The new patent law, 2022
Ann, Patent Law, 8th ed. 2022
Hornung/Schallbruch (ed.) IT Security Law, 2020

↑

Related courses

Rules for the choice of courses

One of the two specialisations must be chosen (the same specialisation that was taken in the orientation must be chosen).

Public law:
Energy Law 1
Energy Law 2
Civil law: (2 of the 3 courses must be chosen)
IT security law
Patent and trade mark law
Public procurement law

Students on the Sustainable Energy Technology Master's programme can only choose the Public Law specialisation.

Compulsory attendance

Name of the course	SWS	Eventtype	Language
Energy Law 1	2,0	Lecture	german
Energy Law 2	2,0	Lecture	german
IT Security Law	2,0	Lecture	german
Patent Law and Trademark Law	2,0	Lecture	german

Literature

- Patent and Design Law (dtv-Beck)
- Competition and Antitrust Law (dtv-Beck)

Procurement Law	2,0	Lecture	german

Title	City and Society		
Number	3307000010	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Bauklimatik und Energie der Architektur
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Henriette Bertram
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Contents			
Objective qualification			
Literature			
Wird zu Beginn des jeweiligen Semesters bekannt gegeben			

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title			
Number	3303000030	**Module version**	
Shorttext		**Language**	english
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Tragwerks-entwurf
Hours per Week / ECTS	6 / 6,0	**Module owner**	Prof. Dr. Norman Hack
Workload (h)	180 h		
Class attendance (h)	70	**Self studying (h)**	110
Compulsory requirements			
Expected performance/ Type of examination	Portfolio (with Presentation)		
Course achievement			

Contents

Teaching of digital design theory, computer-aided design, robotic fabrication, and additive manufacturing.

Objective qualification

The set of online available materials consisting lectures and tutorials cover topics related to digitalisation across all phases from design and planning to execution. The focus includes the following aspects: 3D modelling, computational geometry, digital simulation and analysis tools (such as structural optimisation, lighting simulation, and thermal simulation), parametric and generative design methods, Building Information Modelling (BIM), robot-based fabrication processes and additive manufacturing, 3D scanning, virtual and augmented reality, big data, and the application of artificial intelligence in planning.

In the accompanying exercises, students are introduced to the basics of programming in Grasshopper and Python. For this purpose, the widely used 3D NURBS modelling software Rhino 3D is employed, as it offers interfaces to many of the digital design, planning, and execution tools discussed in the lectures.

The independent teaching is supported with personal consultations with lecturers, to support the students and provide additional resources and explanations.

Literature

Recommended literature is optional and corresponds to the continuously updated course content each semester. Detailed information on the specific courses and topics offered is provided in the respective semester programme.

↑

Related courses			
Rules for the choice of courses			
Students who have attended the module “Digital Construction (4198440)” in the Bachelor's program in Architecture cannot attend this module.			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
Foundations of Digital Design and Fabrication	4,0	Seminar	english

Title	Structural Design for Additive Manufacturing in Construction		
Number	3303000020	**Module version**	
Shorttext		**Language**	english
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Tragwerks-entwurf
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Harald Kloft
Workload (h)	180 h		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Recommended requirements	It is strongly recommended that students possess preliminary and broad knowledge of Additive Manufacturing in Construction. This should be documented by the successful completion of both: 1. *Angewandte Additive Fertigung* (M.Sc.) and 2. *Foundations of Digital Design and Fabrication* (M.Sc.) / *Digital Construction* (B.Sc.), or an equivalent set of courses completed at another university. The two courses mentioned above may also be taken in parallel with the current course in order to acquire the required background knowledge.		
Expected performance/ Type of examination	Written Exam (60 min) or Oral Exam (30 min) and Term Paper		
Course achievement			
Module grade composition	50% Writte Exam or Oral Exam, 50% Term Paper		

Contents

Strategies and concepts for safety and durability verification in Additive Manufacturing for Construction (AMC), including existing norms and standards, and practical approach based on selected examples.

A series of lectures will introduce 1) relevant existing norms, standards, and guidelines, including: DIN EN ISO/ASTM 52939 and ICC-ES AC509, as well as 2) selected examples of design assisted by testing of additively manufactured structures.

The homework is a written report from design and validation plan of a selected structural element (e.g. a beam, a wall) produced with selected additive manufacturing method, including: 1) design and validation plan, 2) fabrication method selection, 3) design for fabrication and structural calculation, 4) planning of testing for validation and/or quality control.

Objective qualification

Upon successful completion of the module, students will be familiar with the relevant standards and codes applicable in Europe and internationally for the structural and durability verification of additively manufactured structures, with a particular focus on Digital Fabrication with Concrete. They will be prepared to participate in the structural design and execution of projects involving additive manufacturing—especially concrete 3D printing—and to operate effectively in international contexts, including normative environments beyond

Germany. This will also involve the ability to draw analogies from standards and codes not directly valid in Germany.

To this end, students will learn to apply fundamental physical principles and engineering laws to navigate within the currently unregulated domain of structural design using novel materials and fabrication processes. They will gain an understanding of the underlying concepts and logics behind existing design formulas (e.g., those found in the Eurocodes) and will be capable of using them appropriately in situations where the materials or methods lie outside the scope of current normative documents. This ability will enable them to assess and design using a variety of materials, including advanced cementitious composites, and reinforcement types from both structural performance and durability perspectives.

Finally, students will be introduced to the fundamentals of design assisted by testing—a methodology that is not only crucial in the context of Digital Fabrication with Concrete, but also broadly applicable in structural engineering practice, for instance in the verification and assessment of existing structures through physical testing.

Literature

Additive Manufacturing for construction – Qualification principles – Structural and infrastructure elements (ISO/ASTM 52939:2023)

Acceptance Criteria 509 - 3D Automated Construction Technology for 3D Concrete Walls (ICC-ES AC509)

Kloft, H., Sawicki, B., Bos, F., Dörrie, R., Freund, N., Gantner, S., Gebhard, L., Hack, N., Ivaniuk, E., Kruger, J. and Kaufmann, W., 2024. Interaction of reinforcement, process, and form in digital fabrication with concrete. Cement and Concrete Research, 186, p.107640. Available at: https://doi.org/10.1016/j.cemconres.2024.107640

F.P. Bos, C. Menna, M. Pradena, E. Kreiger, W.R. Leal da Silva, A.U. Rehman, D. Weger, R.J.M. Wolfs, Y. Zhang, L. Ferrara, V. Mechtcherine, The realities of additively manufactured concrete structures in practice, Cement and Concrete Research, Volume 156, 2022, 106746, https://doi.org/10.1016/j.cemconres.2022.106746

V. Mechtcherine et al.‘Additive Fertigung mit Beton – Leitfaden für die Planung und die Durchführung von Projekten’, Beton- und Stahlbetonbau, 119.4 (2024), pp. 290–310, doi:10.1002/best.202400005

↑

Related courses

Rules for the choice of courses

Compulsory attendance

Name of the course	SWS	Eventtype	Language
Structural Design for Additive Manufacturing in Construction	4,0	Lecture/Exercise	english

Title			
Number	1514330	**Module version**	
Shorttext		**Language**	english german
Frequency of offer	every term	**Teaching unit**	
Module duration		**Institution**	Abteilung für Bodenwissenschaften
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Ilhan Özgen
Workload (h)	180h		
Class attendance (h)	12	**Self studying (h)**	168
Compulsory requirements			
Expected performance/ Type of examination	written report (12 pages)		
Course achievement	oral presentation (15 min)		

Contents

Students develop their own project in the field of ecohydrology. At the end of the course, students give a 15-minute presentation and submit a written report of approximately 12 pages, depending on the nature of the project.

During the course, students have regular meetings with their supervisors.

The presentation and report may be given or written in either English or German

Objective qualification

Students are able to develop an independent scientific research question in the field of ecohydrology, address it using appropriate scientific methods, and critically analyse and discuss the results. In doing so, they gain experience in planning and conducting their own research project, as well as in scientifically presenting and documenting their work in both oral and written form.

Literature

Baird & Wilby (2000) Eco-Hydrology, Routledge, Oxfordshire, UK.
Yin & Porporato (2021) Ecohydrology: Dynamics of Life and Water in the Critical Zone, Cambridge University Press, Cambridge, UK.

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**

	4,0	Project	english ger-man

Title			
Number	3312000010	**Module version**	
Shorttext		**Language**	english
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Statik und Dynamik
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Ursula Kowalsky
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements	Introduction to Finite Element Method		
Recommended requirements	Thinwalled Structures		
Expected performance/ Type of examination	Portfolio		
Course achievement			
Contents			
In the "Advanced FEM" course, students gain in-depth knowledge of element technology, as well as physical and geometric nonlinearities and their solution methods. Students practice numerical implementation in the CA-Pool.			
Objective qualification			
Upon completion of the module, students will be able to develop complex structural mechanics models, perform the corresponding numerical analyses, and evaluate the results.			
Literature			
A comprehensive textbook is available: Zienkiewicz et.al., Finite Element Methods, Vol. 2 Bathe, Finite Element Methoden			

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	1,0	Lecture	english
	3,0	Laboratory	english

Key Qualifications

Title	Key Qualifications		
Number	4301040	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration	1	**Institution**	
Hours per Week / ECTS	6 / 6,0	**Module owner**	
Workload (h)			
Class attendance (h)	84	**Self studying (h)**	96
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Contents			
Objective qualification			
Literature			

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**

Study Project

Title	Study Project		
Number	4310800	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration	1	**Institution**	
Hours per Week / ECTS	0 / 10,0	**Module owner**	
Workload (h)	300		
Class attendance (h)	1	**Self studying (h)**	300
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Contents			
Objective qualification			
Literature			

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**

Title	Study Project		
Number	4310810	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration	1	**Institution**	
Hours per Week / ECTS	0 / 6,0	**Module owner**	
Workload (h)	180		
Class attendance (h)	1	**Self studying (h)**	180
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Contents			
Objective qualification			
Literature			

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**

Academic Graduation Area

Title	Master's Thesis		
Number	4399360	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration	1	**Institution**	
Hours per Week / ECTS	0 / 20,0	**Module owner**	
Workload (h)			
Class attendance (h)		**Self studying (h)**	600
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Contents			
Objective qualification			
Literature			
abhängig von der konkreten Aufgabenstellung			

↑

Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**