

### **Module Manual**

Master of Science (M.Sc.)

### Water and Environmental Engineering

Cohort: Winter Term 2021 Updated: 26th June 2024

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### **Program description**

### Content

#### Master of Science in 'Water and Environmental Engineering'

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

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

### **Core Qualification**

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

#### Courses

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

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

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

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

Courses				
		Torr	Une fools	68
Fitle		<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 2
Biology (L1428) Geology and Soil Science (L0903)		Lecture	2	1
nvironmental Analysis (L0354)		Lecture	2	3
Module Responsible	Dr. Dorothea Rechtenbach			
Admission Requirements	None			
<b>Recommended Previous</b>	Fundamentals of inorganic/organic c	chemistry and biology (knowledge acquired at scho	ool)	
Knowledge				
Professional Competence	After taking part successfully, stude	nts have reached the following learning results		
	With the completion of this module	students acquire profound knowledge of the geo-	and nodecohere biege	achomical proces
Knowledge				
	and the face of migrating compound	ls in soil and groundwater. They learn about metho	ous to investigate sites in	or different use.
Skills	s With the completion of this module students can apply the acquired theoretical knowledge to model sites and assess the situation			
	technically and conceptually. They are able to draw comparisons on different investigation strategies and techniques. Mode			
	projects can be devised and treated			
Personal Competence				
Social Competence	Students can discuss technical and s	scientific tasks within a seminar subject specific an	nd interdisciplinary .	
Autonomi	Students can independently explait.	sources , acquire the particular knowledge of the s	whice t and apply it to p	ow problems
Autonomy	Students can independently exploit	sources, acquire the particular knowledge of the s	subject and apply it to ne	ew problems.
Workload in Hours	Independent Study Time 96, Study T	Time in Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	2 Std. 15 Min.			
scale				
Assignment for the	Civil Engineering: Specialisation Wat	ter and Traffic: Elective Compulsory		
	Water and Environmental Engineering			

Course L1428: Biology	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Johannes Gescher
Language	EN
Cycle	WiSe
Content	
Literature	Umweltmikrobiologie, Reineke, W. und Schlömann, M. (2015) 2. Aufl., Springer Spektrum Verlag

Course L0903: Geology and S	Soil Science
Тур	Lecture
Hrs/wk	2
СР	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dr. Joachim Gerth, Sonja Götz
Language	DE
Cycle	WiSe
Content	Geology: formation of the Earth, plate tectonics, macroscopic rock identification, introduction to Earth history, introduction to halokinesis. Soil science: soil use and function in ecosystems, faktors and processes of soil formation, mineral and organic components, surface types and properties, retention of nutrients and pollutants, hazards from faulty land use, erosion, salinization, and contamination, measures to preserve soils
Literature	R. Vinx (2011): "Gesteinsbestimmung im Gelände" H. Bahlburg & C. Breitkreutz (2012): "Grundlagen der Geologie", TUB Signatur GWB-318 R. Walter (2003): "Ergeschichte" TUB Signatur: 2816-1769 F.Scheffer und P. Schachtschabel (2002): "Lehrbuch der Bodenkunde" TUB Signatur AGG-308 W.E.H. Blum (2007): "Bodenkunde in Stichworten" TUB Signatur AGG-317

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

Module M0962: Susta	inability and Risk Managem	ent		
Courses				
Title		Тур	Hrs/wk	СР
Safety, Reliability and Risk Assessm	ient (L1145)	Seminar	2	3
Environment and Sustainability (L03	319)	Lecture	2	3
Module Responsible	Prof. Kerstin Kuchta			
Admission Requirements	None			
<b>Recommended Previous</b>	none			
Knowledge				
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results		
Professional Competence				
Knowledge	Students are able to describe single techniques and to give an overview for the field of safety and risk assessment as well as environmental and sustainable engineering, in detail:			
	<ul> <li>basics in safety and reliability of te</li> </ul>	echnical facilities		
	<ul> <li>safety and reliability analysis meth</li> </ul>	nods		
	<ul> <li>risk assessment</li> </ul>			
	<ul> <li>Production and usage of bio-char</li> </ul>			
	<ul> <li>energy production and supply</li> </ul>			
	<ul> <li>sustainable product design</li> </ul>			
Skills		y system-oriented methods for risk assessme		reporting. They can
	evaluate the effort and costs for processe	es and select economically feasible treatment co	oncepts.	
Personal Competence				
Social Competence				
Autonomy	Students can gain knowledge of the sub	pject area from given sources and transform it	to new questions. F	urthermore, they can
	define targets for new application or rese	earch-oriented duties in for risk management ar	nd sustainability conc	cepts accordance with
	the potential social, economic and cultura	al impact.		
Workload in Hours	Independent Study Time 124, Study Time	e in Lecture 56		
· ·				
	Written elaboration			
	Elaboration and presentation (45 minutes	s in groups)		
scale	• • • • • • • • • • • • • • • • • • • •			
Assignment for the	Civil Engineering: Core Qualification: Com	npulsory		
-	<b>e e</b> 1	C - Bioeconomic Process Engineering, Focus	s Management and	Controlling: Elective
	Compulsory			
	International Management and Engineering	ng: Specialisation II. Civil Engineering: Elective (	Compulsory	
	Product Development, Materials and Prod	duction: Specialisation Product Development: Ele	ective Compulsory	
	Product Development, Materials and Prod	duction: Specialisation Production: Elective Com	pulsory	
		duction: Specialisation Materials: Elective Compu	ulsory	
	Water and Environmental Engineering: Co	ore Qualification: Compulsory		

Course L1145: Safety, Reliab	ility and Risk Assessment		
Тур	Seminar		
Hrs/wk	2		
CP	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Dr. Marco Ritzkowski		
Language	DE		
Cycle	WiSe		
Content	An introduction in safety and risk assessment is given and some typical problems of structural and environmental engineering are treated: • basics in safety and reliability of technical facilities • safety and reliability analysis methods • risk assessment • practical examples and excursions • discussions and presentations		
Literature	- Vorlesungsunterlagen - Schneider, J., Schlatter, H.P.: Sicherheit und Zuverlässigkeit im Bauwesen. www.risksafety.ch/files/ <b>sicherheit</b> _und_zuverlaessigkeit.pdf		

Course L0319: Environment a	and Sustainability	
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Kerstin Kuchta	
Language	EN	
Cycle	WiSe	
Content	This course presents actual methodologies and examples of environmental relevant, sustainable technologies, concepts and	
	strategies in the field of energy supply, product design, water supply, waste water treatment or mobility. The following list show	
	examples.	
	Production and Usage of Bio-char	
	Engergy production with algae	
	Environmental product design	
	Clean Development mechanism (CDM)	
	Democracy and Energy	
	New Concepts for a sustainable Energy Supply	
	Recycling of Wind Turbines	
	Alternative Mobility	
	Disposal of Nuclear Wastes	
	Waste2Energy	
	Offshore Wind energy	
Literature	Wird in der Veranstaltung bekannt gegeben.	

### **Specialization Cities**

Module M0830: Envir	onmental Protection and Management			
Courses				
Title		Тур	Hrs/wk	СР
Integrated Pollution Control (L0502)		Lecture	2	2
Health, Safety and Environmental I Health, Safety and Environmental I	5	Lecture Recitation Section (small)	2 1	3 1
Module Responsible		Rectation Section (smail)	1	Ŧ
Admission Requirements				
Recommended Previous				
Knowledge	<ul> <li>Good knowledge in Technologies for Environmental Protection (end-of-pipe, integrated solutions)</li> </ul>			
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
	The students are able to describe the basics of regulations, economic instruments, voluntary initiatives, fundamentals of HS legislation ISO 14001, EMAS and Responsible Care ISO 14001 requirements. They can analyse and discuss industrial processe substance cycles and approaches from end-of-pipe technology to eco-efficiency and eco-effectiveness, showing their soun knowledge of complex industry related problems. They are able to judge environmental issues and to widely consider, apply of carry out innovative technical solutions, remediation measures and further interventions as well as conceptual problem solvir approaches in the full range of problems in different industrial sectors.			
Skills	Students are able to assess current problems and situations in the field of environmental protection. They can consider the be available techniques and to plan and suggest concrete actions in a company- or branch-specific context. By this means they ca solve problems on a technical, administrative and legislative level.			
Personal Competence				
Social Competence	The students can work together in international groups.			
Autonomy	Students are able to organize their work flow to prepar can acquire appropriate knowledge by making enquiries		contributions to tl	he discussions. Th
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elect			
Following Curricula	Bioprocess Engineering: Specialisation C - Bioeconor	nic Process Engineering, Focus M	anagement and	Controlling: Elect
	Compulsory			
	Environmental Engineering: Core Qualification: Compuls	,	tar Elective Comp	ulcon
	Joint European Master in Environmental Studies - Cities a Joint European Master in Environmental Studies - Cities a			-
	Product Development, Materials and Production: Special			puisory
	Product Development, Materials and Production: Special Product Development, Materials and Production: Special			
	Product Development, Materials and Production: Special		-	
	Process Engineering: Specialisation Environmental Proce		-	
	Water and Environmental Engineering: Specialisation En			
	Water and Environmental Engineering: Specialisation Cit	ies: Compulsory		

Course L0502: Integrated Po	Ilution Control
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Ralf Otterpohl
Language	EN
Cycle	WiSe
	The lecture focusses on:  The Regulatory Framework Pollution & Impacts, Characteristics of Pollutants Approaches of Integrated Pollution Control Sevilla Process, Best Available Technologies & BREF Documents Case Studies: paper industry, cement industry, automotive industry Field Trip
Literature	Förstner, Ulrich (1998): Integrated Pollution Control, Springer-Verlag Berlin Heidelberg, ISBN 978-3-642-80313-0 Shen, Thomas T. (1999): Industrial Pollution Prevention, Springer-Verlag Berlin Heidelberg, ISBN 978-3-540-65208-3

Course L0387: Health, Safety	/ and Environmental Management
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Hans-Joachim Nau
Language	EN
Cycle	WiSe
Content	<ul> <li>Objectives of and benefit from HSE management</li> <li>From dilution and end-of-pipe technology to eco-efficiency and eco-effectiveness Behaviour control: regulations, economic instruments and voluntary initiatives</li> <li>Fundamentals of HSE legislation ISO 14001, EMAS and Responsible Care ISO 14001 requirements Environmental performance evaluation Risk management: hazard, risk and safety Health and safety at the workplace</li> <li>Crisis management</li> </ul>
Literature	C. Stephan: Industrial Health, Safety and Environmental Management, MV-Verlag, Münster, 2007/2012 (can be found in the library under GTG 315) Exercises can be downloaded from StudIP

Course L0388: Health, Safety and Environmental Management		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Hans-Joachim Nau	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0902: Waste	ewater Treatment and Air Pe	ollution Abatement		
Courses				
		Тур	Hrs/wk	СР
<b>Title</b> Biological Wastewater Treatment (L0517)		Lecture	2	3
Air Pollution Abatement (L0203)		Lecture	2	3
Module Responsible	Dr. Swantje Pietsch-Braune			
Admission Requirements	None			
Recommended Previous	Basic knowledge of biology and chemistr	ry		
Knowledge				
	Basic knowledge of solids process engine	eering and separation technology		
Educational Objectives	After taking part successfully, students h	nave reached the following learning results		
Professional Competence				
Knowledge	After successful completion of the modul	le students are able to		
	<ul> <li>name and explain biological proce</li> </ul>	esses for waste water treatment		
	<ul> <li>characterize waste water and sew</li> </ul>			
	<ul> <li>discuss legal regulations in the are</li> </ul>			
	explain the effects of air pollutant			
		nt processes and to define their area of applicati	ion	
CI-ill-				
SKIIIS	Students are able to			
	<ul> <li>choose and design processs steps</li> </ul>	s for the biological waste water treatment		
	<ul> <li>combine processes for cleaning of</li> </ul>	f off-gases depending on the pollutants containe	d in the gases	
Personal Competence				
Social Competence				
Autonomy				
	Independent Study Time 124, Study Time	ne in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water a	nd Traffic: Elective Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation A	- General Bioprocess Engineering: Elective Com	ipulsory	
	Chemical and Bioprocess Engineering: Sp	pecialisation General Process Engineering: Electi	ive Compulsory	
	Environmental Engineering: Specialisatic	on Waste and Energy: Elective Compulsory		
	International Management and Engineer	ing: Specialisation II. Energy and Environmental	Engineering: Elective (	Compulsory
	Joint European Master in Environmental S	Studies - Cities and Sustainability: Specialisation	Water: Elective Comp	ulsory
	Renewable Energies: Specialisation Bioe	5, , , , , , , , , , , , , , , , , , ,		
	5 5 1	ronmental Process Engineering: Elective Compul	lsory	
	Process Engineering: Specialisation Proce			
		Specialisation Water: Elective Compulsory		
	Water and Environmental Engineering: S			
	Water and Environmental Engineering: S	specialisation Cities: Compulsory		

Course L0517: Biological Wastewater Treatment		
Тур	Lecture	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Dr. Joachim Behrendt	
Language	DE/EN	
Cycle	WiSe	
Content	Charaterisation of Wastewater	
	Metobolism of Microorganisms	
	Kinetic of mirobiotic processes	
	Calculation of bioreactor for wastewater treatment	
	Concepts of Wastewater treatment	
	Design of WWTP	
	Excursion to a WWTP	
	Biofilms	
	Biofim Reactors	
	Anaerobic Wastewater and sldge treatment	
	resources oriented sanitation technology	
	Future challenges of wastewater treatment	

Literature	Gujer, Willi
	Siedlungswasserwirtschaft : mit 84 Tabellen
	ISBN: 3540343296 (Gb.) URL: http://www.gbv.de/dms/bs/toc/516261924.pdf URL: http://deposit.d-nb.de/cgi-bin/dokserv?
	id=2842122&prov=M&dok_var=1&dok_ext=htm
	Berlin [u.a.] : Springer, 2007
	TUB_HH_Katalog
	Henze, Mogens
	Wastewater treatment : biological and chemical processes
	ISBN: 3540422285 (Pp.)
	Berlin [u.a.] : Springer, 2002
	TUB_HH_Katalog
	The second secon
	Taschenbuch der Stadtentwässerung : mit 10 Tafeln
	ISBN: 3486263331 ((Gb.))
	München [u.a.] : Oldenbourg, 1999
	TUB_HH_Katalog
	Lange, Jörg (Otterpohl, Ralf; Steger-Hartmann, Thomas;)
	Abwasser : Handbuch zu einer zukunftsfähigen Wasserwirtschaft
	ISBN: 3980350215 (kart.) URL: http://www.gbv.de/du/services/agi/52567E5D44DA0809C12570220050BF25/000000700334
	Donaueschingen-Pfohren : Mall-Beton-Verl., 2000
	TUB_HH_Katalog
	Mudrack, Klaus (Kunst, Sabine;)
	Biologie der Abwasserreinigung : 18 Tabellen
	ISBN: 382741427X URL: http://www.gbv.de/du/services/agi/94B581161B6EC747C1256E3F005A8143/420000114903
	Heidelberg [u.a.] : Spektrum, Akad. Verl., 2003
	TUB_HH_Katalog
	Tchobanoglous, George (Metcalf & Eddy, Inc., ;)
	Wastewater engineering : treatment and reuse
	ISBN: 0070418780 (alk. paper) ISBN: 0071122508 (ISE (*pbk))
	Boston [u.a.] : McGraw-Hill, 2003
	TUB_HH_Katalog
	Henze, Mogens
	Activated sludge models ASM1, ASM2, ASM2d and ASM3
	ISBN: 1900222248
	London : IWA Publ., 2002
	TUB_HH_Katalog
	Kunz, Peter
	Umwelt-Bioverfahrenstechnik
	Vieweg, 1992
	Bauhaus-Universität., Arbeitsgruppe Weiterbildendes Studium Wasser und Umwelt (Deutsche Vereinigung für
	Wasserwirtschaft, Abwasser und Abfall, ;)
	Abwasserbehandlung : Gewässerbelastung, Bemessungsgrundlagen, Mechanische Verfahren, Biologische Verfahren, Reststoffe
	aus der Abwasserbehandlung, Kleinkläranlagen
	ISBN: 3860682725 URL: http://www.gbv.de/dms/weimar/toc/513989765_toc.pdf URL:
	http://www.gbv.de/dms/weimar/abs/513989765_abs.pdf
	Weimar : Universitätsverl, 2006
	TUB_HH_Katalog
	Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall
	DWA-Regelwerk
	Hennef : DWA, 2004
	TUB_HH_Katalog
	Wiesmann, Udo (Choi, In Su; Dombrowski, Eva-Maria;)
	Fundamentals of biological wastewater treatment
	ISBN: 3527312196 (Gb.) URL: http://deposit.ddb.de/cgi-bin/dokserv?id=2774611&prov=M&dok_var=1&dok_ext=htm
	Weinheim : WILEY-VCH, 2007
	TUB_HH_Katalog
	1

Course L0203: Air Pollution	Abatement
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Swantje Pietsch-Braune, Christian Eichler
Language	EN
Cycle	WiSe
Content	In the lecture methods for the reduction of emissions from industrial plants are treated. At the beginning a short survey of the different forms of air pollutants is given. In the second part physical principals for the removal of particulate and gaseous pollutants form flue gases are treated. Industrial applications of these principles are demonstrated with examples showing the removal of specific compounds, e.g. sulfur or mercury from flue gases of incinerators.
Literature	Handbook of air pollution prevention and control, Nicholas P. Cheremisinoff Amsterdam [u.a.] : Butterworth-Heinemann, 2002 Atmospheric pollution : history, science, and regulation, Mark Zachary Jacobson Cambridge [u.a.] : Cambridge Univ. Press, 2002 Air pollution control technology handbook, Karl B. Schnelle Boca Raton [u.a.] : CRC Press, c 2002 Air pollution, Jeremy Colls 2. ed London [u.a.] : Spon, 2002

Courses	
Title	Typ Hrs/wk CP
Integrated Transportation Planning	(L1068) Project-/problem-based Learning 4 6
Module Responsible	Prof. Carsten Gertz
Admission Requirements	None
<b>Recommended Previous</b>	some knowledge of transport planning, e.g. through taking the undergraduate class "Transport Planning and Traffic Engineerin
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to:
	describe interdependencies between land-use/location choice and transportation/mobility behaviour
	• explain and evaluate the social, ecological and economic effects of transport and land-use policy measures.
	<ul> <li>relate current issues in the area of integrated transport planning and formulate an opinion on them.</li> </ul>
Chille	Students are able to:
SKIIIS	Students are able to:
	• quantify important parameters, which influence travel demand or are influenced by it.
	• comprehensively examine a pre-defined or self-selected topic from a transportation studies perspective and document the
	results in accordance with scientific conventions.
Personal Competence	
Social Competence	Students are able to:
	<ul> <li>provide feedback on topical contents and their teaching.</li> </ul>
	<ul> <li>constructively handle feedback on their own work.</li> </ul>
	<ul> <li>produce results in group work and document these.</li> </ul>
Autonomy	Students are able to:
	assess potential consequences of their future professional activities
	<ul> <li>independently plan working on a pre-defined project topic, acquire the necessary knowledge and use appropriate means f</li> </ul>
	its execution.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written elaboration
Examination duration and	written assignment with presentation during the semester
scale	
-	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory Civil Engineering: Specialisation Water and Traffic: Compulsory
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure and Mobility: Elective Compulsory
	Water and Environmental Engineering: Specialisation Water: Elective Compulsory
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory
	Water and Environmental Engineering: Specialisation Cities: Compulsory

Course L1068: Integrated Tr	ansportation Planning
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Carsten Gertz, Dr. Philine Gaffron, Jacqueline Bianca Maaß
Language	DE
Cycle	WiSe
Content	The course will provide students with an understanding of interdependencies between land-use and transportation. Specific topics include a.o.:     interactions between transport and the environment and consequent limitations  characteristics of integrated planning  complex planning processes  interdependencies of location choice and mobility behaviour  transport and land-use policies  project on current issues in transportation studies
Literature	Kutter, Eckhard (2005) Entwicklung innovativer Verkehrsstrategien für die mobile Gesellschaft. Erich Schmidt Verlag. Berlin. Bracher, Tilman u. a. (Hrsg.) (68. Ergänzung 2013) Handbuch der kommunalen Verkehrsplanung. Herbert Wichmann Verlag. Berlin, Offenbach. (Loseblattsammlung mit kontinuierlichen Ergänzungen)

Engineering"				
Module M0511: Electi	rical Energy from Solar Radiation a	and Wind Power		
Courses				
Title		Тур	Hrs/wk	СР
Sustainability Management (L0007	)	Lecture	2	1
Hydro Power Use (L0013)		Lecture	1	1
Wind Turbine Plants (L0011)		Lecture	2	3
Wind Energy Use - Focus Offshore	L0012)	Lecture	1	1
Module Responsible	Dr. Isabel Höfer			
Admission Requirements	None			
<b>Recommended Previous</b>	Module: Technical Thermodynamics I,			
Knowledge	Module: Technical Thermodynamics II,			
	Module: Fundamentals of Fluid Mechanics			
Educational Objectives	After taking part successfully, students have reac	hed the following learning results		
Professional Competence				
Knowledge	By ending this module students can explain in c	letail knowledge of wind turbines wit	th a particular focus of	f wind energy use ir
	offshore conditions and can critical comment the	se aspects in consideration of current	t developments. Furthe	ermore, they are able
	to describe fundamentally the use of water power	to generate electricity. The students	reproduce and explain	the basic procedure
	in the implementation of renewable energy project	ts in countries outside Europe.		
	Through active discussions of various topics wit	hin the seminar of the module stur	lents improve their un	derstanding and the
	application of the theoretical background and are		•	
	application of the theoretical background and are	this usic to transfer what they have	icamea în practice.	
Skills	Students are able to apply the acquired theorem	tical foundations on exemplary water	r or wind power syster	ms and evaluate and
	assess technically the resulting relationships in the	he context of dimensioning and oper	ation of these energy s	systems. They can ir
	compare critically the special procedure for the in	nplementation of renewable energy p	rojects in countries out	tside Europe with the
	in principle applied approach in Europe and can a	pply this procedure on exemplary the	oretical projects.	
Demonal Commetence				
Personal Competence		rational and the state of a state of the sta		
Social Competence	Students can discuss scientific tasks subjet-speci	nciy and multidisciplinary within a ser	ninar.	
Autonomy	Students can independently exploit sources in th	a context of the emphasis of the le	cture material to clear	r the contents of the
Autonomy	lecture and to acquire the particular knowledge al			
		bout the subject area.		
Workload in Hours	Independent Study Time 96, Study Time in Lectur	e 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	2.5 hours written exam + written elaboration (incl	. presentation) in sustainability mana	gement	
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engine	ering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Eng	ineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineeri	ng: Elective Compulsory		
	International Management and Engineering: Speci	alisation II. Energy and Environmenta	I Engineering: Elective	Compulsory
	International Management and Engineering: Speci	alisation II. Renewable Energy: Election	ve Compulsory	
	Product Development, Materials and Production: S			
	Product Development, Materials and Production: S			
	Product Development, Materials and Production: S		pulsory	
	Renewable Energies: Core Qualification: Compulso			
	Theoretical Mechanical Engineering: Specialisation			
	Process Engineering: Specialisation Environmenta		ulsory	
	Water and Environmental Engineering: Specialisat			
	Water and Environmental Engineering: Specialisat	tion Cities: Elective Compulsory		

Course L0007: Sustainability	Management
Тур	Lecture
Hrs/wk	2
СР	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dr. Anne Rödl
Language	DE
Cycle	SoSe
Content	The lecture "Sustainability Management" gives an insight into the different aspects and dimensions of sustainability. First, essential terms and definitions, significant developments of the last years, and legal framework conditions are explained. The various aspects of sustainability are then presented and discussed in detail. The lecture mainly focuses on concepts for the implementation of the topic sustainability in companies:
	<ul> <li>What is "sustainability"?</li> <li>Why is this concept an important topic for companies?</li> <li>What opportunities and business risks are addressed or are associated with it?</li> <li>How can the often mentioned three pillars of sustainability - economy, ecology, and social- be meaningfully integrated into corporate management despite their sometimes contradictory tendencies, and how a corresponding compromise can be found?</li> <li>What concepts or frameworks exist for the implementation of sustainability management in companies?</li> <li>Which sustainability labels exist for products or companies? What do they have in common, and where do they differ?</li> <li>Furthermore, the lecture is intended to provide insights into the concrete implementation of sustainability aspects into business practice. External lecturers from companies will be invited to report on how sustainability is integrated into their daily processes.</li> <li>In the course of an independently carried out group work, the students will analyze and discuss the implementation of sustainability aspects based on short case studies. By studying and comparing best practice examples, the students will learn about corporate decisions' effects and implications. It should become clear which risks or opportunities are associated if sustainability aspects are taken into account in management decisions.</li> </ul>
Literature	Die folgenden Bücher bieten einen Überblick: Engelfried, J. (2011) Nachhaltiges Umweltmanagement. München: Oldenbourg Verlag. 2. Auflage Corsten H., Roth S. (Hrsg.) (2011) Nachhaltigkeit - Unternehmerisches Handeln in globaler Verantwortung. Wiesbaden: Gabler Verlag.

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

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

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

Module M0827: Mode	ling in Water Management			
Courses				
Title	ow (10543)	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b>
Groundwater Modeling using Modflow (L0543) Groundwater Modeling using Modflow (L0544)		Recitation Section (small)	2	2
Modeling of Water Supply and Sew		Project-/problem-based Learning	2	3
Module Responsible	Dr. Klaus Johannsen			
Admission Requirements	None			
<b>Recommended Previous</b>	Groundwater			
Knowledge	Knowledge • groundwater hydraulics and transport of substances			
	Pipe Systems			
	Knowledge on urban water infrastructure	s, in particular drinking water systemsand u	urban drainag	e systems includi
	special structures			
	Hydraulics of drinking water supply systems	s and sewer systems		
	Basic knowledge on water management			
Educational Objectives	After taking part successfully, students have reach	ned the following learning results		
Professional Competence				
Knowledge	The students are able to describe the modelling of	f groundwater flow and transport as well as url	oan water infra	astructures. They c
	carry out systems analyses and can detect technical and conceptual weak points within the systems in case studies. Besides the			
	are able to analyse interdependencies of hydraulio	and toxic phenomena in soil and water.		
Skills	The students are able to construct and apply scientific groundwater models indipendently. They can work on different scenario and can compare or assess different solutions for existing problems by application of selected software products. The students ar able to use different software solutions (e.g. EPANET, EPA-SWMM).			
Personal Competence				
Social Competence	Wird nicht vermittelt.			
Autonomy	Wird nicht vermittelt.			
Workload in Hours	Independent Study Time 110, Study Time in Lectu	re 70		
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	20 min			
scale				
Assignment for the		•		
Following Curricula	Civil Engineering: Specialisation Geotechnical Eng			
	Civil Engineering: Specialisation Coastal Engineeri	• • •		
	Civil Engineering: Specialisation Water and Traffic			
	Water and Environmental Engineering: Specialisat Water and Environmental Engineering: Specialisat			
	Water and Environmental Engineering: Specialisat	ion cities: Elective Compulsory		

ture
ependent Study Time 16, Study Time in Lecture 14
ja Götz
EN
be
oduction and application of the groundwater model MODFLOW (PMWIN); theoretical backround of the modell, students do work
h the model PMWIN for practical case studies.
DFLOW-Handbuch
ang, Wen Hsien: PMWIN
ep ja ep ja

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

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

Module M1717: Adva	nced Vadose Zone Hydrolog	У		
Courses				
<b>Fitle</b>		Тур	Hrs/wk	СР
Modeling Processes in Vadose Zone	e (L2734)	Lecture	1	1
Modeling Processes in Vadose Zone	e (L2735)	Recitation Section (small)	1	1
/adose Zone Hydrology (L2732)		Lecture	2	2
/adose Zone Hydrology (L2733)		Recitation Section (large)	2	2
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
<b>Recommended Previous</b>				
Knowledge				
Educational Objectives	After taking part successfully, students h	have reached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 96, Study Time	e in Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water a	nd Traffic: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Water a	nd Traffic: Elective Compulsory		
	Environmental Engineering: Specialisatio	on Water: Elective Compulsory		
	Environmental Engineering: Specialisatio	on Water: Elective Compulsory		
	Water and Environmental Engineering: S	Specialisation Water: Elective Compulsory		
	Water and Environmental Engineering: S	Specialisation Environment: Elective Compulsory		
	Water and Environmental Engineering: S	Specialisation Cities: Elective Compulsory		
	Water and Environmental Engineering: S	Specialisation Cities: Elective Compulsory		
		Specialisation Environment: Elective Compulsory		
	Water and Environmental Engineering: S	Specialisation Water: Elective Compulsory		

Course L2734: Modeling Processes in Vadose Zone		
Тур	Lecture	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Hannes Nevermann, Prof. Nima Shokri	
Language	EN	
Cycle	SoSe	
Content		
Literature		

Course L2735: Modeling Processes in Vadose Zone		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Hannes Nevermann	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L2732: Vadose Zone Hydrology		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Nima Shokri	
Language	EN	
Cycle	SoSe	
Content		
Literature		

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

Module M1718: Multi	phase Flow in Porous Media			
Courses				
Fitle		Тур	Hrs/wk	СР
5 1	Multiphase Flow in Porous Media (L2738)	Recitation Section (small)	2	2
Fundamentals of Multiphase Flow in		Lecture	2	2
Fundamentals of Multiphase Flow in	n Porous Media (L2737)	Recitation Section (large)	2	2
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
<b>Recommended Previous</b>				
Knowledge				
Educational Objectives	After taking part successfully, students have reac	hed the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic	:: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Eng	gineering: Elective Compulsory		
	Civil Engineering: Specialisation Geotechnical Eng	gineering: Elective Compulsory		
	Civil Engineering: Specialisation Water and Traffic	: Elective Compulsory		
	Environmental Engineering: Specialisation Water:	Elective Compulsory		
	Environmental Engineering: Specialisation Water:	Elective Compulsory		
	Water and Environmental Engineering: Specialisa	tion Cities: Elective Compulsory		
	Water and Environmental Engineering: Specialisa	tion Cities: Elective Compulsory		
	Water and Environmental Engineering: Specialisa	tion Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialisa	tion Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialisa	tion Water: Elective Compulsory		
	Water and Environmental Engineering: Specialisa	tion Water: Elective Compulsory		

Course L2738: Advanced Modeling Techniques for Multiphase Flow in Porous Media		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Nima Shokri	
Language	EN	
Cycle	SoSe	
Content		
Literature		

Course L2736: Fundamentals of Multiphase Flow in Porous Media		
Тур	Lecture	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Nima Shokri	
Language	EN	
Cycle	SoSe	
Content		
Literature		

Course L2737: Fundamentals	ourse L2737: Fundamentals of Multiphase Flow in Porous Media		
Тур	Recitation Section (large)		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Hannes Nevermann		
Language	EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Lingineering				
Module M1721: Wate	r and Environment: Theory and	Application		
Courses				
Title		Тур	Hrs/wk	СР
Water and Environment: Applicatio	n and Field Work (L2754)	Project-/problem-based Learning	3	4
Water and Environment: Theory (L2	2753)	Lecture	1	2
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
<b>Recommended Previous</b>				
Knowledge				
Educational Objectives	After taking part successfully, students have n	eached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Report (about 5-10 pages) and Presentation (a	bout 15 min)		
scale				
Assignment for the	Civil Engineering: Specialisation Coastal Engin	eering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Water and Tra	affic: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engin	eering: Elective Compulsory		
	Civil Engineering: Specialisation Water and Tra	affic: Elective Compulsory		
	Environmental Engineering: Specialisation Wa	ter: Elective Compulsory		
	Environmental Engineering: Specialisation Wa	ter: Elective Compulsory		
	Water and Environmental Engineering: Specia			
	Water and Environmental Engineering: Specia			
	Water and Environmental Engineering: Specia			
	Water and Environmental Engineering: Specia			
	Water and Environmental Engineering: Specia			
	Water and Environmental Engineering: Specia	lisation Water: Elective Compulsory		

Course L2754: Water and Environment: Application and Field Work	
Тур	Project-/problem-based Learning
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Anna Luisa Hemshorn de Sánchez, Dr. Salome Shokri-Kuehni
Language	EN
Cycle	SoSe
Content	
Literature	

Course L2753: Water and Environment: Theory		
Тур	Lecture	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Nima Shokri	
Language	EN	
Cycle	SoSe	
Content		
Literature		

-					
Courses					
Title		Тур	Hrs/wk	СР	
Solid Matter Process Technology for	Biomass (L0052)	Lecture	2	2	
Thermal Waste Treatment (L0320) Thermal Waste Treatment (L1177)		Lecture Recitation Section (large)	2	2	
Module Responsible	Prof Korstin Kuchta	Reclation Section (arge)	1	2	
Admission Requirements					
Recommended Previous					
Knowledge					
	thermo dynamics				
	fluid dynamics				
	chemistry				
Educational Objectives	After taking part successfully, students have re	ached the following learning results			
Professional Competence					
-	The students can name, describe current is:	sue and problems in the field of therma	l waste treatment	and particle proce	
-	engineering and contemplate them in the contemplate	ext of their field.			
	The industrial application of unit operations as				
	technologies and solid biomass processes. Co				
	renewable resources and wastes are described and refining edible oils, electricity , heat and m		ing solid fuels and i	bioetrianoi, producii	
	and remning cable ons, electricity, near and m				
Skills	The students are able to select suitable proces	ses for the treatment of wastes or raw mai	terial with respect to	o their characteristi	
	and the process aims. They can evaluate the efforts and costs for processes and select economically feasible treatment concepts				
Personal Competence					
Social Competence	Students can				
social competence					
	<ul> <li>respectfully work together as a team and discuss technical tasks</li> </ul>				
		<ul> <li>participate in subject-specific and interdisciplinary discussions,</li> </ul>			
	develop cooperated solutions				
	<ul> <li>promote the scientific development and</li> </ul>	l accept professional constructive criticism.			
Autonomy	Students can independently tap knowledge	of the subject area and transform it to	new questions. T	hey are capable,	
	consultation with supervisors, to assess their	learning level and define further steps on	this basis. Furtherm	nore, they can defir	
	targets for new application-or research-oriente	d duties in accordance with the potential so	cial, economic and	cultural impact.	
	Independent Study Time 110, Study Time in Le	cture /0			
Credit points					
Course achievement					
Examination					
Examination duration and	120 min				
scale Assignment for the	Civil Engineering: Specialisation Water and Tra	ffic: Elective Compulsory			
5	Bioprocess Engineering: Specialisation Water and Tra		ulsory		
. Showing curricula	International Management and Engineering: Specialisation A - Gen		-	Compulsory	
				. compaisory	
	International Management and Engineering: Specialisation II. Renewable Energy: Elective Compulsory Renewable Energies: Specialisation Bioenergy Systems: Elective Compulsory				
	Process Engineering: Specialisation Chemical P				
	Process Engineering: Specialisation Process En	5 5 1 5			
	Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory				
	Water and Environmental Engineering: Specialisation Environment: Compulsory				
	Water and Environmental Engineering: Special				

Course L0052: Solid Matter F	Process Technology for Biomass
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Werner Sitzmann
Language	DE
Cycle	SoSe
Content	The industrial application of unit operations as part of process engineering is explained by actual examples of solid biomass processes. Size reduction, transportation and dosing, drying and agglomeration of renewable resources are described as important unit operations when producing solid fuels and bioethanol, producing and refining edible oils, when making Btl - and WPC - products. Aspects of explosion protection and plant design complete the lecture.
Literature	Kaltschmitt M., Hartmann H. (Hrsg.): Energie aus Bioamsse, Springer Verlag, 2001, ISBN 3-540-64853-4 Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz, Schriftenreihe Nachwachsende Rohstoffe, Fachagentur Nachwachsende Rohstoffe e.V. www.nachwachsende-rohstoffe.de Bockisch M.: Nahrungsfette und -öle, Ulmer Verlag, 1993, ISBN 380000158175

Course L0320: Thermal Wast	re Treatment
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Kerstin Kuchta
Language	EN
Cycle	SoSe
Content	<ul> <li>Introduction, actual state-of-the-art of waste incineration, aims. legal background, reaction principals</li> <li>basics of incineration processes: waste composition, calorific value, calculation of air demand and flue gas composition</li> <li>Incineration techniques: grate firing, ash transfer, boiler</li> <li>Flue gas cleaning: Volume, composition, legal frame work and emission limits, dry treatment, scrubber, de-nox techniques, dioxin elimination, Mercury elimination</li> <li>Ash treatment: Mass, quality, treatment concepts, recycling, disposal</li> </ul>
Literature	Thomé-Kozmiensky, K. J. (Hrsg.): Thermische Abfallbehandlung Bande 1-7. EF-Verlag für Energie- und Umwelttechnik, Berlin, 196 - 2013.

Course L1177: Thermal Waste Treatment		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Kerstin Kuchta	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

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

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

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

Module M0857: Geocl	nemical Engineering				
Courses					
Title		Тур	Hrs/wk	СР	
Title Contaminated Sites and Landfilling (L0906)		Lecture	2	2	
Contaminated Sites and Landfilling		Recitation Section (large)		2	
Geochemical Engineering (L0904)		Lecture	2	2	
Module Responsible	Dr. Marco Ritzkowski				
Admission Requirements	None				
<b>Recommended Previous</b>	Module: General and Inorganic Chemistry,				
Knowledge	Module:Organic Chemistry,				
	Biology (Basic Knowledge)				
	After taking part successfully, students have	reached the following learning results			
-	After taking part successfully, students have reached the following learning results				
Professional Competence	With the completion of this module students acquire profound knowledge of biogeochemical processes, the fate of pollutants				
Knowledge					
soil and groundwater, and techniques to deposit contaminated waste material. They are able to describe in princip					
	of chemicals in the environment. Students can explain and report the approach to remediate contaminated sites.				
Skills	With the completion of this module students can apply the acquired theoretical knowledge to model cases of site pollution and				
	critically assess the situation technically and conceptually. They are able to draw comparisons on different remediation strategies				
	and techniques. Model projects can be devis				
Personal Competence					
Social Competence	Students can discuss technical and scientific tasks within a seminar subject specific and interdisciplinary .				
Autonomy	Students can independently exploit sources , acquire the particular knowledge of the subject and apply it to new problems.				
Workload in Hours	Independent Study Time 110, Study Time in	Lecture 70			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	2 hours				
scale					
Assignment for the	Civil Engineering: Specialisation Water and	Fraffic: Elective Compulsory			
Following Curricula	Environmental Engineering: Core Qualification	on: Elective Compulsory			
Water and Environmental Engineering: Specialisation Water: Elective Compulsory					
Water and Environmental Engineering: Specialisation Environment: Elective Compulsory					
	Water and Environmental Engineering: Specialisation Cities: Elective Compulsory				

Course L0906: Contaminated	l Sites and Landfilling	
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Dr. Marco Ritzkowski, Dr. Joachim Gerth	
Language	EN	
Cycle	SoSe	
Content	The part Contaminated Sites gives an introduction into different scales of pollution and identifies key pollutants. Geochemical attenuation mechanisms and the role of organisms are highlighted affecting the fate of pollutants in leachate and groundwater. Techniques for site characterization and remediation are discussed including economical aspects. The part Landfilling is introduced by discussing fundamental aspects and the worldwide situation of waste management. The lecture highlights transformation processes in landfill bodies, emissions of gases and leachate, and the long-term behaviour of landfill sites with measures of aftercare.	
Literature	<ol> <li>Waste Management. Bernd Bilitewski; Georg Härdtle; Klaus Marek (Eds.), ISBN: 9783540592105 , Springer Verlag Lehrbuchsammlung der TUB, Signatur USH-305</li> <li>Solid Waste Technology and Management. Thomas Christensen (Ed.), ISBN: 978-1-4051-7517-3 , Wiley Verlag Lesesaal 2: US - Umweltschutz, Signatur USH-332</li> <li>Natural attenuation of fuels and chlorinated solvents in the subsurface. Todd H. Wiedemeier(Ed.), ISBN: 0471197491 Lesesaal 2: US - Umweltschutz, Signatur USH-844</li> </ol>	

ourse L0907: Contaminated Sites and Landfilling			
Тур	ecitation Section (large)		
Hrs/wk	1		
СР	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Dr. Marco Ritzkowski, Dr. Joachim Gerth		
Language	EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L0904: Geochemical	Engineering
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Joachim Gerth
Language	EN
Cycle	SoSe
	As an introduction cases are presented in which geochemical engineering was used to solve environmental problems. Environmentally important minerals are discussed and methods for their detection. It is demonstrated how solution equilibria can be modified to eliminate elevated concentrations of unwanted species in solution and how carbon dioxide concentration affects pH and the dissolution of carbonate minerals. Modifications of redox conditions, pH, and electrolyte concentration are shown to be effective tools for controlling the mobility and fate of hazardous species in the environment.
Literature	Geochemistry, groundwater and pollution. C. A. J. Appelo; D. Postma
	Leiden [u.a.] Balkema 2005 Lehrbuchsammlung der TUB, Signatur GWC-515

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

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

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

Module M0871: Hydro	In wheel Country of				
	logical Systems				
Courses					
Title		Тур	Hrs/wk	СР	
Applied Surface Hydrology (L0289)		Lecture	2	2	
Applied Surface Hydrology (L1412)		Project-/problem-based Learning	1	2	
Interaction Water - Environment in F	luvial Areas (L0295)	Project-/problem-based Learning	1	2	
Module Responsible	Prof. Peter Fröhle				
Admission Requirements	None				
Recommended Previous	Fundamentals of Hydromechanics and Hyd	raulic Engineering: Hydraulic Engineering I and Hydrau	ulic Engineerii	ng II	
Knowledge					
Educational Objectives	After taking part successfully, students hav	ve reached the following learning results			
Professional Competence					
Knowledge	The students are able to define the basic o	concepts of hydrology and water management. They	are able to d	escribe and quantif	
f	the relevant processes of the hydrological	water cycle. Besides, the students know the main asp	ects of rainfa	ll-run-off-models an	
	are able to theoretically derive established	reservoir / storage models and a unit-hydrograph.			
		ydrological concepts and approaches and are able t			
		graph as the basis for rainfall-run-off-models. The stu			
,	concepts of measurements of hydrological	I and hydrodynamic values in nature and are able to	perform, ana	lyze and statisticall	
;	assess these measurements. Furthermore,	they are able to apply a hydrological model to basic h	ydrological pr	roblems.	
Personal Competence					
Social Competence	The students are able to deploy their gaine	ed knowledge in applied problems of the hydrology and	d water mana	gement. Additionaly	
	they will be able to work in team with engir				
		extend their knowledge and apply it to new problems			
	Independent Study Time 124, Study Time in	n Lecture 56			
Credit points					
Course achievement					
Examination					
		The examination includes tasks with respect to the ge	neral underst	anding of the lectur	
scale	contents and calculations tasks.				
Assignment for the	Civil Engineering: Specialisation Water and	Traffic: Elective Compulsory			
Following Curricula	Environmental Engineering: Core Qualificat	ion: Elective Compulsory			
1	Joint European Master in Environmental Stu	udies - Cities and Sustainability: Core Qualification: Con	mpulsory		
	Water and Environmental Engineering: Spe	cialisation Water: Elective Compulsory			
	Water and Environmental Engineering: Specialisation water. Elective Compulsory				
	Water and Environmental Engineering: Spe	cialisation Environment: Elective Compulsory			

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

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

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

Engineering					
Module M0874: Wast	ewater Systems				
Courses					
Title		Тур	Hrs/wk	СР	
Wastewater Systems - Collection, T	reatment and Reuse (L0934)	Lecture	2	2	
Wastewater Systems - Collection, 1	reatment and Reuse (L0943)	Recitation Section (large)	1	1	
Advanced Wastewater Treatment (	L0357)	Lecture	2	2	
Advanced Wastewater Treatment (	L0358)	Recitation Section (large)	1	1	
Module Responsible	Prof. Ralf Otterpohl				
Admission Requirements	None				
<b>Recommended Previous</b>	Knowledge of wastewater management and t	he key processes involved in wastewater tre	atment.		
Knowledge					
Educational Objectives	After taking part successfully, students have i	reached the following learning results			
Professional Competence					
Knowledge	Students are able to outline key areas of the	full range of treatment systems in waste wa	ter management, as	s well as their mutu	
	dependence for sustainable water protection.	They can describe relevant economic, envir	onmental and social	factors.	
		10		<b>C</b> (1) - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -	
SKIIIS	Students are able to pre-design and explain		ses and the scope o	of their application	
	municipal and for some industrial treatment plants.				
Personal Competence					
-	Social skills are not targeted in this module.				
Autonomy	Students are in a position to work on a sub	pject and to organize their work flow indep	endently. They can	also present on th	
	subject.				
Workload in Hours	Independent Study Time 96, Study Time in Le	ecture 84			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	120 min				
scale					
Assignment for the	Civil Engineering: Specialisation Structural En	gineering: Elective Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnical	Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory				
	Civil Engineering: Specialisation Water and Traffic: Compulsory				
	Bioprocess Engineering: Specialisation A - Ger	neral Bioprocess Engineering: Elective Comp	ulsory		
	Environmental Engineering: Specialisation Water: Elective Compulsory				
	International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory				
	International Management and Engineering: S	Specialisation II. Energy and Environmental E	ngineering: Elective	Compulsory	
	Process Engineering: Specialisation Environm	ental Process Engineering: Elective Compuls	ory		
	Process Engineering: Specialisation Process E	ngineering: Elective Compulsory			
	Water and Environmental Engineering: Specia				
	Water and Environmental Engineering: Specia				
	Water and Environmental Engineering: Specia				
	- <u>5</u> - <u>5</u> - <u>5</u> - <u>5</u>	, ,			

#### Course L0934: Wastewater Systems - Collection, Treatment and Reuse

Тур	Lecture			
Hrs/wk	2			
СР	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Ralf Otterpohl			
Language	EN			
Cycle	SoSe			
Content	•Understanding the global situation with water and wastewater			
	Regional planning and decentralised systems			
	•Overview on innovative approaches			
	In depth knowledge on advanced wastewater treatment options for different situations, for end-of-pipe and reuse			
	Mathematical Modelling of Nitrogen Removal			
	•Exercises with calculations and design			
Literature	Henze, Mogens:			
	Wastewater Treatment: Biological and Chemical Processes, Springer 2002, 430 pages			
	George Tchobanoglous, Franklin L. Burton, H. David Stensel:			
	Wastewater Engineering: Treatment and Reuse, Metcalf & Eddy			
	McGraw-Hill, 2004 - 1819 pages			

Course L0943: Wastewater Systems - Collection, Treatment and Reuse		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Ralf Otterpohl	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

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

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

Module M0875: Nexu	s Engineering - Water, Soil, Foo	d and Energy			
-					
Courses					
Title		Тур	Hrs/wk	СР	
	nergy, Soil and Food Nexus (L1229)	Seminar	2	2	
Water & Wastewater Systems in a		Lecture	2	4	
Module Responsible					
Admission Requirements					
Recommended Previous Knowledge	Basic knowledge of the global situation with rising poverty, soil degradation, migration to cities, lack of water resources an sanitation				
Educational Objectives	After taking part successfully, students have r	reached the following learning results			
Professional Competence					
Knowledge	Students can describe the facets of the global water situation. Students can judge the enormous potential of the implementation synergistic systems in Water, Soil, Food and Energy supply.				
Skills	Students are able to design ecological settlements for different geographic and socio-economic conditions for the main clima around the world.				
Personal Competence					
Social Competence	The students are able to develop a specific topic in a team and to work out milestones according to a given plan.				
Autonomy	Students are in a position to work on a subject and to organize their work flow independently. They can also present on thi subject.				
Workload in Hours	Independent Study Time 124, Study Time in L	ecture 56			
Credit points	6				
Course achievement	None				
Examination	Subject theoretical and practical work				
Examination duration and	During the course of the semester, the stude	nts work towards mile stones. The work	includes presentations a	and papers. Detaile	
scale	information can be found at the beginning of t	the smester in the StudIP course module	handbook.		
Assignment for the	Civil Engineering: Specialisation Water and Tr	affic: Elective Compulsory			
Following Curricula	Bioprocess Engineering: Specialisation A - Ger	neral Bioprocess Engineering: Elective Co	mpulsory		
	Chemical and Bioprocess Engineering: Specialisation General Process Engineering: Elective Compulsory				
	Environmental Engineering: Core Qualification: Elective Compulsory				
	Joint European Master in Environmental Studies - Cities and Sustainability: Core Qualification: Compulsory				
	Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory				
	Process Engineering: Specialisation Process Engineering	ngineering: Elective Compulsory			
	Water and Environmental Engineering: Specia	lisation Water: Elective Compulsory			
	Water and Environmental Engineering: Specia	lisation Environment: Elective Compulsor	У		
	Water and Environmental Engineering: Specia	lisation Cities: Elective Compulsory			

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

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

Engineering"	
Module M0922: City F	lanning
Courses	
Fitle	Typ Hrs/wk CP
City Planning (L1066)	Project-/problem-based Learning 4 6
Module Responsible	Prof. Carsten Gertz
Admission Requirements	None
<b>Recommended Previous</b>	for "Principles of Urban Planning": none
Knowledge	for "Designing Urban Streetscapes": some knowledge of transport planning, e.g. through taking the undergraduate class "Trans
	Planning and Traffic Engineering"
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
	Students are able to:
5	
	use technical terms of urban planning.
	<ul> <li>describe the main determinants of urban development.</li> <li>explain and compare different possibilities of how urban development can be influenced.</li> </ul>
	<ul> <li>explain and compare difference possibilities of now disan development can be initialitied.</li> <li>discuss requirements for public streetscapes.</li> </ul>
	<ul> <li>explain the importance of street design.</li> </ul>
Skills	Students are able to:
	<ul> <li>read and analyze urban development concepts and designs for streetscapes</li> </ul>
	<ul> <li>appraise such concepts in the context of competing requirements.</li> </ul>
	design, justify and reflect their own solutions for concrete examples.
Personal Competence	
Social Competence	Students are able to:
	discuss intermediate results with each other.
	<ul> <li>constructively accept feedback on their own work.</li> </ul>
	provide constructive feedback to others.
Autonomy	Students are able to:
hatohomy	
	<ul> <li>independently complete a written report including drawings following a broadly pre-defined process.</li> </ul>
	<ul> <li>assess the consequences of their proposed solutions.</li> <li>independently acquire knowledge and apply this to new issues or problem areas.</li> </ul>
	• Independenci y acquire knowledge and apply this to new issues of problem areas.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	
Examination duration and	written assignment, designwork during the semester
scale	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory
Assignment for the Following Curricula	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory
. Showing curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory
	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure and Mobility: Elective Compulsory
	Water and Environmental Engineering: Specialisation Water: Elective Compulsory
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory
	Water and Environmental Engineering: Specialisation Cities: Compulsory

Course L1066: City Planning	
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Carsten Gertz
Language	DE
Cycle	SoSe
Content	"Principles of Urban Planning" deals with the determinants of urban development and their interactions. Topics include:
	<ul> <li>legal framework,</li> <li>instruments and methods of planning,</li> <li>functional requirements,</li> <li>stakeholders and actors</li> <li>basic design requirements</li> <li>different planning levels and</li> <li>historical contexts.</li> </ul> The objective of the course is for students to acquire a basic understanding of urban development problems and approaches for solving them. They will also be able to comprehend the process of urban planning. The course also covers the various functional and aesthetic requirements for designing streetscape as the most important elements of public space. The project work deals with a real life scenario and includes drawing up a development plan, an urban design concept, a building
	masterplan and a street redesign.
Literature	Albers, Gerd; Wekel, Julian (2009) Stadtplanung: Eine illustrierte Einführung. Primus Verlag. Darmstadt.
	Frick, Dieter (2008) Theorie des Städtebaus: Zur baulich-räumlichen Organisation von Stadt. Wasmuth-Verlag. Tübingen
	Jonas, Carsten (2009) Die Stadt und ihr Grundriss. Wasmuth-Verlag. Tübingen
	Kostof, Spiro; Castillo, Greg (1998) Die Anatomie der Stadt. Geschichte städtischer Strukturen. Campus-Verlag. Frankfurt/New York.

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

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

Engineering"				
Module M0663: Marin	e Geotechnics			
Courses				
Title		Тур	Hrs/wk	СР
Marine Geotechnics (L0548)		Lecture	1	2
Marine Geotechnics (L0549)		Recitation Section (large)	2	2
Steel Structures in Foundation and		Lecture	2	2
Module Responsible				
Admission Requirements	None			
<b>Recommended Previous</b>	complete modules: Geotechnics I-III, Mathematics	1-111		
Knowledge	courses: Soil laboratory course			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 110, Study Time in Lectu	ire 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Geotechnical Eng	ineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Structural Engine	ering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineeri	ing: Compulsory		
	Theoretical Mechanical Engineering: Specialisation	n Maritime Technology: Elective Compulsory		
	Water and Environmental Engineering: Specialisat	tion Cities: Elective Compulsory		
	Water and Environmental Engineering: Specialisat			
	Water and Environmental Engineering: Specialisat	tion Water: Elective Compulsory		

Course L0548: Marine Geotechnics			
Тур	cture		
Hrs/wk	1		
СР	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Jürgen Grabe		
Language	DE		
Cycle	SoSe		
Content	<ul> <li>Geotechnical investigation an description of the seabed</li> <li>Foundations of Offshore-Constructions</li> <li>cCliff erosion</li> <li>Sea dikes</li> <li>Port structures</li> <li>Flood protection structures</li> </ul>		
Literature	<ul> <li>EAK (2002): Empfehlungen für Küstenschutzbauwerke</li> <li>EAU (2004): Empfehlungen des Arbeitsausschusses Uferbauwerke</li> <li>Poulos H.G. (1988): Marine Geotechnics. Unwin Hyman, London</li> <li>Wagner P. (1990): Meerestechnik: Eine Einführung für Bauingenieure. Ernst &amp; Sohn, Berlin</li> </ul>		

Course L0549: Marine Geotechnics	
Тур	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1146: Steel Structur	ourse L1146: Steel Structures in Foundation and Hydraulic Engineering		
Тур	Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Frank Feindt		
Language	DE		
Cycle	SoSe		
Content	Design of a sheet pile wall, design of a combined sheet pile wall, piles, walings, connections, fatigue		
Literature	EAU 2012, EA-Pfähle, EAB		

Engineering"				
Module M1724: Smar	t Monitoring			
Courses				
Title		Тур	Hrs/wk	СР
Smart Monitoring (L2762)		Integrated Lecture	2	2
Smart Monitoring (L2763)		Recitation Section (small)	2	4
Module Responsible	Prof. Kay Smarsly			
Admission Requirements	None			
<b>Recommended Previous</b>	Basic knowledge or interest in object-oriented mod	leling, programming, and sensor technol	ogies are helpfu	I. Interest in mod
Knowledge	research and teaching areas, such as Internet of T	hings, Industry 4.0 and cyber-physical sy	stems, as well a	is the will to dee
	skills of scientific working, are required. Basic knowl	edge in scientific writing and good English	ı skills.	
Educational Objectives	After taking part successfully, students have reache	d the following learning results		
Professional Competence			-	
	The students will become familiar with the princip	oles and practices of smart monitoring	The students w	ill be able to de
Kilowicuge	decentralized smart systems to be applied for c			
	environment. In addition, the students will learn to			
	analysis techniques, modern software design conce			
	also part of this module. In small groups, the s		-	
	"intelligent" sensors to be implemented by the s	5	-	5
	techniques. The smart monitoring systems will be r			
	on scaled lab structures for validation purposes. Th		-	
	module will "automatically" participate with their			
	written papers and oral examinations form the final			
	- Fritten			
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 124, Study Time in Lecture	56		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	10 pages of work with 15-minute oral presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic: E	lective Compulsory		
Following Curricula				
	Civil Engineering: Specialisation Coastal Engineering			
	Civil Engineering: Specialisation Structural Engineer	5 1 5		
	Civil Engineering: Specialisation Coastal Engineering			
	Civil Engineering: Specialisation Geotechnical Engine	5 1 5		
	Civil Engineering: Specialisation Structural Engineer			
	Civil Engineering: Specialisation Water and Traffic: E			
	Environmental Engineering: Specialisation Waste an			
	Environmental Engineering: Specialisation Biotechno	55 1 5		
	Environmental Engineering: Specialisation Water: El			
	Environmental Engineering: Specialisation Waste an			
	Environmental Engineering: Specialisation Biotechno			
	Environmental Engineering: Specialisation Water: El			
	Water and Environmental Engineering: Specialisatio			
	Water and Environmental Engineering: Specialisatio			
	Water and Environmental Engineering: Specialisatio			
	Water and Environmental Engineering: Specialisatio			
	Water and Environmental Engineering: Specialisatio			
	Water and Environmental Engineering: Specialisatio	n water: Elective Compulsory		

Course L2762: Smart Monitoring		
Тур	Integrated Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Kay Smarsly	
Language	EN	
Cycle	WiSe/SoSe	
Content	In this course, principles of smart monitoring will be taught, focusing on modern concepts of data acquisition, data storage, and data analysis. Also, fundamentals of intelligent sensors and embedded computing will be illuminated. Autonomous software and decentralized data processing are further crucial parts of the course, including concepts of the Internet of Things, Industry 4.0 and cyber-physical systems. Furthermore, measuring principles, data acquisition systems, data management and data analysis algorithms will be discussed. Besides the theoretical background, numerous practical examples will be shown to demonstrate how smart monitoring may advantageously be used for assessing the condition of systems in the built or natural environment.	
Literature		

Course L2763: Smart Monito	ring
Тур	Recitation Section (small)
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Kay Smarsly
Language	EN
Cycle	WiSe/SoSe
Content	The contents of the exercises are based on the lecture contents. In addition to the exercises, project work will be conducted, which will consume the majority of the workload. As part of the project work, students will design smart monitoring systems that will be tested in the laboratory or in the field. As mentioned in the module description, the students will participate in the "Smart Monitoring" competition, hosted annually by the Institute of Digital and Autonomous Construction. Students are encouraged to contribute their own ideas. The tools required to implement the smart monitoring systems will be taught in the group exercises as well as through external sources, such as video tutorials and literature.
Literature	

Module M1123: Selec	ted Topics in Environmental Engi	neering		
Courses				
Title		Тур	Hrs/wk	СР
Environmental Aquatic Chemistry (	L1444)	Lecture	2	3
Excellence in International Project	Delivery (L2387)	Integrated Lecture	2	2
Sludge Treatment (L0520)		Lecture	2	3
Thermal Biomass Utilization (L1767	')	Lecture	2	2
Thermal Biomass Utilization (L2386	5)	Practical Course	1	1
Module Responsible	Prof. Mathias Ernst			
Admission Requirements	None			
<b>Recommended Previous</b>				
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Depends on choice of courses			
Credit points	6			
Assignment for the	Environmental Engineering: Core Qualification: E	Elective Compulsory		
Following Curricula	Water and Environmental Engineering: Specialisation Cities: Elective Compulsory			
	Water and Environmental Engineering: Specialis	ation Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialis	ation Water: Elective Compulsory		

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

Course L2387: Excellence in	International Project Delivery
Тур	Integrated Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	2 h
scale	
Lecturer	Dr. Jens Huckfeldt
Language	EN
Cycle	SoSe
Content	Simply and easy to avoid mistake in project delivery can deliver projects within budget and as per schedule.You
	have to attend if you see yourself in project execution and potentially even abroad.
Literature	

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

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

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

Engineering"				
Module M0581: Wate	r Protection			
Courses				
Title		Тур	Hrs/wk	СР
Water Protection and Wastewater I	lanagement (L0226)	Lecture	3	3
Water Protection and Wastewater I	Aanagement (L2008)	Project Seminar	3	3
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
<b>Recommended Previous</b>	. Desis la sudadas in unha reservant			
Knowledge	<ul> <li>Basic knowledge in water management</li> <li>Good knowledge in urban drainage;</li> </ul>			
	<ul><li>Good knowledge in urban drainage;</li><li>Good knowledge of wastewater treatment</li></ul>	ant techniques:		
	<ul> <li>Good knowledge of waterwater redund</li> <li>Good knowledge of pollutants (e.g. COE</li> </ul>			
Educational Objectives	After taking part successfully, students have r	eached the following learning results		
Professional Competence				
Knowledge	The students can describe the basic principles	of the regulatory framework related to the	international and Eu	iropean water secto
	They can explain limnological processes, su			
	problems related to water protection, such a		tment with a special	focus on innovati
	solutions, remediation measures as well as co	nceptual approaches.		
Skills	Students can accurately assess current proble	ems and situations in a country-specific or	local context. They o	can suggest concre
	actions to contribute to the planning of tom	norrow's urban water cycle. Furthermore,	they can suggest a	ppropriate technica
	administrative and legislative solutions to solv	e these problems.		
Personal Competence				
Personal Competence	The students can work together in internation	al groups		
Social Competence		al groups.		
Autonomy	Students are able to organize their work flow	to prepare presentations and discussions.	They can acquire ap	propriate knowled
	by making enquiries independently.			
Workload in Hours	Independent Study Time 96, Study Time in Le	cture 84		
Credit points				
Course achievement				
Examination	Presentation			
	Term paper plus presentation			
scale	· · · · · · · · · · · · · · · · · · ·			
5	Civil Engineering: Specialisation Structural Eng	, , ,		
Following Curricula	Civil Engineering: Specialisation Geotechnical	• • • • •		
	Civil Engineering: Specialisation Coastal Engin	• • • •		
	Civil Engineering: Specialisation Water and Tra			
	Environmental Engineering: Specialisation Wa		·	
	International Management and Engineering: S			
	Joint European Master in Environmental Studie		water: Elective Comp	Juisory
	Water and Environmental Engineering: Specia Water and Environmental Engineering: Specia			
	Water and Environmental Engineering: Specia Water and Environmental Engineering: Specia			
	water and Environmental Engineering. Specia	isation Environment. Compulsory		

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

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

Engineering							
Module M0620: Speci	al Aspec	ts of W	aste Resource Ma	anagement			
Courses							
Title					Тур	Hrs/wk	СР
Advanced Topics in Waste Resource	e Managemei	nt (L1055)			Project-/problem-based Learning	3	3
International Waste Management (I	L0317)				Project-/problem-based Learning	2	3
Module Responsible	Prof. Kersti	n Kuchta					
Admission Requirements	None						
<b>Recommended Previous</b>	basics in w	aste treatn	nent technologies				
Knowledge							
Educational Objectives	After taking	g part succ	essfully, students have re	ached the followi	ng learning results		
Professional Competence							
Knowledge	The studen	nts are able	e to describe waste as a i	resource as well	as advanced technologies for re	ecycling and re	ecovery of resources
	from waste	in detail. 1	This covers collection, trar	isport, treatment	and disposal in national and inte	ernational con	texts.
Chille	Ctudanta a	ra ablata a	alast suitable processos f	or the treatment	with respect to the national or c	ultural and do	volonmental context
SKIIIS					with respect to the national or c		
	They can e	valuate the	ecological impact and th	e technical enori	of different technologies and m	anagement sy	stems.
Personal Competence							
Social Competence	Students can work together as a team of 2-5 persons, participate in subject-specific and interdisciplinary discussions, develop						
	cooperated solutions and defend their own work results in front of others and promote the scientific development of colleagues						
	Furthermor	re, they car	n give and accept professi	onal constructive	e criticisms.		
Autonomi	Ctudopto o	an indonor	dontly goin additional k	anyladaa of the	aubiast area and apply it in a	luing the give	on course tacks on
Autonomy	projects.	an indeper	identiy gain additional ki	lowledge of the	subject area and apply it in so	fiving the giv	en course lasks and
	projects.						
Workload in Hours	Independer	nt Study Tir	me 110, Study Time in Le	cture 70			
Credit points	6						
Course achievement	Compulsory	Bonus	Form	Description			
	Yes	20 %	Written elaboration				
Examination	Presentatio	on					
Examination duration and	PowerPoint	presentati	on (10-15 minutes)				
scale							
Assignment for the	-	• •	cialisation Water and Traf				
Following Curricula			ering: Specialisation Wast				
	Joint Europ	ean Master	in Environmental Studies	- Cities and Sust	ainability: Specialisation Energy	Elective Com	pulsory
	Water and	Environme	ntal Engineering: Speciali	sation Water: Ele	ctive Compulsory		
		Water and Environmental Engineering: Specialisation Environment: Elective Compulsory					
	Water and	Environme	ntal Engineering: Speciali	sation Cities: Eleo	ctive Compulsory		

Course L1055: Advanced Top	oics in Waste Resource Management
Тур	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Rüdiger Siechau
Language	EN
Cycle	WiSe
Content	<ul> <li>Focus of the course "Advanced topics of waste resource management" lies on the organisational structures in waste management - such as planning, financing and logistics. One excursion will be offered to take part in (incineration plant, vehicle fleet and waste collection systems).</li> <li>The course is split into two parts: <ol> <li>part: "Conventional" lecture (development of waste management, legislation, collection, transportation and organisation of waste management, costs, fees and revenues).</li> <li>part: Project base learning: You will get a project to work out in groups of 4 to 6 students; all tools and data you need to work out the project were given before during the conventional lecture. Course documents are published in StudIP and communication during project work takes place via StudIP.</li> </ol> </li> <li>The results of the project work are presented at the end of the semester. The final mark for the course consists of the grade for the presentation.</li> </ul>
Literature	Einführung in die Abfallwirtschaft; Martin Kranert, Klaus Cord-Landwehr (Hrsg.); Vieweg + Teubner Verlag; 2010 PowerPoint slides in Stud IP

Course L0317: International	Waste Management
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Kerstin Kuchta
Language	EN
Cycle	WiSe
Content	Waste avoidance and recycling are the focus of this lecture. Additionally, waste logistics ( Collection, transport, export, fees and taxes) as well as international waste shipment solutions are presented. Other specific wastes, e.g. industrial waste, treatment concepts will be presented and developed by students themselves Waste composition and production on international level, wast eulogistic, collection and treatment in emerging and developing countries. Single national projects and studies will be prepared and presented by students
Literature	Basel convention

Courses						
Title				Тур	Hrs/wk	СР
Waste and Environmental Chemist	-			Practical Course	2	2
Biological Waste Treatment (L0318				Project-/problem-based Learning	3	4
Module Responsible						
Admission Requirements						
Recommended Previous	chemical and biologica	cal basics				
Knowledge						
Educational Objectives	After taking part succe	cessfully, students have r	eached the followir	ng learning results		
Professional Competence						
Knowleage	design and layout of a	anaerobic and aerobic w	aste treatment plar	biological waste treatment plan nts in detail, describe different t methods for waste analytics.		
Skills	control measurements	ts. The students can rec	nerché and evaluat	yout of plants. They can critical te literature and date connected uating findings in the group.	-	
Personal Competence						
Social Competence	Students can participa	oate in subject-specific a	nd interdisciplinary	discussions, develop cooperat	ed solutions ar	nd defend their o
	work results in front accept professional co		the scientific deve	elopment in front of colleagues	: Furthermore,	they can give a
Autonomy	are capable, in consul steps on this basis. Fu	Iltation with supervisors	as well as in the int efine targets for ne	ness or test reports and transfo erim presentation, to assess the w application-or research-orien	eir learning leve	el and define furt
		ime 110 Study Time in L	ecture 70			
Workload in Hours	Independent Study Tir	e 110, stady find lift				
	Independent Study Tir					
Credit points	6	Form	Description			
		Subject theoretical	Description and			
Credit points Course achievement	6 Compulsory Bonus Yes None					
Credit points Course achievement Examination	6 Compulsory Bonus Yes None Presentation	Subject theoretical practical work	and			
Credit points Course achievement Examination Examination duration and	6 Compulsory Bonus Yes None Presentation	Subject theoretical practical work	and			
Credit points Course achievement Examination Examination duration and scale	6 Compulsory Bonus Yes None Presentation Elaboration and Prese	Subject theoretical practical work entation (15-25 minutes	and n groups)	Compulsory		
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 Compulsory Bonus Yes None Presentation Elaboration and Prese Civil Engineering: Spec	Subject theoretical practical work entation (15-25 minutes ecialisation Structural En	and n groups) gineering: Elective			
Credit points Course achievement Examination Examination duration and scale	6 Compulsory Bonus Yes None Presentation Elaboration and Prese Civil Engineering: Spe- Civil Engineering: Spe-	Subject theoretical practical work entation (15-25 minutes ecialisation Structural En ecialisation Geotechnical	and n groups) gineering: Elective Engineering: Electi	ve Compulsory		
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 Compulsory Bonus Yes None Presentation Elaboration and Prese Civil Engineering: Spec Civil Engineering: Spec Civil Engineering: Spec	Subject theoretical practical work entation (15-25 minutes ecialisation Structural En ecialisation Geotechnical ecialisation Coastal Engir	and n groups) gineering: Elective Engineering: Electi eering: Elective Co	ve Compulsory mpulsory		
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 Compulsory Bonus Yes None Presentation Elaboration and Prese Civil Engineering: Spec Civil Engineering: Spec Civil Engineering: Spec Civil Engineering: Spec	Subject theoretical practical work entation (15-25 minutes ecialisation Structural En ecialisation Geotechnical ecialisation Coastal Engir ecialisation Water and Tr	and n groups) gineering: Elective Engineering: Elective cong eering: Elective Cong affic: Elective Cong	ve Compulsory mpulsory		
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 Compulsory Bonus Yes None Presentation Elaboration and Prese Civil Engineering: Spec Civil Engineering: Spec Civil Engineering: Spec Civil Engineering: Spec Civil Engineering: Spec Civil Engineering: Spec Environmental Engine	Subject theoretical practical work entation (15-25 minutes ecialisation Structural En- ecialisation Geotechnical ecialisation Coastal Engir ecialisation Water and Tr eering: Core Qualificatior	and n groups) gineering: Elective Engineering: Electi eering: Elective Comp affic: Elective Comp : Compulsory	ve Compulsory mpulsory pulsory	ring: Elective (	Compulsory
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 Compulsory Bonus Yes None Presentation Elaboration and Prese Civil Engineering: Spec Civil Engineering: Spec Civil Engineering: Spec Civil Engineering: Spec Civil Engineering: Spec Environmental Engine International Manager	Subject theoretical practical work entation (15-25 minutes ecialisation Structural En ecialisation Geotechnical ecialisation Coastal Engir ecialisation Water and Tr eering: Core Qualificatior ment and Engineering: S	and n groups) gineering: Elective Engineering: Elective compulsory pecialisation II. Ene	ve Compulsory mpulsory pulsory ergy and Environmental Enginee		
Credit points Course achievement Examination Examination duration and scale Assignment for the	6 Compulsory Bonus Yes None Presentation Elaboration and Prese Civil Engineering: Spec Civil Engineering: Spec Civil Engineering: Spec Civil Engineering: Spec Civil Engineering: Spec Environmental Engine International Manager Joint European Master	Subject theoretical practical work entation (15-25 minutes ecialisation Structural En ecialisation Geotechnical ecialisation Coastal Engir ecialisation Water and Tr eering: Core Qualificatior ment and Engineering: S	and n groups) gineering: Elective Engineering: Elective compulsory pecialisation II. Ene es - Cities and Susta	ve Compulsory mpulsory pulsory ergy and Environmental Enginee ainability: Specialisation Energy		

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

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

Module M0801: Water	Resources and -Supply			
	,			
Courses				
Title		Тур	Hrs/wk	СР
Chemistry of Drinking Water Treatn		Lecture	2	1
Chemistry of Drinking Water Treatn		Recitation Section (large)	1	2
Water Resource Management (L040 Water Resource Management (L040		Lecture Recitation Section (small)	2 1	2 1
Module Responsible		,		
	None			
Recommended Previous	Knowledge of water management and the	key processes involved in water treatment.		
Knowledge				
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results		
Professional Competence				
	outline the organisational structures of wa the scope of their application.	ant economic, environmental and social factors. ater companies. They will be able to explain the av	ailable water trea	itment processes a
SKIIIS	s Students will be able to assess complex problems in drinking water production and establish solutions involving wat management and technical measures. They will be able to assess the evaluation methods that can be used for this. Students v be able to carry out chemical calculations for selected treatment processes and apply generally accepted technical rules a standards to these processes.			
Personal Competence				
Social Competence	Working in a diverse group of specialists,	students will be able to develop and document co	omplex solutions	for the manageme
	and treatment of drinking water. They w	ill be able to take an appropriate professional po	sition, for examp	le representing us
	interests. They will be able to develop join	t solutions in teams of diverse experts and present	t these solutions t	o others.
Autonomy	Students will be in a position to work on a	subject independently and present on this subject.		
Workload in Hours	Independent Study Time 96, Study Time ir	n Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 min (chemistry) + presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structural	l Engineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechn	ical Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Water and	d Traffic: Compulsory		
	Civil Engineering: Specialisation Coastal En	ngineering: Elective Compulsory		
	International Management and Engineerin	g: Specialisation II. Energy and Environmental Eng	ineering: Elective	Compulsory
	Process Engineering: Specialisation Enviro	nmental Process Engineering: Elective Compulsory	,	
	Process Engineering: Specialisation Proces	ss Engineering: Elective Compulsory		
	Water and Environmental Engineering: Sp	ecialisation Water: Compulsory		
		ecialisation Environment: Elective Compulsory		

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

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

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

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

Module M0802: Memb	vrane Technology			
House House Herri	in the rectinology			
Courses				
Title		Тур	Hrs/wk	СР
Membrane Technology (L0399)		Lecture	2	3
Membrane Technology (L0400)		Recitation Section (small)	1	2
Membrane Technology (L0401)		Practical Course	1	1
Module Responsible				
Admission Requirements				
	Basic knowledge of water chemistry. Knowledge of the	e core processes involved in water, gas	and steam treat	ment
Knowledge				
	After taking part successfully, students have reached t	the following learning results		
Professional Competence				
Knowledge	Students will be able to rank the technical applications			
	the different driving forces behind existing membrar			
	membrane filtration and their advantages and disadv		lain the key diffe	erences in the use
	membranes in water, other liquid media, gases and in	iiquid/gas mixtures.		
Skills	Students will be able to prepare mathematical equation	ions for material transport in porous a	nd solution-diffu	sion membranes a
	calculate key parameters in the membrane separation	n process. They will be able to handle	technical memb	rane processes us
	available boundary data and provide recommendation	ons for the sequence of different trea	tment processes	s. Through their o
	experiments, students will be able to classify the s	separation efficiency, filtration charac	teristics and ap	plication of different
	membrane materials. Students will be able to characte	erise the formation of the fouling layer i	in different water	rs and apply techni
	measures to control this.			
Personal Competence				
Social Competence	Students will be able to work in diverse teams on task	ks in the field of membrane technology	. They will be ab	le to make decisio
	within their group on laboratory experiments to be und	dertaken jointly and present these to ot	hers.	
Autonomy	Students will be in a position to solve homework on	the topic of membrane technology in	dependently. The	ey will be capable
	finding creative solutions to technical questions.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	6		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Electronic Specialisation Water and Traffic: Electronic Specialisation (Specialisation Specialisation Specialis	ctive Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation A - General Biop	process Engineering: Elective Compulse	ory	
	Bioprocess Engineering: Specialisation B - Industrial Bi	oprocess Engineering: Elective Compul	sory	
	Chemical and Bioprocess Engineering: Specialisation C	Chemical Process Engineering: Elective	Compulsory	
	Chemical and Bioprocess Engineering: Specialisation G		ompulsory	
	Environmental Engineering: Specialisation Water: Elect	, ,		
	Joint European Master in Environmental Studies - Cities		er: Elective Com	pulsory
	Process Engineering: Specialisation Process Engineering	· · ·		
	Process Engineering: Specialisation Environmental Pro			
	Water and Environmental Engineering: Specialisation V			
	Water and Environmental Engineering: Specialisation E			
	Water and Environmental Engineering: Specialisation (	Cities: Elective Compulsory		

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

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

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

Module M0822: Proce	ss Modeling in Water Technolog	ју		
Courses				
Title		Тур	Hrs/wk	СР
Process Modelling of Wastewater T	reatment (L0522)	Project-/problem-based Learning	2	3
Process Modeling in Drinking Water		Project-/problem-based Learning	2	3
Module Responsible	Dr. Klaus Johannsen			
Admission Requirements	None			
<b>Recommended Previous</b>	Knowledge of the most important processes in	drinking water and waste water treatment.		
Knowledge				
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
<b>Professional Competence</b>				
Knowledge	Students are able to explain selected process	es of drinking water and waste water treatment i	n detail. The	ey are able to explair
	basics as well as possibilities and limitations of	dynamic modeling.		
Skille	Students are able to use the most important	features Modelica offers. They are able to transpo		processes in drinking
SKIIIS		ematical model in Modelica with respect to equilib		
	They are able to set up and apply models and		num, kinetic	s and mass balances
	They are able to set up and apply models and	assess their possibilities and initiations.		
Devenuel Competence				
Personal Competence	Chudanta and able to achieve much lands and do an			
Social Competence		ment solutions in a group with members of different		background. They are
	able to give appropriate feedback and can wor	k constructively with feedback concerning their wo	IFK.	
Autonomy	Students are able to define a problem, gain the	e required knowledge and set up a model.		
	Independent Study Time 124, Study Time in Le	ecture 56		
Credit points				
Course achievement Examination				
Examination duration and	30 min			
scale	Civil Engineering: Specialization Water and Tra	ffic: Elective Compulsory		
-	Civil Engineering: Specialisation Water and Tra			
Following Curricula	Environmental Engineering: Specialisation Wat	er: Elective Compulsory s - Cities and Sustainability: Specialisation Water: F	-lective Com	nulsony
	Process Engineering: Specialisation Environme		LICCLIVE COM	բայյուն
	Process Engineering: Specialisation Environme Process Engineering: Specialisation Process En			
	Water and Environmental Engineering: Special			
	Water and Environmental Engineering: Special			
	Water and Environmental Engineering: Special			
	mater and Environmental Engineering. Special	isación ciuca. Elective compuisory		

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

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

Module M0894: Study	/ Work Cities
House Hoose, Study	Hork entes
Courses	
<b>Fitle</b>	Typ Hrs/wk CP
Module Responsible	Dozenten des SD B
Admission Requirements	None
Recommended Previous Knowledge	<ul> <li>Basics of Urban Planning</li> <li>Urban Infrastructures (Water, Energy, Heat)</li> <li>Environmental Technologies (Solid Waste Disposal, Air Quality Control, Wastewater Treatement, etc.)</li> </ul>
Educational Objectives	After taking part successfully, students have reached the following learning results
<b>Professional Competence</b>	
Knowledge	The students are able to demonstrate their detailed knowledge in the field of Water and Environmental Engineering. They ca exemplify the state of technology and application and discuss critically in the context of actual problems and general conditions science and society. The students can develop solving strategies and approaches for fundamental and practical problems in the field of Water ar Environmental Engineering. They may apply theory based procedures and integrate safety-related, ecological, ethical, ar economic view points of science and society.
	Scientific work techniques that are used can be described and critically reviewed.
Skills	The students are able to independently select methods or planning approaches for the project work and to justify their choic They can explain how these methods or approaches relate to solutions in the field of work and how the context of application h to be adjusted. General findings and further developments may essentially be outlined.
Personal Competence	
	The students are able to condense the relevance and the structure of the project work, the work steps and the sub-problems f the presentation and discussion in front of a bigger group. They can lead the discussion and give a feedback on the project to the colleagues.
Autonomy	The students are capable of independently planning and documenting the work steps and procedures while considering the give deadlines. This includes the ability to accurately procure the newest scientific information. Furthermore, they can obtain feedbac from experts with regard to the progress of the work, and to accomplish results on the state of the art in science and technology.
Workload in Hours	Independent Study Time 180, Study Time in Lecture 0
Credit points	6
Course achievement	None
Examination	Study work
Examination duration and scale	
Assignment for the Following Curricula	Water and Environmental Engineering: Specialisation Cities: Compulsory

Module M0949: Rural	Development and Resources Oriented	l Sanitation for diffe	erent Climate Zon	es
Courses				
Title		Тур	Hrs/wk	СР
Rural Development and Resources	Oriented Sanitation for different Climate Zones (L0942)	Seminar	2	3
Rural Development and Resources	Oriented Sanitation for different Climate Zones (L0941)	Lecture	2	3
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
<b>Recommended Previous</b>	Basic knowledge of the global situation with rising pove	rty, soil degradation, lack of w	ater resources and sanita	ition
Knowledge				
<b>Educational Objectives</b>	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	Students can describe resources oriented wastewater	systems mainly based on sou	urce control in detail. The	ey can comment or
	techniques designed for reuse of water, nutrients and s	oil conditioners.		
	Students are able to discuss a wide range of proven ap	proaches in Pural Developmen	t from and for many regio	ons of the world
	students are use to discuss a wide range of proven ap	souches in Rural Developmen	c nom and for many regic	nis of the world.
Skills	Students are able to design low-tech/low-cost sanitat	ion, rural water supply, rainv	water harvesting systems	s, measures for the
	rehabilitation of top soil quality combined with food and	I water security. Students can	consult on the basics of s	soil building through
	"Holisitc Planned Grazing" as developed by Allan Savor	/.		
Personal Competence				
	The students are able to develop a specific topic in a te	am and to work out milestone	s according to a given pla	n.
Autonomy	Students are in a position to work on a subject and	to organize their work flow ir	dependently. They can a	also present on this
	subject.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	During the course of the semester, the students work	owards mile stones. The work	includes presentations a	and papers. Detailed
scale	information will be provided at the beginning of the smo	ester.		
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elect	tive Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation A - General Biop	rocess Engineering: Elective C	ompulsory	
	Chemical and Bioprocess Engineering: Specialisation Ge	eneral Process Engineering: Ele	ective Compulsory	
	Environmental Engineering: Specialisation Water: Electi	ve Compulsory		
	International Management and Engineering: Specialisat	ion II. Energy and Environmen	tal Engineering: Elective (	Compulsory
	Joint European Master in Environmental Studies - Cities	and Sustainability: Specialisat	ion Water: Elective Comp	ulsory
	Process Engineering: Specialisation Environmental Proc	ess Engineering: Elective Com	pulsory	
	Process Engineering: Specialisation Process Engineering	: Elective Compulsory		
	Water and Environmental Engineering: Specialisation W	ater: Elective Compulsory		
	Water and Environmental Engineering: Specialisation En	nvironment: Elective Compulso	ory	
	Water and Environmental Engineering: Specialisation C	ties: Elective Compulsory		

Course L0942: Rural Development and Resources Oriented Sanitation for different Climate Zones		
Тур	Seminar	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Ralf Otterpohl	
Language	EN	
Cycle	WiSe	
Content		
	<ul> <li>Central part of this module is a group work on a subtopic of the lectures. The focus of these projects will be based on an interview with a target audience, practitioners or scientists.</li> <li>The group work is divided into several Milestones and Assignments. The outcome will be presented in a final presentation at the end of the semester.</li> </ul>	
Literature	<ul> <li>J. Lange, R. Otterpohl 2000: Abwasser - Handbuch zu einer zukunftsfähigen Abwasserwirtschaft. Mallbeton Verlag (TUHH Bibliothek)</li> <li>Winblad, Uno and Simpson-Hébert, Mayling 2004: Ecological Sanitation, EcoSanRes, Sweden (free download)</li> <li>Schober, Sabine: WTO/TUHH Award winning Terra Preta Toilet Design: http://youtu.be/w_R09cYq6ys</li> </ul>	

Course L0941: Rural Develop	ment and Resources Oriented Sanitation for different Climate Zones	
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Ralf Otterpohl	
Language	EN	
Cycle	WiSe	
Content	<ul> <li>Living Soil - THE key element of Rural Development</li> <li>Participatory Approaches</li> <li>Rainwater Harvesting</li> <li>Ecological Sanitation Principles and practical examples</li> <li>Permaculture Principles of Rural Development</li> <li>Performance and Resilience of Organic Small Farms</li> <li>Going Further: The TUHH Toolbox for Rural Development</li> <li>EMAS Technologies, Low cost drinking water supply</li> </ul>	
Literature	<ul> <li>Miracle Water Village, India, Integrated Rainwater Harvesting, Water Efficiency, Reforestation and Sanitation: http://youtu.be/9hmkgn0nBgk</li> <li>Montgomery, David R. 2007: Dirt: The Erosion of Civilizations, University of California Press</li> </ul>	

Module M1716: Subsu	Irface Processes			
Courses				
Title		Тур	Hrs/wk	СР
Modeling of Subsurface Processes (		Lecture	2	2
Modeling of Subsurface Processes (		Recitation Section (small)	1	1
Modern Techniques for Subsurface Modern Techniques for Subsurface		Lecture Recitation Section (large)	2 1	2 1
Module Responsible		Rectation Section (hige)	1	Ŧ
Admission Requirements				
Recommended Previous	Basic Mathematics, Hydrology			
Knowledge				
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
Knowledge	Upon completion of this module, the stude	ents will understand the mechanisms controll	ng solute transpor	t in soil and natu
	porous media and will be able to work with t	he equations that govern the fate and transpo	rt of solutes in porc	ous media. Analytic
	numerical and experimental tools and techni			,
Skills	In addition to the physical insights, the stude	ents will be exposed to analytical, experimenta	al and numerical to	ols and techniques
	this module. This provides them with an exce	ellent opportunity to improve their skills on mu	Iltiple fronts which	will be useful in the
	future career.			
Personal Competence				
Social Competence	Teamwork & problem solving			
Autonomy	The students will be involved in writing in	dividual reports and presentation. This will	contribute to the	students' ability a
	willingness to work independently and respo	nsibly.		
Workload in Hours	Independent Study Time 96, Study Time in L	ecture 84		
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	Report and Presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering	ngineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnica	I Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engi	ineering: Elective Compulsory		
	Civil Engineering: Specialisation Water and T	raffic: Elective Compulsory		
	Process Engineering: Specialisation Environm	nental Process Engineering: Elective Compulso	ry	
	Process Engineering: Specialisation Process I	Engineering: Elective Compulsory		
	Water and Environmental Engineering: Speci	alisation Water: Compulsory		
	Water and Environmental Engineering: Speci	alisation Environment: Elective Compulsory		
	Water and Environmental Engineering: Speci	alisation Cities: Elective Compulsory		

Course L2730: Modeling of S	Course L2730: Modeling of Subsurface Processes		
Тур	Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Sonja Götz		
Language	EN		
Cycle	WiSe		
Content			
Literature			

Course L2731: Modeling of Subsurface Processes		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Sonja Götz	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L2728: Modern Techr	Course L2728: Modern Techniques for Subsurface Solute Transport		
Тур	Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Nima Shokri		
Language	EN		
Cycle	WiSe		
Content			
Literature			

Course L2729: Modern Techr	urse L2729: Modern Techniques for Subsurface Solute Transport		
Тур	Recitation Section (large)		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Hannes Nevermann		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M1720: Emerg	ging Trends in Environmental	Engineering		
		J J		
Courses				
Title		Тур	Hrs/wk	СР
Environmental Research Trends (L2		Seminar	2	2
Microplastics in Environment (L275		Lecture	2	2
Scientific Communication and Meth		Lecture	1	2
Module Responsible	Prof. Nima Shokri			
•	None			
	Basic knowledge on water, soil and enviror	nmental research.		
Knowledge				
Educational Objectives	After taking part successfully, students have	ve reached the following learning results		
Professional Competence				
Knowledge	The students will be exposed to up-to-date research topics focused on soil, water and climate related challenges with a particula focus on the effects of microplastics in environment. Data analysis, data measurement, curation and presentation will be other skills that the students will develop in this module.			
Skills	Students' research skills will be improved in this module. How to prepare and deliver an effective presentation, how to write a abstract, research paper and proposal will be discussed in this module. Moreover, through Research-Based Learning approaches the students will be exposed to current research trends in environmental engineering.			
Personal Competence				
Social Competence	Developing teamwork and problem solving	skills through Research-Based Teaching appr	oaches will be at the	core of this module.
Autonomy	The students will be involved in writing individual reports and presentation. This will contribute to the students' ability and willingness to work independently and responsibly.			
Workload in Hours	Independent Study Time 110, Study Time i	in Lecture 70		
Credit points				
Course achievement	None			
Examination	Written elaboration			
Examination duration and scale	Report and Presentation			
Assignment for the	Civil Engineering: Specialisation Water and	I Traffic: Elective Compulsory		
Following Curricula	Environmental Engineering: Specialisation	Water: Elective Compulsory		
	Environmental Engineering: Specialisation	Waste and Energy: Elective Compulsory		
	Environmental Engineering: Specialisation	Biotechnology: Elective Compulsory		
	Water and Environmental Engineering: Spe	ecialisation Cities: Elective Compulsory		
		ecialisation Environment: Elective Compulsory		
	Water and Environmental Engineering: Spe	ecialisation Water: Elective Compulsorv		

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

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

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

ourses	
itle peration of Public Transportation	TypHrs/wkCPSystems (L1179)Project-/problem-based Learning46
Module Responsible	
Admission Requirements	
	some knowledge of transport planning, e.g. through taking the undergraduate class "Transport Planning and Traffic Engineerir
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
<b>Professional Competence</b>	
Knowledge	Students are able to:
	e describe public transport (PT) systems in technical language
	<ul> <li>describe public transport (PT) systems in technical language.</li> <li>autling the entire PT system including the interdependencies of the different elements.</li> </ul>
	<ul> <li>outline the entire PT system including the interdependencies of the different elements.</li> <li>explain the requirements for a PT system from different perspectives.</li> </ul>
	<ul> <li>explain the requirements for a PT system norm uniferent perspectives.</li> <li>explain the role of PT in the transport system.</li> </ul>
Skills	Students are able to:
	<ul> <li>systematically develop a public transport system when there are no clear cut correct or incorrect approaches.</li> </ul>
	cope with imprecise and incomplete data.
	<ul> <li>develop and appraise alternative solutions.</li> </ul>
	<ul> <li>distinguish or develop appropriate methods of analysis and modes of presentation.</li> </ul>
	<ul> <li>reflect and evaluate their own transport concept, considering competing requirements.</li> </ul>
Personal Competence	
Social Competence	Students are able to:
	<ul> <li>correcteut and complete a group preject, inclusive of an apprendiate allocation of tacks</li> </ul>
	<ul> <li>carry out and complete a group project, inclusive of an appropriate allocation of tasks.</li> <li>capactructively provide and accept feedback.</li> </ul>
	<ul> <li>constructively provide and accept feedback.</li> <li>present their own results to others.</li> </ul>
Autonomy	
	<ul> <li>independently develop a bus PT concept within a given framework.</li> <li>determine and justify the facus of their work.</li> </ul>
	<ul> <li>determine and justify the focus of their work.</li> <li>organize and follow their work process regarding time and content</li> </ul>
	<ul> <li>organize and follow their work process regarding time and content.</li> <li>independently author a written report.</li> </ul>
	<ul> <li>independency author a written report.</li> <li>assess the consequences of the solutions they develop.</li> </ul>
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written elaboration
Examination duration and	written assignment as groupwork with presentation during the semester
scale	
-	Logistics, Infrastructure and Mobility: Core Qualification: Compulsory
Following Curricula	Water and Environmental Engineering: Specialisation Cities: Elective Compulsory

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

Courses				
<b>Title</b> Sustainable Nature-based Coastal I	Protection in a Changing Climate (SeaPiaC) (L2926)	<b>Typ</b> Project-/problem-based Learning	Hrs/wk	<b>CP</b> 6
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous Knowledge	<ul> <li>Hydraulic Engineering</li> <li>Hydromechanics, Hydraulics</li> <li>Fundamentals of Coastal Engineering, Coastal- an</li> </ul>	d Flood Protection		
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence Knowledge	<ul> <li>Climate and Climate Change</li> <li>General Impacts of Climate Change on Wind Regir</li> <li>Consequences of Climate Change for Coastal Procedure</li> <li>Coastal Protection in Taiwan and Germany</li> <li>Fundamentals of Climate Adaptation</li> <li>Nature-based Solutions (NBS) for Coastal Protection</li> </ul>	esses		
Skills	<ul> <li>Critical thinking: analysis of processes and relation</li> <li>Creative thinking: development of adaptation stra</li> <li>Practical thinking: inclusion of restrictions, applimethods</li> <li>Consideration of complex tasks</li> </ul>	tegies and adaptation measures	ods, numerica	al models, plannin
Personal Competence				
Social Competence Autonomy	<ul> <li>Working in heterogenous groups</li> <li>Working in international groups</li> <li>Working with different scientific / non-scientific dis</li> <li>Self reflection</li> <li>Application oriented use of knowledge and skills</li> <li>Autonomous work on complex tasks</li> </ul>	sciplines		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement	None			
Examination	Written elaboration			
	Preparation of a written report on a complex task with happens in the course of the lecture.	a presentation and subsequent discussion	on. The work o	on the complex ta
Assignment for the Following Curricula		g: Elective Compulsory Elective Compulsory ve Compulsory ies: Elective Compulsory		

Course L2926: Sustainable N	Course L2926: Sustainable Nature-based Coastal Protection in a Changing Climate (SeaPiaC)		
Тур	Project-/problem-based Learning		
Hrs/wk	4		
СР	6		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Lecturer	Prof. Peter Fröhle		
Language	EN		
Cycle	WiSe		
Content	<ul> <li>Climate and Climate Change</li> <li>General Impacts of Climate Change on Wind Regime and Water Cycle</li> <li>Consequences of Climate Change for Coastal Processes</li> <li>Coastal Protection in Taiwan and Germany</li> <li>Fundamentals of Climate Adaptation</li> <li>Nature-Based Solutions (NBS) for Coastal Protection</li> </ul>		
Literature	Materials provided on eLearning Platform (HOOU Platform)		

Courses	
Title	Typ Hrs/wk CP
Adaptation to climate change in hy	
Module Responsible	
Admission Requirements Recommended Previous	
Knowledge	Hydrology Hydraulic Engineering
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge Skills	<ul> <li>Climate protection and climate adaptation</li> <li>Insights into climate change and its regional characteristics - fundamentals, climate modelling / climate models</li> <li>Impacts of climate change on the components of the regional hydrological cycle</li> <li>Fundamentals of analysis of climate data</li> <li>Consequences of the impact of the climate change</li> <li>Measures for climate adaptation</li> <li>Assessment, prioritization and communication of adaptation measures</li> <li>Fundamentals of the analysis of hydrometeorological and hydrological data</li> </ul>
Bernard Commenter	<ul> <li>Practical thinking: inclusion of restrictions, application of calculation approaches, methods, numerical models, plann methods</li> <li>Consideration of complex tasks</li> </ul>
Personal Competence Social Competence	
	<ul> <li>Working in heterogenous groups</li> <li>Working with different scientific / non-scientific disciplines</li> <li>Self reflection</li> </ul>
Autonomy	<ul> <li>Application oriented use of knowledge and skills</li> <li>Autonomous work on complex tasks</li> </ul>
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	
Examination	Written elaboration
Examination duration and scale	
Assignment for the	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory
	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory
	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory
	Water and Environmental Engineering: Specialisation Cities: Elective Compulsory
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory
	Water and Environmental Engineering: Specialisation Water: Elective Compulsory

Course L2291: Adaptation to	climate change in hydraulic engineering
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	WiSe
Content	<ul> <li>Climate protection and climate adaptation</li> <li>Findings on climate change and its regional characteristics: fundamentals of climate change, climate modelling / climate models</li> <li>Impacts of climate change on the components of the regional hydrological cycle(climate science view)</li> <li>Fundamentals of the analysis of climate data</li> <li>Concequences of the impacts of climate change (ingenieering science view)</li> <li>Measures for climate change adaptation</li> <li>Assessment, prioritization and communication of measures</li> <li>Fundamentals of analysis of hydrometeorological and hydrological data</li> </ul>
Literature	Bereitgestellte eLearning Plattform

#### **Specialization Environment**

Courses					
Title		Тур	Hrs/wk	СР	
Integrated Pollution Control (L0502 Health, Safety and Environmental I		Lecture Lecture	2	2 3	
Health, Safety and Environmental I	5	Recitation Section (small)		3	
Module Responsible		Recitation Section (Small)	-	-	
Admission Requirements	None				
Recommended Previous	None				
Kecommended Previous Knowledge	Good knowledge in Technologies for Er	nvironmental Protection (end-of-pipe, integra	ated solutions)		
Kilowiedge	<ul> <li>Good knowledge of the relevant Enviro</li> </ul>	nmental Legislation			
	Basic knowledge of instruments for Env	vironmental Assessment			
Educational Objectives	After taking part successfully, students have	reached the following learning results			
Educational Objectives	After taking part successfully, students have i	reached the following learning results			
Professional Competence	The students are able to describe the basis	e of regulations, oconomic instruments, y	aluntan, initiativas	fundamentals of U	
Knowledge	The students are able to describe the basic				
	legislation ISO 14001, EMAS and Responsible substance cycles and approaches from end				
	knowledge of complex industry related problems				
	carry out innovative technical solutions, rem				
	approaches in the full range of problems in di		is as then as concep		
Skills	Students are able to assess current problem:	s and situations in the field of environment	al protection. They o	can consider the b	
	s Students are able to assess current problems and situations in the field of environmental protection. They can consider the be available techniques and to plan and suggest concrete actions in a company- or branch-specific context. By this means they c				
	solve problems on a technical, administrative		,		
Personal Competence					
Social Competence	The students can work together in internation	al groups.			
Autonomy	Students are able to organize their work flow	to prepare themselves for presentations a	nd contributions to t	the discussions. Th	
	can acquire appropriate knowledge by making enquiries independently.				
Workload in Hours	Independent Study Time 110, Study Time in L	Lecture 70			
Credit points					
Course achievement					
	Written exam				
Examination duration and	90 min				
scale					
Assignment for the			Manager	Controlling El 1	
Following Curricula		bioeconomic Process Engineering, Focus	management and	Controlling: Elect	
	Compulsory	a: Compulsory			
	Environmental Engineering: Core Qualification		Water: Elective Com	nulson	
	Joint European Master in Environmental Studies - Cities and Sustainability: Specialisation Water: Elective Compulsory				
	Joint European Master in Environmental Studies - Cities and Sustainability: Specialisation Energy: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory				
	Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory Product Development, Materials and Production: Specialisation Production: Elective Compulsory				
	Product Development, Materials and Production				
	Process Engineering: Specialisation Environm		-		
		Endering Elective computer			
	Water and Environmental Engineering: Specia	alisation Environment: Compulsory			

Course L0502: Integrated Po	Ilution Control
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Ralf Otterpohl
Language	EN
Cycle	WiSe
	The lecture focusses on:  The Regulatory Framework  Pollution & Impacts, Characteristics of Pollutants  Approaches of Integrated Pollution Control  Sevilla Process, Best Available Technologies & BREF Documents  Case Studies: paper industry, cement industry, automotive industry  Field Trip
	Förstner, Ulrich (1998): Integrated Pollution Control, Springer-Verlag Berlin Heidelberg, ISBN 978-3-642-80313-0 Shen, Thomas T. (1999): Industrial Pollution Prevention, Springer-Verlag Berlin Heidelberg, ISBN 978-3-540-65208-3

Course L0387: Health, Safety	y and Environmental Management
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Hans-Joachim Nau
Language	EN
Cycle	WiSe
Content	<ul> <li>Objectives of and benefit from HSE management</li> <li>From dilution and end-of-pipe technology to eco-efficiency and eco-effectiveness Behaviour control: regulations, economic instruments and voluntary initiatives</li> <li>Fundamentals of HSE legislation ISO 14001, EMAS and Responsible Care ISO 14001 requirements Environmental performance evaluation Risk management: hazard, risk and safety Health and safety at the workplace</li> <li>Crisis management</li> </ul>
Literature	C. Stephan: Industrial Health, Safety and Environmental Management, MV-Verlag, Münster, 2007/2012 (can be found in the library under GTG 315) Exercises can be downloaded from StudIP

Course L0388: Health, Safety	Course L0388: Health, Safety and Environmental Management	
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Hans-Joachim Nau	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0902: Waste	ewater Treatment and Air P	ollution Abatement			
Courses					
litle		Turn	Line (mile	СР	
Biological Wastewater Treatment (I	0517)	<b>Typ</b> Lecture	Hrs/wk 2	3	
Air Pollution Abatement (L0203)	0517)	Lecture	2	3	
Module Responsible	Dr. Swantje Pietsch-Braune				
Admission Requirements	None				
Recommended Previous	Basic knowledge of biology and chemisti	ry			
Knowledge					
	Basic knowledge of solids process engine	eering and separation technology			
Educational Objectives	After taking part successfully, students h	have reached the following learning results			
Professional Competence					
Knowledge	After successful completion of the modu	le students are able to			
	<ul> <li>name and explain biological proce</li> </ul>	esses for waste water treatment			
	<ul> <li>characterize waste water and sewage sludge,</li> <li>discuss legal regulations in the area of emissions and air quality</li> </ul>				
	<ul> <li>explain the effects of air pollutants on the environment,</li> </ul>				
	<ul> <li>name and explan off gas tretament processes and to define their area of application</li> </ul>				
Skills	Students are able to				
	<ul> <li>choose and design processs steps</li> </ul>	s for the biological waste water treatment			
	<ul> <li>combine processes for cleaning of</li> </ul>	f off-gases depending on the pollutants containe	d in the gases		
Personal Competence					
Social Competence					
Autonomy					
	Independent Study Time 124, Study Tim	ne in Lecture 56			
Credit points					
Course achievement					
Examination	Written exam				
Examination duration and	90 min				
scale					
Assignment for the	Civil Engineering: Specialisation Water a	and Traffic: Elective Compulsory			
Following Curricula	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory				
	Chemical and Bioprocess Engineering: Specialisation General Process Engineering: Elective Compulsory				
	Environmental Engineering: Specialisation	on Waste and Energy: Elective Compulsory			
	International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory				
	Joint European Master in Environmental Studies - Cities and Sustainability: Specialisation Water: Elective Compulsory				
	Renewable Energies: Specialisation Bioe	55 5			
	5 5 1	ironmental Process Engineering: Elective Compul	lsory		
	Process Engineering: Specialisation Proc				
		Specialisation Water: Elective Compulsory			
	Water and Environmental Engineering: S	1 1 5			
	Water and Environmental Engineering: S	Specialisation Cities: Compulsory			

ourse L0517: Biological Wastewater Treatment			
Тур	cture		
Hrs/wk	2		
CP	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Dr. Joachim Behrendt		
Language	DE/EN		
Cycle	WiSe		
Content	Charaterisation of Wastewater		
	Metobolism of Microorganisms		
	Kinetic of mirobiotic processes		
	Calculation of bioreactor for wastewater treatment		
	Concepts of Wastewater treatment		
	Design of WWTP		
	Excursion to a WWTP		
	Biofilms		
	Biofim Reactors		
	Anaerobic Wastewater and sldge treatment		
	resources oriented sanitation technology		
	Future challenges of wastewater treatment		

Literature Gujer, Willi	
Literature Gujer, will	Literature
Siedlungswasserwirtschaft : mit 84 Tabellen	
ISBN: 3540343296 (Gb.) URL: http://www.gbv.de/dms/bs/toc/516261924.pdf URL: http://deposit.d-nb.de/cgi-bin/dokserv	
id=2842122&prov=M&dok_var=1&dok_ext=htm	
Berlin [u.a.] : Springer, 2007	
TUB_HH_Katalog	
Henze, Mogens	
Wastewater treatment : biological and chemical processes	
ISBN: 3540422285 (Pp.)	
Berlin [u.a.] : Springer, 2002	
TUB_HH_Katalog	
Imhoff, Karl (Imhoff, Klaus R.;)	
Taschenbuch der Stadtentwässerung : mit 10 Tafeln	
ISBN: 3486263331 ((Gb.))	
München [u.a.] : Oldenbourg, 1999	
TUB_HH_Katalog	
Lange, Jörg (Otterpohl, Ralf; Steger-Hartmann, Thomas;)	
Abwasser : Handbuch zu einer zukunftsfähigen Wasserwirtschaft	
ISBN: 3980350215 (kart.) URL: http://www.gbv.de/du/services/agi/52567E5D44DA0809C12570220050BF25/000000700334	
Donaueschingen-Pfohren : Mall-Beton-Verl., 2000	
TUB_HH_Katalog	
Mudrack, Klaus (Kunst, Sabine;)	
Biologie der Abwasserreinigung : 18 Tabellen	
ISBN: 382741427X URL: http://www.gbv.de/du/services/agi/94B581161B6EC747C1256E3F005A8143/420000114903	
Heidelberg [u.a.] : Spektrum, Akad. Verl., 2003	
TUB_HH_Katalog	
Tchobanoglous, George (Metcalf & Eddy, Inc., ;)	
Wastewater engineering : treatment and reuse	
ISBN: 0070418780 (alk. paper) ISBN: 0071122508 (ISE (*pbk))	
Boston [u.a.] : McGraw-Hill, 2003	
TUB_HH_Katalog	
Henze, Mogens	
Activated sludge models ASM1, ASM2, ASM2d and ASM3	
ISBN: 1900222248	
London : IWA Publ., 2002	
TUB_HH_Katalog	
Kunz, Peter	
Umwelt-Bioverfahrenstechnik	
Vieweg, 1992	
Bauhaus-Universität., Arbeitsgruppe Weiterbildendes Studium Wasser und Umwelt (Deutsche Vereinigung fü	
Wasserwirtschaft, Abwasser und Abfall, ;)	
Abwasserbehandlung : Gewässerbelastung, Bemessungsgrundlagen, Mechanische Verfahren, Biologische Verfahren, Reststoff	
aus der Abwasserbehandlung, Kleinkläranlagen	
ISBN: 3860682725 URL: http://www.gbv.de/dms/weimar/toc/513989765_toc.pdf UR	
http://www.gbv.de/dms/weimar/abs/513989765_abs.pdf	
Weimar : Universitätsverl, 2006	
TUB_HH_Katalog	
Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall	
DWA-Regelwerk	
Hennef : DWA, 2004	
TUB_HH_Katalog	
Wiesmann, Udo (Choi, In Su; Dombrowski, Eva-Maria;)	
Fundamentals of biological wastewater treatment	
ISBN: 3527312196 (Gb.) URL: http://deposit.ddb.de/cgi-bin/dokserv?id=2774611&prov=M&dok_var=1&dok_ext=htm	
Weinheim : WILEY-VCH, 2007	
TUB_HH_Katalog	

Course L0203: Air Pollution A	Abatement
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Swantje Pietsch-Braune, Christian Eichler
Language	EN
Cycle	WiSe
Content	In the lecture methods for the reduction of emissions from industrial plants are treated. At the beginning a short survey of the different forms of air pollutants is given. In the second part physical principals for the removal of particulate and gaseous pollutants form flue gases are treated. Industrial applications of these principles are demonstrated with examples showing the removal of specific compounds, e.g. sulfur or mercury from flue gases of incinerators.
Literature	Handbook of air pollution prevention and control, Nicholas P. Cheremisinoff Amsterdam [u.a.] : Butterworth-Heinemann, 2002 Atmospheric pollution : history, science, and regulation, Mark Zachary Jacobson Cambridge [u.a.] : Cambridge Univ. Press, 2002 Air pollution control technology handbook, Karl B. Schnelle Boca Raton [u.a.] : CRC Press, c 2002 Air pollution, Jeremy Colls 2. ed London [u.a.] : Spon, 2002

Engineering					
Module M1403: Const	ruction and Simulation of S	Sewerage Systems			
Courses					
Title		Тур	Hrs/wk	СР	
Construction and renovation of urb	an sewer systems (L1998)	Seminar	3	3	
Simulation of sewerage systems (L	2006)	Seminar	3	3	
Module Responsible	Prof. Ralf Otterpohl				
Admission Requirements	None				
Recommended Previous Knowledge	Hydraulics in pipes and gravity-se	ewers			
	<ul><li>Mechanics</li><li>Soil mechanics and foundation er</li></ul>	nainearing			
		• •			
	<ul> <li>Knowledge about urban sewerage</li> </ul>	e systems and water management			
Educational Objectives	After taking part successfully, students	have reached the following learning results			
Professional Competence					
Knowledge	dge Students can describe urban wastewater systems by means of software-based modeling. In case studies they can perform sy				
	and weak point analyzes. In addition, they can analyze the hydraulic effects quantitatively. Furthermore, they have the knowledg				
	to comprehend flow events in gravity-sewers based on the St. Venant equations.				
	Students have knowledge of static and structural requirements of the sewer system. Cases of damage are investigated and th				
	knowledge regarding different renovation technologies for sewer systems is acquired.				
Skille	The students can simulate different run off events in sever systems and are able to dimension the sever systems assortingly				
SKIIIS	The students can simulate different run-off events in sewer systems and are able to dimension the sewer systems accordingl Moreover, they can determine suitable construction materials and static requirements for different cases of application.				
	Moreover, they can determine suitable		for uniferenceases of ap	oplication.	
Personal Competence					
Social Competence	Students are able to apply the acquired	skills in a team and can impart this knowledge	2.		
A . I					
Autonomy	Students can solve problems in the field of wastewater systems independently, concerning in particular dimensioning ar				
	simulation of sewer systems. Furthermo	pre, they are able to present and justify their so	olutions.		
Workload in Hours	Independent Study Time 96, Study Time	e in Lecture 84			
Credit points	6				
Course achievement	Compulsory Bonus Form	Description			
	No 20 % Presentation				
Examination	Written elaboration				
Examination duration and	nach Absprache				
scale					
Assignment for the	Civil Engineering: Specialisation Water a	and Traffic: Compulsory			
-	Water and Environmental Engineering:				
Following Curricula					

	and renovation of urban sewer systems		
Тур	Seminar		
Hrs/wk	3		
СР	3		
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42		
Lecturer	Prof. Ingo Weidlich		
Language	EN		
Cycle	WiSe		
Content	The lecture focusses on construction and renovation of urban s Construction:	ewer pipelines.	
	<ul> <li>Pipe materials, types and joint technology</li> <li>Open trenches</li> <li>Trenchless technologies</li> <li>Pipe Statics:</li> </ul>		
	<ul> <li>Design of sewers according to ATV A 127</li> <li>Earth pressure on pipes, pipe deformation, cutting forces</li> <li>Comparison with other international calculation approact</li> </ul>		
	<ul> <li>Renovation:</li> <li>Failure case study</li> <li>Overview on the different renovation technologies</li> <li>Liner design according to DWA-A 143</li> </ul>		
Literature	Nr. 1	Titel ATV A 127, Abwassertechnische Vereinigung e.V., Arbeitsblatt A	
	2	127, Regelwerk Abwasser-Abfall, Vertrieb: GFA, DK 628.22 (083),A 127, 2000 DIN EN 1610, Verlegung und Prüfung von Abwasserleitungen und	
	3	-kanälen, Beuth Verlag, Berlin, 1997 Arbeitsblatt DWA-A 143-1, Sanierung vo Entwässerungssystemen außerhalb von Gebäuden, Teil 1	
	4	Planung und Überwachung von Sanierungsmaßnahmen Februa 2015 Arbeitsblatt DWA-A 143-2, Sanierung vo	
	•	Entwässerungssystemen außerhalb von Gebäuden Teil 2 Statische Berechnung zur Sanierung von Abwasserleitungen un	
	5	-kanälen mit Lining und Montageverfahren, Juli 2015 DIN EN 752:2008, 2008: Entwässerungssysteme außerhalb vo Gebäuden - Kanalmanagement.	
	7	Zeitschrift 3R, Fachzeitschrift für sichere und effizient Rohrleitungssysteme Handbuch für den Rohrleitungsbau Band 1 und 2, 4. Auflag	
	8	Günter Wossog, 2015 Rohrleitungstechnik, Walter Wagner, Vogel Buchverlag, 2006	
	9	Stein D., Stein R., "Instandhaltung von Kanalisationen", 1008 S ISBN 978-3-9810648-4-1   Verlag Prof. DrIng. Stein & Partne GmbH, 2014	
	10	Stein, D., "Grabenloser Leitungsbau", 1. Auflage, Gebunder Ausgabe - 1166 Seiten, Ernst & Sohn Verlag, 2003, ISB 3433017786	
	11	Willoughby D:A: "Horizontal Directional Drilling: Utility ar Pipeline Applications" Digital Engineering Library @ McGraw-Hill The McGraw-Hill Companies, Inc., 2005	
	12	Weidlich I., "Erddruck auf Rohre", 1. Auflage, ISBN 3-89999-02 7, 227 Seiten, 2012	

Course L2006: Simulation of	sewerage systems
Тур	Seminar
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Ralf Otterpohl
Language	EN
Cycle	WiSe
Content	<ul> <li>Modeling of sewer systems:</li> <li>Modeling approaches in wastewater management, especially approaches to integrated modeling</li> <li>Planning processes, calculations and design approaches for elements of gravity-sewers</li> <li>Model setup</li> <li>St. Venant equation and simplifications of models (kinematic wave etc.)</li> <li>Calculation &amp; modeling of solids transport (advection, diffusion, dispersion and sales processes)</li> <li>Examples for modeling with SWMM (EPA, USA)</li> </ul>
Literature	

Engineering"				
Module M0581: Wate	r Protection			
Courses				
Title		Тур	Hrs/wk	СР
Water Protection and Wastewater M	lanagement (L0226)	Lecture	3	3
Water Protection and Wastewater N	Aanagement (L2008)	Project Seminar	3	3
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
<b>Recommended Previous</b>	. Desis la sudadas in unha secondadas	-		
Knowledge	<ul> <li>Basic knowledge in water manageme</li> <li>Good knowledge in urban drainage;</li> </ul>	nt;		
	<ul><li>Good knowledge in urban drainage;</li><li>Good knowledge of wastewater treat</li></ul>	ment techniques:		
	<ul> <li>Good knowledge of vulsterrater deal</li> <li>Good knowledge of pollutants (e.g. Cl</li> </ul>			
	e cood knowledge of politicality (e.g. c	bb, bbb, 15, 1, 1, and their properties,		
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge	The students can describe the basic princip	es of the regulatory framework related to the	international and Eu	ropean water secto
		substance cycles and water morphology in		
		as ecosystem service and wastewater trea	tment with a special	focus on innovati
	solutions, remediation measures as well as	conceptual approaches.		
Skills	Students can accurately assess current pro	blems and situations in a country-specific or	local context. They c	an suggest concre
	actions to contribute to the planning of to	omorrow's urban water cycle. Furthermore,	they can suggest ap	opropriate technica
	administrative and legislative solutions to so	olve these problems.		
Personal Competence				
-	The students can work together in internation	anal groups		
Autonomy		w to prepare presentations and discussions.	They can acquire ap	propriate knowledg
	by making enquiries independently.			
Workload in Hours	Independent Study Time 96, Study Time in I	actura 94		
	macpenaene beauj mine bo, beauj mine mi			
	6			
Credit points Course achievement		Lecture 64		
Credit points Course achievement				
Credit points Course achievement Examination	None	ecture 64		
Credit points Course achievement Examination	None Presentation	ecture 64		
Credit points Course achievement Examination Examination duration and scale	None Presentation Term paper plus presentation			
Credit points Course achievement Examination Examination duration and scale Assignment for the	None Presentation Term paper plus presentation Civil Engineering: Specialisation Structural E	ngineering: Elective Compulsory		
Credit points Course achievement Examination Examination duration and scale Assignment for the	None Presentation Term paper plus presentation Civil Engineering: Specialisation Structural E Civil Engineering: Specialisation Geotechnic	ngineering: Elective Compulsory al Engineering: Elective Compulsory		
Credit points Course achievement Examination Examination duration and scale Assignment for the	None Presentation Term paper plus presentation Civil Engineering: Specialisation Structural E Civil Engineering: Specialisation Geotechnic Civil Engineering: Specialisation Coastal Eng	ngineering: Elective Compulsory al Engineering: Elective Compulsory ineering: Elective Compulsory		
Credit points Course achievement Examination Examination duration and scale Assignment for the	None Presentation Term paper plus presentation Civil Engineering: Specialisation Structural E Civil Engineering: Specialisation Geotechnic Civil Engineering: Specialisation Coastal Eng Civil Engineering: Specialisation Water and	ingineering: Elective Compulsory al Engineering: Elective Compulsory ineering: Elective Compulsory Fraffic: Elective Compulsory		
Credit points Course achievement Examination Examination duration and scale Assignment for the	None Presentation Term paper plus presentation Civil Engineering: Specialisation Structural E Civil Engineering: Specialisation Geotechnic Civil Engineering: Specialisation Coastal Eng Civil Engineering: Specialisation Water and T Environmental Engineering: Specialisation V	ingineering: Elective Compulsory al Engineering: Elective Compulsory ineering: Elective Compulsory Fraffic: Elective Compulsory /ater: Elective Compulsory	ampulsony	
Credit points Course achievement Examination Examination duration and scale Assignment for the	None Presentation Term paper plus presentation Civil Engineering: Specialisation Structural E Civil Engineering: Specialisation Geotechnic Civil Engineering: Specialisation Coastal Eng Civil Engineering: Specialisation Water and T Environmental Engineering: Specialisation V International Management and Engineering:	ngineering: Elective Compulsory al Engineering: Elective Compulsory ineering: Elective Compulsory Fraffic: Elective Compulsory /ater: Elective Compulsory Specialisation II. Civil Engineering: Elective C		
Credit points Course achievement Examination Examination duration and scale Assignment for the	None Presentation Term paper plus presentation Civil Engineering: Specialisation Structural E Civil Engineering: Specialisation Geotechnic Civil Engineering: Specialisation Coastal Eng Civil Engineering: Specialisation Water and Environmental Engineering: Specialisation V International Management and Engineering: Joint European Master in Environmental Stud	ngineering: Elective Compulsory al Engineering: Elective Compulsory ineering: Elective Compulsory Fraffic: Elective Compulsory /ater: Elective Compulsory Specialisation II. Civil Engineering: Elective C lies - Cities and Sustainability: Specialisation		pulsory
Credit points Course achievement Examination Examination duration and scale Assignment for the	None Presentation Term paper plus presentation Civil Engineering: Specialisation Structural E Civil Engineering: Specialisation Geotechnic Civil Engineering: Specialisation Coastal Eng Civil Engineering: Specialisation Water and T Environmental Engineering: Specialisation V International Management and Engineering:	ngineering: Elective Compulsory al Engineering: Elective Compulsory ineering: Elective Compulsory Fraffic: Elective Compulsory /ater: Elective Compulsory Specialisation II. Civil Engineering: Elective C dies - Cities and Sustainability: Specialisation ialisation Cities: Elective Compulsory		pulsory

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

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

Engineering"				
Module M0511: Elect	rical Energy from Solar Radiatio	on and Wind Power		
Courses				
Title		Тур	Hrs/wk	СР
Sustainability Management (L0007	)	Lecture	2	1
Hydro Power Use (L0013)		Lecture	1	1
Wind Turbine Plants (L0011)		Lecture	2	3
Wind Energy Use - Focus Offshore	(L0012)	Lecture	1	1
Module Responsible	Dr. Isabel Höfer			
Admission Requirements	None			
<b>Recommended Previous</b>	Module: Technical Thermodynamics I,			
Knowledge	Modulo: Tochnical Thormodynamics II			
	Module: Technical Thermodynamics II,			
	Module: Fundamentals of Fluid Mechanics			
Educational Objectives	After taking part successfully, students have r	reached the following learning results		
<b>Professional Competence</b>				
Knowledge	By ending this module students can explain	in detail knowledge of wind turbines with	n a particular focus o	of wind energy use
	offshore conditions and can critical comment	these aspects in consideration of current	developments. Furthe	ermore, they are ab
	to describe fundamentally the use of water po	ower to generate electricity. The students r	reproduce and explair	n the basic procedur
	in the implementation of renewable energy pr	rojects in countries outside Europe.		
	Through active discussions of various tanies	within the cominar of the module, stud	anto importavo thoir ur	dorstanding and th
	Through active discussions of various topics			nderstanding and tr
	application of the theoretical background and	are thus able to transfer what they have it	earned in practice.	
Skills	Students are able to apply the acquired the	eoretical foundations on exemplary water	or wind power system	ms and evaluate ar
	assess technically the resulting relationships	in the context of dimensioning and opera	tion of these energy	systems. They can
	compare critically the special procedure for the	he implementation of renewable energy pr	ojects in countries ou	tside Europe with th
	in principle applied approach in Europe and ca	an apply this procedure on exemplary theo	retical projects.	
Demonstration of Community of				
Personal Competence				
Social Competence	Students can discuss scientific tasks subjet-s	pecificly and multidisciplinary within a sem	linar.	
Autonomy	Students can independently explait courses	in the context of the emphasic of the los	tura matarial ta claa	r the contents of th
Autonomy	Students can independently exploit sources		lure material to clea	r the contents of th
	lecture and to acquire the particular knowledge	ge about the subject area.		
Workload in Hours	Independent Study Time 96, Study Time in Le	ecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	2.5 hours written exam + written elaboration	(incl. presentation) in sustainability managed	jement	
scale				
Assignment for the	Civil Engineering: Specialisation Structural En	gineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical			
	Civil Engineering: Specialisation Coastal Engir	neering: Elective Compulsory		
	International Management and Engineering: S			Compulsory
	International Management and Engineering: S			
	Product Development, Materials and Productio			
	Product Development, Materials and Productio			
	Product Development, Materials and Production		ulsory	
	Renewable Energies: Core Qualification: Com	5		
	Theoretical Mechanical Engineering: Specialis	5, , , , , , , , , , , , , , , , , , ,		
	Process Engineering: Specialisation Environme		lsory	
	Water and Environmental Engineering: Specia			
	Water and Environmental Engineering: Specia	alisation Cities: Elective Compulsory		

Course L0007: Sustainability	Management
Тур	Lecture
Hrs/wk	2
СР	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dr. Anne Rödl
Language	DE
Cycle	SoSe
Content	The lecture "Sustainability Management" gives an insight into the different aspects and dimensions of sustainability. First, essential terms and definitions, significant developments of the last years, and legal framework conditions are explained. The various aspects of sustainability are then presented and discussed in detail. The lecture mainly focuses on concepts for the implementation of the topic sustainability in companies:
	<ul> <li>What is "sustainability"?</li> <li>Why is this concept an important topic for companies?</li> <li>What opportunities and business risks are addressed or are associated with it?</li> <li>How can the often mentioned three pillars of sustainability - economy, ecology, and social- be meaningfully integrated into corporate management despite their sometimes contradictory tendencies, and how a corresponding compromise can be found?</li> <li>What concepts or frameworks exist for the implementation of sustainability management in companies?</li> <li>Which sustainability labels exist for products or companies? What do they have in common, and where do they differ?</li> <li>Furthermore, the lecture is intended to provide insights into the concrete implementation of sustainability aspects into business practice. External lecturers from companies will be invited to report on how sustainability is integrated into their daily processes.</li> <li>In the course of an independently carried out group work, the students will analyze and discuss the implementation of sustainability aspects based on short case studies. By studying and comparing best practice examples, the students will learn about corporate decisions' effects and implications. It should become clear which risks or opportunities are associated if sustainability aspects are taken into account in management decisions.</li> </ul>
Literature	Die folgenden Bücher bieten einen Überblick: Engelfried, J. (2011) Nachhaltiges Umweltmanagement. München: Oldenbourg Verlag. 2. Auflage Corsten H., Roth S. (Hrsg.) (2011) Nachhaltigkeit - Unternehmerisches Handeln in globaler Verantwortung. Wiesbaden: Gabler Verlag.

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

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

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

Module M0827: Mode	ling in Water Management			
Courses				
Title		Тур	Hrs/wk	СР
Groundwater Modeling using Modfl	ow (L0543)	Lecture	1	1
Groundwater Modeling using Modfl		Recitation Section (small)	2	2
Modeling of Water Supply and Sew	er Network (L0875)	Project-/problem-based Learning	2	3
Module Responsible	Dr. Klaus Johannsen			
Admission Requirements	None			
<b>Recommended Previous</b>	Groundwater			
Knowledge	<ul> <li>groundwater hydraulics and transport of substances</li> </ul>			
	Pipe Systems			
	Knowledge on urban water infrastructures, in p	particular drinking water systemsand u	urban drainag	e systems includir
	special structures		aramag	
	<ul> <li>Hydraulics of drinking water supply systems and s</li> </ul>	sewer systems		
	Basic knowledge on water management	<b>,</b>		
Educational Objectives	After taking part successfully, students have reached the	a following loarning results		
Educational Objectives Professional Competence	After taking part successfully, students have reached the			
	The students are able to describe the modelling of grour	dwater flow and transport as well as urb	an water infra	structures. They c
Kilowieuge	carry out systems analyses and can detect technical and			
	are able to analyse interdependencies of hydraulic and t			studies. Besides th
	are able to analyse interdependencies of hydraulic and t	oxic phenomena in son and water.		
Skille	The students are able to construct and apply scientific	groundwater models indipendently. The	v can work o	a different scenario
Skills The students are able to construct and apply scientific groundwater models indipendently. They can work				
and can compare or assess different solutions for existing problems by application of selected software products. Th			LIS. The students a	
able to use different software solutions		A-SWMM).		
Personal Competence				
Social Competence	Wird nicht vermittelt.			
Autonomv	Wird nicht vermittelt.			
	Independent Study Time 110, Study Time in Lecture 70			
Credit points Course achievement				
Examination				
Examination duration and				
scale	20 11111			
Assignment for the	Civil Engineering: Specialisation Structural Engineering:	Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineerin			
-	Civil Engineering: Specialisation Coastal Engineering: Ele	· · ·		
	Civil Engineering: Specialisation Water and Traffic: Electi			
	Water and Environmental Engineering: Specialisation Wa			
	Water and Environmental Engineering: Specialisation En			
	Water and Environmental Engineering: Specialisation Cit			

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

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

Course L0875: Modeling of Water Supply and Sewer Network			
Тур	oject-/problem-based Learning		
Hrs/wk	2		
СР	<b>CP</b> 3		
Workload in Hours	pendent Study Time 62, Study Time in Lecture 28		
Lecturer	Dr. Klaus Johannsen, Weitere Mitarbeiter		
Language	Language DE		
Cycle	SoSe		
Content			
Literature	Mutschmann/Stimmelmayr: Taschenbuch der Wasserversorgung, 16. Auflage. Springer Vieweg - Verlag. Wiesbaden 2014.		

Module M1717: Adva	nced Vadose Zone Hydrolog	11/		
		<b>3</b> 3		
Courses				
<b>Fitle</b>		Тур	Hrs/wk	СР
Modeling Processes in Vadose Zone	e (L2734)	Lecture	1	1
Modeling Processes in Vadose Zone	e (L2735)	Recitation Section (small)	1	1
Vadose Zone Hydrology (L2732)		Lecture	2	2
Vadose Zone Hydrology (L2733)	1	Recitation Section (large)	2	2
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
<b>Recommended Previous</b>				
Knowledge				
Educational Objectives	After taking part successfully, students	have reached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 96, Study Time	e in Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water a	and Traffic: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Water a	and Traffic: Elective Compulsory		
	Environmental Engineering: Specialisati	on Water: Elective Compulsory		
	Environmental Engineering: Specialisati	on Water: Elective Compulsory		
	Water and Environmental Engineering:	Specialisation Water: Elective Compulsory		
	Water and Environmental Engineering:	Specialisation Environment: Elective Compulsory		
	Water and Environmental Engineering:	Specialisation Cities: Elective Compulsory		
	Water and Environmental Engineering:	Specialisation Cities: Elective Compulsory		
	Water and Environmental Engineering:	Specialisation Environment: Elective Compulsory		
	Water and Environmental Engineering:	Specialisation Water: Elective Compulsory		

Course L2734: Modeling Processes in Vadose Zone	
Тур	Lecture
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Hannes Nevermann, Prof. Nima Shokri
Language	EN
Cycle	SoSe
Content	
Literature	

Course L2735: Modeling Processes in Vadose Zone				
Тур	Typ Recitation Section (small)			
Hrs/wk	1			
СР	<b>CP</b> 1			
Workload in Hours	Workload in Hours Independent Study Time 16, Study Time in Lecture 14			
Lecturer	Lecturer Hannes Nevermann			
Language	Language EN			
Cycle	SoSe			
Content	See interlocking course			
Literature	See interlocking course			

Course L2732: Vadose Zone Hydrology	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Nima Shokri
Language	EN
Cycle	SoSe
Content	
Literature	

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

Module M1718: Multi	phase Flow in Porous Media			
_				
Courses				
<b>Fitle</b>		Тур	Hrs/wk	СР
5 1	Multiphase Flow in Porous Media (L2738)	Recitation Section (small)	2	2
Fundamentals of Multiphase Flow in		Lecture	2	2
Fundamentals of Multiphase Flow in		Recitation Section (large)	2	2
Module Responsible				
Admission Requirements	None			
<b>Recommended Previous</b>				
Knowledge				
Educational Objectives	After taking part successfully, students have reac	hed the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 96, Study Time in Lectur	re 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic	:: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Eng	gineering: Elective Compulsory		
	Civil Engineering: Specialisation Geotechnical Eng	gineering: Elective Compulsory		
	Civil Engineering: Specialisation Water and Traffic	: Elective Compulsory		
	Environmental Engineering: Specialisation Water:	Elective Compulsory		
	Environmental Engineering: Specialisation Water:	Elective Compulsory		
	Water and Environmental Engineering: Specialisa	tion Cities: Elective Compulsory		
	Water and Environmental Engineering: Specialisa	tion Cities: Elective Compulsory		
	Water and Environmental Engineering: Specialisa	tion Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialisa	tion Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialisa	tion Water: Elective Compulsory		
	Water and Environmental Engineering: Specialisa	tion Water: Elective Compulsory		

Course L2738: Advanced Modeling Techniques for Multiphase Flow in Porous Media				
Тур	Typ Recitation Section (small)			
Hrs/wk	2			
СР	2			
Workload in Hours	Workload in Hours Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Nima Shokri			
Language	EN			
Cycle	SoSe			
Content				
Literature				

Course L2736: Fundamentals of Multiphase Flow in Porous Media	
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Nima Shokri
Language	EN
Cycle	SoSe
Content	
Literature	

Course L2737: Fundamentals	ourse L2737: Fundamentals of Multiphase Flow in Porous Media			
Тур	Typ Recitation Section (large)			
Hrs/wk	2			
СР	<b>CP</b> 2			
Workload in Hours	Workload in Hours Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Hannes Nevermann			
Language	EN			
Cycle	SoSe			
Content	See interlocking course			
Literature	See interlocking course			

Madula M1701, Wata	a such The descent of The same such	Augliestica		
Module M1/21: Wate	r and Environment: Theory and	Application		
Courses				
ītle		Тур	Hrs/wk	СР
Nater and Environment: Applicatio	n and Field Work (L2754)	Project-/problem-based Learning	3	4
Vater and Environment: Theory (L		Lecture	1	2
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
<b>Recommended Previous</b>				
Knowledge				
Educational Objectives	After taking part successfully, students have i	reached the following learning results		
<b>Professional Competence</b>				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 124, Study Time in L	lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Report (about 5-10 pages) and Presentation (	about 15 min)		
scale				
Assignment for the	Civil Engineering: Specialisation Coastal Engin	neering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Water and Tr	affic: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engir	neering: Elective Compulsory		
	Civil Engineering: Specialisation Water and Tr	affic: Elective Compulsory		
	Environmental Engineering: Specialisation Wa			
	Environmental Engineering: Specialisation Wa			
	Water and Environmental Engineering: Specia			
	Water and Environmental Engineering: Specia			
	Water and Environmental Engineering: Specia			
	Water and Environmental Engineering: Specia			
	Water and Environmental Engineering: Specia			
	Water and Environmental Engineering: Specia	ansation water: Elective Compulsory		

Course L2754: Water and Environment: Application and Field Work	
Тур	Project-/problem-based Learning
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Anna Luisa Hemshorn de Sánchez, Dr. Salome Shokri-Kuehni
Language	EN
Cycle	SoSe
Content	
Literature	

Course L2753: Water and Environment: Theory	
Тур	Lecture
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Nima Shokri
Language	EN
Cycle	SoSe
Content	
Literature	

Module M0513: Svste	m Aspects of Renewable Energies			
······································				
Courses				
Title		Тур	Hrs/wk	СР
Fuel Cells, Batteries, and Gas Stora	ge: New Materials for Energy Production and Storage (L0021)	Lecture	2	2
Energy Trading (L0019)		Lecture	1	1
Energy Trading (L0020)		Recitation Section (small)	1	1
Deep Geothermal Energy (L0025)		Lecture	2	2
-	Prof. Martin Kaltschmitt			
Admission Requirements				
	Module: Technical Thermodynamics I			
Knowledge	Module: Technical Thermodynamics II			
Educational Objectives	After taking part successfully, students have reached the fol	llowing learning results		
Professional Competence				-
Skills	relation to current subject specific problems. Furthermore, they are able to explain the basics of thermodynamics of electrochemical energy conversion in fuel cells and can establish and explain the relationship to different types of fuel cells and their respective structure. Students can compare this technology with other energy storage options. In addition, students can give an overview of the procedure and the energetic involvement of deep geothermal energy. Students can apply the learned knowledge of storage systems for excessive energy to explain for various energy systems different approaches to ensure a secure energy supply. In particular, they can plan and calculate domestic, commercial and industrial heating equipment using energy storage systems in an energy-efficient way and can assess them in relation to complex power systems. In this context, students can assess the potential and limits of geothermal power plants and explain their operating mode. Furthermore, the students are able to explain the procedures and strategies for marketing of energy and apply it in the context of other modules on renewable energy projects. In this context they can unassistedly carry out analysis and evaluations of energie markets and energy trades.			
Personal Competence				
Social Competence	Students are able to discuss issues in the thematic fields in the renewable energy sector addressed within the module.			
Autonomy	Students can independently exploit sources , acquire the particular knowledge about the subject area and transform it to new questions.			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and				
scale				
Assignment for the	Bioprocess Engineering: Specialisation A - General Bioproces	ss Engineering: Elective Compulso	iry	
Following Curricula	International Management and Engineering: Specialisation II. Renewable Energy: Elective Compulsory			
	International Management and Engineering: Specialisation I	I. Energy and Environmental Engir	neering: Elective	Compulsory
	International Management and Engineering: Specialisation I	I. Process Engineering and Biotech	nnology: Elective	Compulsory
	Renewable Energies: Core Qualification: Compulsory			
	Process Engineering: Specialisation Environmental Process E	Engineering: Elective Compulsory		
	Process Engineering: Specialisation Process Engineering: Ele	ective Compulsory		
	Water and Environmental Engineering: Specialisation Water	: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Enviro	nment: Elective Compulsory		

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

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

ourse L0020: Energy Trading	
Тур	Recitation Section (small)
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Michael Sagorje, Dr. Sven Orlowski
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

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

Module M0828: Urbar	Environmental Management			
Courses				
Title	Тур		Hrs/wk	СР
Noise Protection (L1109)	Lectu	ire	2	2
Urban Infrastructures (L0874)	Projec	ct-/problem-based Learning	2	4
Module Responsible	Dr. Dorothea Rechtenbach			
Admission Requirements	None			
<b>Recommended Previous</b>	Knowledge on Urban planning			
Knowledge	Knowledge on measures for climate protection			
	General knowledge of scientific writing/working			
Educational Objectives	After taking part successfully, students have reached the following lea	rning results		
Professional Competence				
Knowledge	Students can describe urban development corridors as well as current	and future urban environm	nental proble	ms. They are able t
	explain the causes of environmental problems (like noise).			
	Students can specify applications for various technical innovations and		oute to the im	provement of urba
	life. They can, for example, derive and discuss measures for effective	noise abatement.		
Skills	Students are able to develop specific solutions for correcting estimates	xisting or future environ	ment-related	problems of urba
	development. They can define a range of conceptual and technical sol	÷		•
	paths. To solve specific urban environmental problems they can sele			
	context.			
Personal Competence				
Social Competence	The students can work together in international groups.			
Autonomy	Students are able to organize their work flow to prepare themselves	for procentations and cont	ributions to th	a discussions. The
Autonomy	Students are able to organize their work flow to prepare themselves can acquire appropriate knowledge by making enquiries independently		ributions to tr	ne discussions. The
	can acquire appropriate knowledge by making enquiries independenti	y.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Written Report plus oral Presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Co	mpulsory		
	Civil Engineering: Specialisation Coastal Engineering: Elective Compute	•		
	Civil Engineering: Specialisation Water and Traffic: Elective Compulsor	У		
	Environmental Engineering: Core Qualification: Elective Compulsory			
	Joint European Master in Environmental Studies - Cities and Sustainabi			
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure and		ory	
	Water and Environmental Engineering: Specialisation Environment: Ele			
	Water and Environmental Engineering: Specialisation Cities: Compulso	iry		

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

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

Module M1702: Proce	ss Imaging			
_				
Courses				
Title		Тур	Hrs/wk	СР
Process Imaging (L2723)		Lecture	2	3
Process Imaging (L2724)		Project-/problem-based Learning	2	3
Module Responsible	Prof. Alexander Penn			
Admission Requirements	None			
<b>Recommended Previous</b>				
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follow	ving learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	Bioprocess Engineering: Specialisation A - General Bioprocess I	Engineering: Elective Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation A - General Bioprocess I			
3	Bioprocess Engineering: Specialisation B - Industrial Bioprocess		/	
	Bioprocess Engineering: Specialisation B - Industrial Bioprocess			
	Bioprocess Engineering: Specialisation C - Bioeconomic Proce			Technology: Elective
	Compulsory	5 5. 57	·	5,7
	Bioprocess Engineering: Specialisation C - Bioeconomic Proce	ss Engineering, Focus Energy and	d Bioprocess	Technology: Elective
	Compulsory	5 5. 57	·	57
	Chemical and Bioprocess Engineering: Specialisation General P	rocess Engineering: Elective Comp	oulsory	
	Chemical and Bioprocess Engineering: Specialisation General P			
	Chemical and Bioprocess Engineering: Specialisation Bioproces			
	Chemical and Bioprocess Engineering: Specialisation Bioproces			
	Chemical and Bioprocess Engineering: Specialisation Chemical			
	Chemical and Bioprocess Engineering: Specialisation Chemical	Process Engineering: Elective Con	npulsory	
	Computer Science: Specialisation II: Intelligence Engineering: E	lective Compulsory		
	Information and Communication Systems: Specialisation Comm	nunication Systems, Focus Signal F	Processing: Ele	ective Compulsory
	International Management and Engineering: Specialisation II. P	rocess Engineering and Biotechnol	logy: Elective	Compulsory
	Theoretical Mechanical Engineering: Specialisation Robotics an	d Computer Science: Elective Com	pulsory	
	Theoretical Mechanical Engineering: Specialisation Robotics an	d Computer Science: Elective Com	pulsory	
	Process Engineering: Specialisation Process Engineering: Electi	ve Compulsory		
	Process Engineering: Specialisation Process Engineering: Electi	ve Compulsory		
	Process Engineering: Specialisation Chemical Process Engineer	ing: Elective Compulsory		
	Process Engineering: Specialisation Chemical Process Engineer	ing: Elective Compulsory		
	Process Engineering: Specialisation Environmental Process Eng	ineering: Elective Compulsory		
	Process Engineering: Specialisation Environmental Process Eng	ineering: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Environm	nent: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Environm	nent: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Water: El	ective Compulsory		
	Water and Environmental Engineering: Specialisation Water: El	ective Compulsory		

Course L2723: Process Imagi	ourse L2723: Process Imaging		
Тур	Lecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Prof. Alexander Penn		
Language	EN		
Cycle	SoSe		
Content			
Literature			

Course L2724: Process Imaging		
Тур	Project-/problem-based Learning	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Alexander Penn, Dr. Stefan Benders	
Language	EN	
Cycle	SoSe	
Content		
Literature		

Module M0749: Waste	e Treatment and Solid Matter Proce	ess Technology		
House Hoy for Huse		ss reemology		
Courses				
Title		Тур	Hrs/wk	СР
Solid Matter Process Technology fo	r Biomass (L0052)	Lecture	2	2
Thermal Waste Treatment (L0320)		Lecture	2	2
Thermal Waste Treatment (L1177)		Recitation Section (large)	1	2
Module Responsible	Prof. Kerstin Kuchta			
Admission Requirements	None			
<b>Recommended Previous</b>	Basics of			
Knowledge	thermo dynamics			
	fluid dynamics			
	<ul> <li>chemistry</li> </ul>			
	• enemistry			
Educational Objectives	After taking part successfully, students have reache	ed the following learning results		
Professional Competence				
Knowledge	The students can name, describe current issue	and problems in the field of thermal v	vaste treatment	and particle proce
	engineering and contemplate them in the context o	of their field.		
	The industrial application of unit operations as par			
	technologies and solid biomass processes. Compo			
	renewable resources and wastes are described as i		g solid fuels and i	pioethanol, producii
	and refining edible oils, electricity , heat and minera	al recyclables.		
Skills	The students are able to select suitable processes	for the treatment of wastes or raw mater	ial with respect to	o their characteristi
	and the process aims. They can evaluate the efforts	s and costs for processes and select econ	omically feasible	treatment concepts
Personal Competence				
Social Competence	Students can			
	<ul> <li>respectfully work together as a team and dis</li> </ul>	cuss technical tasks		
	<ul> <li>participate in subject-specific and interdiscip</li> </ul>			
	<ul> <li>develop cooperated solutions</li> </ul>			
	<ul> <li>promote the scientific development and acc</li> </ul>	ept professional constructive criticism.		
Autonomy	Students can independently tap knowledge of t	he subject area and transform it to r	ew questions. T	hey are capable,
	consultation with supervisors, to assess their learn	ning level and define further steps on thi	s basis. Furtherm	ore, they can defir
	targets for new application-or research-oriented du	ties in accordance with the potential socia	al, economic and	cultural impact.
Workload in Hours	Independent Study Time 110, Study Time in Lecture	0.70		
Credit points	Independent Study Time 110, Study Time in Lecture			
Course achievement	None			
Examination				
Examination duration and	120 (1)(1)			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic:	1 3	<b>en</b> <i>i</i>	
Following Curricula	Bioprocess Engineering: Specialisation A - General I		-	Compuls
	International Management and Engineering: Specia International Management and Engineering: Specia	5 5	57	compuisory
	• • • •		mpulsol y	
	Renewable Energies: Specialisation Bioenergy Syste			
	Process Engineering: Specialisation Chemical Proce	• • • • •		
	Process Engineering: Specialisation Process Engineering:			
	Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory			
	Water and Environmental Engineering: Specialisatio			
	Water and Environmental Engineering: Specialisation	on cities: Elective Compulsory		

Course L0052: Solid Matter F	Process Technology for Biomass
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Werner Sitzmann
Language	DE
Cycle	SoSe
Content	The industrial application of unit operations as part of process engineering is explained by actual examples of solid biomass processes. Size reduction, transportation and dosing, drying and agglomeration of renewable resources are described as important unit operations when producing solid fuels and bioethanol, producing and refining edible oils, when making Btl - and WPC - products. Aspects of explosion protection and plant design complete the lecture.
Literature	Kaltschmitt M., Hartmann H. (Hrsg.): Energie aus Bioamsse, Springer Verlag, 2001, ISBN 3-540-64853-4 Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz, Schriftenreihe Nachwachsende Rohstoffe, Fachagentur Nachwachsende Rohstoffe e.V. www.nachwachsende-rohstoffe.de Bockisch M.: Nahrungsfette und -öle, Ulmer Verlag, 1993, ISBN 380000158175

Course L0320: Thermal Wast	re Treatment
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Kerstin Kuchta
Language	EN
Cycle	SoSe
Content	<ul> <li>Introduction, actual state-of-the-art of waste incineration, aims. legal background, reaction principals</li> <li>basics of incineration processes: waste composition, calorific value, calculation of air demand and flue gas composition</li> <li>Incineration techniques: grate firing, ash transfer, boiler</li> <li>Flue gas cleaning: Volume, composition, legal frame work and emission limits, dry treatment, scrubber, de-nox techniques, dioxin elimination, Mercury elimination</li> <li>Ash treatment: Mass, quality, treatment concepts, recycling, disposal</li> </ul>
Literature	Thomé-Kozmiensky, K. J. (Hrsg.): Thermische Abfallbehandlung Bande 1-7. EF-Verlag für Energie- und Umwelttechnik, Berlin, 196 - 2013.

Course L1177: Thermal Waste Treatment		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Kerstin Kuchta	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

	nemical Engineering				
Courses					
Title		Tun	Hrs/wk	СР	
Contaminated Sites and Landfilling	(10906)	<b>Typ</b> Lecture	2	2	
Contaminated Sites and Landfilling		Recitation Section (large)	1	2	
Geochemical Engineering (L0904)	,	Lecture	2	2	
Module Responsible	Dr. Marco Ritzkowski				
Admission Requirements	None				
<b>Recommended Previous</b>	Module: General and Inorganic Chemistry,				
Knowledge	Module:Organic Chemistry,				
	Biology (Basic Knowledge)				
-	After taking part successfully, students have reac	ned the following learning results			
Professional Competence					
Knowledge	With the completion of this module students acc				
	soil and groundwater, and techniques to deposit of				
	of chemicals in the environment. Students can ex	plain and report the approach to remediate	contaminated sit	es.	
Skills	With the completion of this module students can apply the acquired theoretical knowledge to model cases of site pollution and				
	critically assess the situation technically and conceptually. They are able to draw comparisons on different remediation strategies				
	and techniques. Model projects can be devised and treated.				
Personal Competence					
Social Competence	Students can discuss technical and scientific task	s within a seminar subject specific and inte	rdisciplinary .		
Autonomy	Students can independently exploit sources , acqu	uire the particular knowledge of the subject	and apply it to ne	ew problems.	
Workload in Hours	Independent Study Time 110, Study Time in Lectu	ure 70			
Credit points					
Course achievement					
Examination	Written exam				
Examination duration and	2 hours				
scale					
Assignment for the	Civil Engineering: Specialisation Water and Traffic	: Elective Compulsory			
-	Environmental Engineering: Core Qualification: El				
<b>-</b>	Water and Environmental Engineering: Specialisa				
	Water and Environmental Engineering: Specialisa				
	Water and Environmental Engineering: Specialisa				

Course L0906: Contaminated	l Sites and Landfilling
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Marco Ritzkowski, Dr. Joachim Gerth
Language	EN
Cycle	SoSe
Content	The part Contaminated Sites gives an introduction into different scales of pollution and identifies key pollutants. Geochemical attenuation mechanisms and the role of organisms are highlighted affecting the fate of pollutants in leachate and groundwater. Techniques for site characterization and remediation are discussed including economical aspects. The part Landfilling is introduced by discussing fundamental aspects and the worldwide situation of waste management. The lecture highlights transformation processes in landfill bodies, emissions of gases and leachate, and the long-term behaviour of landfill sites with measures of aftercare.
Literature	<ol> <li>Waste Management. Bernd Bilitewski; Georg Härdtle; Klaus Marek (Eds.), ISBN: 9783540592105, Springer Verlag Lehrbuchsammlung der TUB, Signatur USH-305</li> <li>Solid Waste Technology and Management. Thomas Christensen (Ed.), ISBN: 978-1-4051-7517-3, Wiley Verlag Lesesaal 2: US - Umweltschutz, Signatur USH-332</li> <li>Natural attenuation of fuels and chlorinated solvents in the subsurface. Todd H. Wiedemeier(Ed.), ISBN: 0471197491 Lesesaal 2: US - Umweltschutz, Signatur USH-844</li> </ol>

Course L0907: Contaminated	urse L0907: Contaminated Sites and Landfilling		
Тур	Recitation Section (large)		
Hrs/wk	1		
СР	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Dr. Marco Ritzkowski, Dr. Joachim Gerth		
Language	EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L0904: Geochemical	Engineering
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Joachim Gerth
Language	EN
Cycle	SoSe
	As an introduction cases are presented in which geochemical engineering was used to solve environmental problems. Environmentally important minerals are discussed and methods for their detection. It is demonstrated how solution equilibria can be modified to eliminate elevated concentrations of unwanted species in solution and how carbon dioxide concentration affects pH and the dissolution of carbonate minerals. Modifications of redox conditions, pH, and electrolyte concentration are shown to be effective tools for controlling the mobility and fate of hazardous species in the environment.
Literature	<b>Geochemistry, groundwater and pollution.</b> C. A. J. Appelo; D. Postma Leiden [u.a.] Balkema 2005 Lehrbuchsammlung der TUB, Signatur GWC-515

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

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

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

Lingineering								
Module M0871: Hydro	ological Systems							
Courses								
Title		Тур	Hrs/wk	СР				
Applied Surface Hydrology (L0289)		Lecture	2	2				
Applied Surface Hydrology (L1412)		Project-/problem-based Learning	, 1	2				
Interaction Water - Environment in I	Fluvial Areas (L0295)	Project-/problem-based Learning	, 1	2				
Module Responsible	Prof. Peter Fröhle							
Admission Requirements	None							
<b>Recommended Previous</b>	Fundamentals of Hydromechanics and Hydromechanics a	raulic Engineering: Hydraulic Engineering I and Hydr	aulic Engineeri	ng II				
Knowledge								
Educational Objectives	After taking part successfully, students hav	e reached the following learning results						
Professional Competence								
Knowledge	The students are able to define the basic of	concepts of hydrology and water management. The	ey are able to c	describe and quantify				
	the relevant processes of the hydrological	water cycle. Besides, the students know the main a	spects of rainfa	all-run-off-models and				
	are able to theoretically derive established	reservoir / storage models and a unit-hydrograph.						
Skills	The students are able to use the basic hy	ydrological concepts and approaches and are able	to theoretical	ly derive established				
	reservoir / storage models or a unit-hydrog	graph as the basis for rainfall-run-off-models. The s	tudent are able	e to explain the basic				
	concepts of measurements of hydrological	and hydrodynamic values in nature and are able	to perform, and	alyze and statistically				
	assess these measurements. Furthermore,	they are able to apply a hydrological model to basic	hydrological p	roblems.				
Personal Competence								
Social Competence	The students are able to deploy their gaine	d knowledge in applied problems of the hydrology a	ind water mana	gement. Additionaly				
	they will be able to work in team with engir	neers of other disciplines.						
Autonomy		extend their knowledge and apply it to new problem	IS					
	Independent Study Time 124, Study Time in	n Lecture 56						
Credit points								
Examination								
	The duration of the examination is 90 min. The examination includes tasks with respect to the general understanding of the lecture							
scale	contents and calculations tasks.							
Assignment for the	Civil Engineering: Specialisation Water and	Traffic: Elective Compulsory		Civil Engineering: Specialisation Water and Traffic: Elective Compulsory				
Assignment for the	Environmental Engineering: Core Qualification: Elective Compulsory							
		idies - Cities and Sustainability: Core Qualification: C	Compulsory					
			Compulsory					
	Joint European Master in Environmental Stu Water and Environmental Engineering: Spe		Compulsory					

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

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

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

Engineering					
Module M0874: Wast	ewater Systems				
Courses					
Title		Тур		Hrs/wk	СР
Wastewater Systems - Collection, T	reatment and Reuse (L0934)	Lecture		2	2
Wastewater Systems - Collection, 1	reatment and Reuse (L0943)	Recitation Se	ection (large)	1	1
Advanced Wastewater Treatment (	L0357)	Lecture		2	2
Advanced Wastewater Treatment (	L0358)	Recitation Se	ection (large)	1	1
Module Responsible	Prof. Ralf Otterpohl				
Admission Requirements	None				
<b>Recommended Previous</b>	Knowledge of wastewater management and t	the key processes involved in wa	astewater treatm	ent.	
Knowledge					
Educational Objectives	After taking part successfully, students have	reached the following learning r	esults		
Professional Competence					
Knowledge	Students are able to outline key areas of the	full range of treatment systems	in waste water	management, as	well as their mutu
	dependence for sustainable water protection	. They can describe relevant ecc	nomic, environm	ental and social	factors.
					· · · · · · ·
Skills	Students are able to pre-design and explain		ment processes	and the scope o	t their application
	municipal and for some industrial treatment	plants.			
Personal Competence					
-	Social skills are not targeted in this module.				
Autonomy	Students are in a position to work on a sul	pject and to organize their wor	k flow independ	ently. They can	also present on th
	subject.				
Workload in Hours	Independent Study Time 96, Study Time in Le	ecture 84			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	120 min				
scale					
Assignment for the	Civil Engineering: Specialisation Structural Er	igineering: Elective Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnica	l Engineering: Elective Compulse	ory		
	Civil Engineering: Specialisation Coastal Engi	neering: Elective Compulsory			
	Civil Engineering: Specialisation Water and T	raffic: Compulsory			
	Bioprocess Engineering: Specialisation A - Ge	neral Bioprocess Engineering: E	lective Compulso	ry	
	Environmental Engineering: Specialisation Wa	ater: Elective Compulsory			
	International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory				
	International Management and Engineering:	Specialisation II. Energy and Env	ironmental Engir	eering: Elective	Compulsory
	Process Engineering: Specialisation Environm		•	-	
	Process Engineering: Specialisation Process E				
	Water and Environmental Engineering: Speci				
	Water and Environmental Engineering: Specia		Compulsory		
	Water and Environmental Engineering: Specia				
		company,			

#### Course L0934: Wastewater Systems - Collection, Treatment and Reuse

Тур	Lecture			
Hrs/wk	2			
СР	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Ralf Otterpohl			
Language	EN			
Cycle	SoSe			
Content	•Understanding the global situation with water and wastewater			
	Regional planning and decentralised systems			
	•Overview on innovative approaches			
	depth knowledge on advanced wastewater treatment options for different situations, for end-of-pipe and reuse			
	•Mathematical Modelling of Nitrogen Removal			
	•Exercises with calculations and design			
Literature	Henze, Mogens:			
	Wastewater Treatment: Biological and Chemical Processes, Springer 2002, 430 pages			
	George Tchobanoglous, Franklin L. Burton, H. David Stensel:			
	Wastewater Engineering: Treatment and Reuse, Metcalf & Eddy			
	Mosewater Engineering. Heatin and Rease, Metean & Eady McGraw-Hill, 2004 - 1819 pages			

ourse L0943: Wastewater Systems - Collection, Treatment and Reuse		
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Ralf Otterpohl	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

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

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

Module M0875: Nexu	s Engineering - Water, Soil, Foo	d and Energy			
-					
Courses					
Title		Тур	Hrs/wk	СР	
	nergy, Soil and Food Nexus (L1229)	Seminar	2	2	
Water & Wastewater Systems in a		Lecture	2	4	
Module Responsible					
Admission Requirements					
Recommended Previous Knowledge	Basic knowledge of the global situation with rising poverty, soil degradation, migration to cities, lack of water resources ar sanitation				
Educational Objectives	After taking part successfully, students have r	reached the following learning results			
Professional Competence					
Knowledge	Students can describe the facets of the global water situation. Students can judge the enormous potential of the implementation or synergistic systems in Water, Soil, Food and Energy supply.				
Skills	Students are able to design ecological settlements for different geographic and socio-economic conditions for the main climate around the world.				
Personal Competence					
Social Competence	The students are able to develop a specific to	pic in a team and to work out milestones	according to a given pla	n.	
Autonomy	Students are in a position to work on a subject and to organize their work flow independently. They can also present on th subject.				
Workload in Hours	Independent Study Time 124, Study Time in L	ecture 56			
Credit points	6				
Course achievement	None				
Examination	Subject theoretical and practical work				
Examination duration and	During the course of the semester, the stude	nts work towards mile stones. The work	includes presentations a	and papers. Detaile	
scale	information can be found at the beginning of t	the smester in the StudIP course module	handbook.		
Assignment for the	Civil Engineering: Specialisation Water and Tr	affic: Elective Compulsory			
Following Curricula	Bioprocess Engineering: Specialisation A - Ger	neral Bioprocess Engineering: Elective Co	mpulsory		
	Chemical and Bioprocess Engineering: Specialisation General Process Engineering: Elective Compulsory				
	Environmental Engineering: Core Qualification: Elective Compulsory				
	Joint European Master in Environmental Studies - Cities and Sustainability: Core Qualification: Compulsory				
	Process Engineering: Specialisation Environme	ental Process Engineering: Elective Comp	ulsory		
	Process Engineering: Specialisation Process Engineering	ngineering: Elective Compulsory			
	Water and Environmental Engineering: Specia	lisation Water: Elective Compulsory			
	Water and Environmental Engineering: Specia	lisation Environment: Elective Compulsor	У		
	Water and Environmental Engineering: Specia	lisation Cities: Elective Compulsory			

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

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

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

Course L1066: City Planning	
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Carsten Gertz
Language	DE
Cycle	SoSe
Content	"Principles of Urban Planning" deals with the determinants of urban development and their interactions. Topics include:
	<ul> <li>legal framework,</li> <li>instruments and methods of planning,</li> <li>functional requirements,</li> <li>stakeholders and actors</li> <li>basic design requirements</li> <li>different planning levels and</li> <li>historical contexts.</li> </ul> The objective of the course is for students to acquire a basic understanding of urban development problems and approaches for solving them. They will also be able to comprehend the process of urban planning. The course also covers the various functional and aesthetic requirements for designing streetscape as the most important elements of public space. The project work deals with a real life scenario and includes drawing up a development plan, an urban design concept, a building masterplan and a street redesign.
Literature	Albers, Gerd; Wekel, Julian (2009) Stadtplanung: Eine illustrierte Einführung. Primus Verlag. Darmstadt. Frick, Dieter (2008) Theorie des Städtebaus: Zur baulich-räumlichen Organisation von Stadt. Wasmuth-Verlag. Tübingen Jonas, Carsten (2009) Die Stadt und ihr Grundriss. Wasmuth-Verlag. Tübingen Kostof, Spiro; Castillo, Greg (1998) Die Anatomie der Stadt. Geschichte städtischer Strukturen. Campus-Verlag. Frankfurt/New
	York.

Engineering"					
Module M0663: Marin	e Geotechnics				
Courses					
Title		Тур	Hrs/wk	СР	
Marine Geotechnics (L0548)		Lecture	1	2	
Marine Geotechnics (L0549)		Recitation Section (large)	2	2	
Steel Structures in Foundation and		Lecture	2	2	
Module Responsible					
Admission Requirements	None				
<b>Recommended Previous</b>	complete modules: Geotechnics I-III, Mathematics	s I-III			
Knowledge	courses: Soil laboratory course				
Educational Objectives	After taking part successfully, students have read	hed the following learning results			
Professional Competence					
Knowledge					
Skills					
Personal Competence					
Social Competence					
Autonomy					
Workload in Hours	Independent Study Time 110, Study Time in Lect	ure 70			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	90 min				
scale					
Assignment for the	Civil Engineering: Specialisation Geotechnical Eng	gineering: Compulsory			
Following Curricula	Civil Engineering: Specialisation Structural Engine	eering: Elective Compulsory			
	Civil Engineering: Specialisation Coastal Engineer	ing: Compulsory			
	Theoretical Mechanical Engineering: Specialisatio	n Maritime Technology: Elective Compulsory			
	Water and Environmental Engineering: Specialisa				
	Water and Environmental Engineering: Specialisa				
	Water and Environmental Engineering: Specialisa	tion Water: Elective Compulsory			

Course L0548: Marine Geote	chnics		
Тур	Lecture		
Hrs/wk	1		
СР	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Jürgen Grabe		
Language	E		
Cycle	SoSe		
Content	<ul> <li>Geotechnical investigation an description of the seabed</li> <li>Foundations of Offshore-Constructions</li> <li>cCliff erosion</li> <li>Sea dikes</li> <li>Port structures</li> <li>Flood protection structures</li> </ul>		
Literature	<ul> <li>EAK (2002): Empfehlungen für Küstenschutzbauwerke</li> <li>EAU (2004): Empfehlungen des Arbeitsausschusses Uferbauwerke</li> <li>Poulos H.G. (1988): Marine Geotechnics. Unwin Hyman, London</li> <li>Wagner P. (1990): Meerestechnik: Eine Einführung für Bauingenieure. Ernst &amp; Sohn, Berlin</li> </ul>		

Course L0549: Marine Geotechnics		
Тур	Recitation Section (large)	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Jürgen Grabe	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L1146: Steel Structur	ourse L1146: Steel Structures in Foundation and Hydraulic Engineering		
Тур	Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Frank Feindt		
Language	DE		
Cycle	SoSe		
Content	Design of a sheet pile wall, design of a combined sheet pile wall, piles, walings, connections, fatigue		
Literature	EAU 2012, EA-Pfähle, EAB		

Engineering"				
Module M1724: Smar	t Monitoring			
Courses				
Title		Тур	Hrs/wk	СР
Smart Monitoring (L2762)		Integrated Lecture	2	2
Smart Monitoring (L2763)		Recitation Section (small)	2	4
Module Responsible	Prof. Kay Smarsly			
Admission Requirements	None			
<b>Recommended Previous</b>	Basic knowledge or interest in object-oriented	modeling, programming, and sensor technol	ogies are helpfu	I. Interest in mo
Knowledge	research and teaching areas, such as Internet	of Things, Industry 4.0 and cyber-physical sy	vstems, as well a	is the will to dee
	skills of scientific working, are required. Basic kr	owledge in scientific writing and good English	n skills.	
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
•	The students will become familiar with the pr	inciples and practices of smart monitoring	The students wi	ill he able to de
, and meage	decentralized smart systems to be applied for			
	environment. In addition, the students will learn			
	analysis techniques, modern software design co			
	also part of this module. In small groups, th			
	"intelligent" sensors to be implemented by the		-	•
	techniques. The smart monitoring systems will			
	on scaled lab structures for validation purposes			
	module will "automatically" participate with th			
	written papers and oral examinations form the f			
Skills	;			
Personal Competence				
Social Competence				
Autonomy	,			
Workload in Hours	Independent Study Time 124, Study Time in Lec	ture 56		
Credit points	6			
Course achievement	None			
	Written elaboration			
Examination duration and	1 3	on		
scale				
-	Civil Engineering: Specialisation Water and Traff			
Following Curricula				
	Civil Engineering: Specialisation Coastal Engineer Civil Engineering: Specialisation Structural Engin			
	Civil Engineering: Specialisation Structural Engineering: Specialisation Coastal Engineering:	5 1 5		
		ring, Elective Compulson,		
	5 5 1 5	5 1 5		
	Civil Engineering: Specialisation Geotechnical Er	gineering: Elective Compulsory		
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Course L2762: Smart Monito	ring
Тур	Integrated Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Kay Smarsly
Language	EN
Cycle	WiSe/SoSe
Content	In this course, principles of smart monitoring will be taught, focusing on modern concepts of data acquisition, data storage, and data analysis. Also, fundamentals of intelligent sensors and embedded computing will be illuminated. Autonomous software and decentralized data processing are further crucial parts of the course, including concepts of the Internet of Things, Industry 4.0 and cyber-physical systems. Furthermore, measuring principles, data acquisition systems, data management and data analysis algorithms will be discussed. Besides the theoretical background, numerous practical examples will be shown to demonstrate how smart monitoring may advantageously be used for assessing the condition of systems in the built or natural environment.
Literature	

Course L2763: Smart Monito	ring
Тур	Recitation Section (small)
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Kay Smarsly
Language	EN
Cycle	WiSe/SoSe
Content	The contents of the exercises are based on the lecture contents. In addition to the exercises, project work will be conducted, which will consume the majority of the workload. As part of the project work, students will design smart monitoring systems that will be tested in the laboratory or in the field. As mentioned in the module description, the students will participate in the "Smart Monitoring" competition, hosted annually by the Institute of Digital and Autonomous Construction. Students are encouraged to contribute their own ideas. The tools required to implement the smart monitoring systems will be taught in the group exercises as well as through external sources, such as video tutorials and literature.
Literature	

Module M1123: Selec	ted Topics in Environmental Engi	neering		
Courses				
Title		Тур	Hrs/wk	СР
Environmental Aquatic Chemistry (	L1444)	Lecture	2	3
Excellence in International Project	Delivery (L2387)	Integrated Lecture	2	2
Sludge Treatment (L0520)		Lecture	2	3
Thermal Biomass Utilization (L1767	")	Lecture	2	2
Thermal Biomass Utilization (L2386	5)	Practical Course	1	1
Module Responsible	Prof. Mathias Ernst			
Admission Requirements	None			
<b>Recommended Previous</b>				
Knowledge				
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Depends on choice of courses			
Credit points	6			
Assignment for the	Environmental Engineering: Core Qualification: E	Elective Compulsory		
Following Curricula	Water and Environmental Engineering: Specialis	ation Cities: Elective Compulsory		
	Water and Environmental Engineering: Specialis	ation Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialis	ation Water: Elective Compulsory		

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

Course L2387: Excellence in	Course L2387: Excellence in International Project Delivery		
Тур	Integrated Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Examination Form	Klausur		
Examination duration and	2 h		
scale			
Lecturer	Dr. Jens Huckfeldt		
Language	EN		
Cycle	SoSe		
Content	Simply and easy to avoid mistake in project delivery can deliver projects within budget and as per schedule.You		
	have to attend if you see yourself in project execution and potentially even abroad.		
Literature			

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

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

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

Lingineering							
Module M0620: Speci	al Aspec	ts of W	aste Resource M	anagement			
Courses							
Title					Тур	Hrs/wk	СР
Advanced Topics in Waste Resource	e Manageme	nt (L1055)			Project-/problem-based Learning	3	3
International Waste Management (I	L0317)				Project-/problem-based Learning	2	3
Module Responsible	Prof. Kersti	n Kuchta					
Admission Requirements	None						
<b>Recommended Previous</b>	basics in w	aste treatn	nent technologies				
Knowledge							
Educational Objectives	After taking	g part succ	essfully, students have re	ached the followi	ing learning results		
<b>Professional Competence</b>							
Knowledge					as advanced technologies for re t and disposal in national and int		-
Skills	Students are able to select suitable processes for the treatment with respect to the national or cultural and developmental context They can evaluate the ecological impact and the technical effort of different technologies and management systems.						
Personal Competence							
Social Competence	Students can work together as a team of 2-5 persons, participate in subject-specific and interdisciplinary discussions, develop						
	cooperated	solutions	and defend their own wo	rk results in fror	it of others and promote the sci	entific develo	oment of colleagues
			n give and accept professi				
Autonomy	Students c	an indeper	ndently gain additional k	nowledge of the	subject area and apply it in so	olving the giv	en course tasks an
	projects.						
Workload in Hours	Independer	nt Study Ti	me 110, Study Time in Le	cture 70			
Credit points	6						
Course achievement	Compulsory	Bonus	Form	Description			
	Yes	20 %	Written elaboration				
Examination	Presentatio	on					
Examination duration and	PowerPoint	presentati	ion (10-15 minutes)				
scale							
Assignment for the	Civil Engine	eering: Spe	cialisation Water and Traf	fic: Elective Com	pulsory		
Following Curricula	Environme	ntal Engine	ering: Specialisation Was	te and Energy: El	lective Compulsory		
	Joint Europ	ean Master	r in Environmental Studies	- Cities and Sust	tainability: Specialisation Energy	: Elective Com	pulsory
	-		ntal Engineering: Speciali				-
			ntal Engineering: Speciali				
	Water and Environmental Engineering: Specialisation Cities: Elective Compulsory						
			5		J		

Course L1055: Advanced Topics in Waste Resource Management				
Тур	Project-/problem-based Learning			
Hrs/wk	3			
СР	3			
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42			
Lecturer	Prof. Rüdiger Siechau			
Language	EN			
Cycle	WiSe			
Content	<ul> <li>Focus of the course "Advanced topics of waste resource management" lies on the organisational structures in waste management - such as planning, financing and logistics. One excursion will be offered to take part in (incineration plant, vehicle fleet and waste collection systems).</li> <li>The course is split into two parts: <ol> <li>part: "Conventional" lecture (development of waste management, legislation, collection, transportation and organisation of waste management, costs, fees and revenues).</li> <li>part: Project base learning: You will get a project to work out in groups of 4 to 6 students; all tools and data you need to work out the project were given before during the conventional lecture. Course documents are published in StudIP and communication during project work takes place via StudIP.</li> </ol> </li> <li>The results of the project work are presented at the end of the semester. The final mark for the course consists of the grade for the presentation.</li> </ul>			
Literature	Einführung in die Abfallwirtschaft; Martin Kranert, Klaus Cord-Landwehr (Hrsg.); Vieweg + Teubner Verlag; 2010 PowerPoint slides in Stud IP			

Course L0317: International	Waste Management
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Kerstin Kuchta
Language	EN
Cycle	WiSe
Content	Waste avoidance and recycling are the focus of this lecture. Additionally, waste logistics ( Collection, transport, export, fees and taxes) as well as international waste shipment solutions are presented. Other specific wastes, e.g. industrial waste, treatment concepts will be presented and developed by students themselves Waste composition and production on international level, wast eulogistic, collection and treatment in emerging and developing countries. Single national projects and studies will be prepared and presented by students
Literature	Basel convention

Engineering					
Module M0801: Wate	r Resources and -Supply				
Courses					
Title		Тур	Hrs/wk	СР	
Chemistry of Drinking Water Treatr	nent (L0311)	Lecture	2	1	
Chemistry of Drinking Water Treatr	nent (L0312)	Recitation Section (large)	1	2	
Water Resource Management (L04)	02)	Lecture	2	2	
Water Resource Management (L04)	03)	Recitation Section (small)	1	1	
Module Responsible	Prof. Mathias Ernst				
Admission Requirements	None				
<b>Recommended Previous</b>	Knowledge of water management and the ke	y processes involved in water treatment.			
Knowledge					
Educational Objectives	After taking part successfully, students have	reached the following learning results			
Professional Competence					
Knowledge	Students will be able to outline key areas o	f conflict in water management, as well as th	eir mutual depend	dence for sustainab	
	water supply. They will understand relevant	t economic, environmental and social factors.	Students will be	able to explain an	
		r companies. They will be able to explain the a			
	the scope of their application.				
	the scope of their application.				
Skills	Students will be able to assess complex	problems in drinking water production an	d establish soluti	ions involving wat	
	management and technical measures. They	will be able to assess the evaluation methods	that can be used	for this. Students w	
	be able to carry out chemical calculations	for selected treatment processes and apply of	enerally accepted	d technical rules a	
	standards to these processes.	1 115			
Personal Competence					
Social Competence	Working in a diverse group of specialists, students will be able to develop and document complex solutions for the managemen				
	and treatment of drinking water. They will be able to take an appropriate professional position, for example representing use				
	interests. They will be able to develop joint s	olutions in teams of diverse experts and preser	t these solutions t	o others.	
Autonomy	Students will be in a position to work on a subject independently and present on this subject.				
Workload in Hours	Independent Study Time 96, Study Time in Le	ecture 84			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	60 min (chemistry) + presentation				
scale					
Assignment for the	Civil Engineering: Specialisation Structural Er	ngineering: Elective Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnica	l Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Water and T	raffic: Compulsory			
	Civil Engineering: Specialisation Coastal Engi	neering: Elective Compulsory			
	International Management and Engineering:	Specialisation II. Energy and Environmental Eng	jineering: Elective	Compulsory	
	Process Engineering: Specialisation Environm	nental Process Engineering: Elective Compulsor	y		
	Process Engineering: Specialisation Process E		-		
	Water and Environmental Engineering: Speci				
	Water and Environmental Engineering: Speci				
	Water and Environmental Engineering: Speci Water and Environmental Engineering: Speci				
	water and Environmental Engineering: Speci	ansation clues. Liective Compuisory			

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

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

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

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

Module M0802: Memb	rane Technology			
Courses				
		<b>T</b>	11	<b>CD</b>
<b>Title</b> Membrane Technology (L0399)		<b>Typ</b> Lecture	Hrs/wk 2	<b>СР</b> 3
Membrane Technology (L0399)		Recitation Section (small)	1	2
Membrane Technology (L0401)		Practical Course	1	1
Module Responsible	Prof. Mathias Ernst			
Admission Requirements	None			
<b>Recommended Previous</b>	Basic knowledge of water chemistry. Knowledge of the core processes involved in water, gas and steam treatment			
Knowledge				
Educational Objectives	After taking part successfully, students have reached	the following learning results		
<b>Professional Competence</b>				
Knowledge	Students will be able to rank the technical application the different driving forces behind existing membra membrane filtration and their advantages and disad membranes in water, other liquid media, gases and in	ne separation processes. Students will vantages. Students will be able to expl	be able to nan	ne materials used
Skills	Students will be able to prepare mathematical equations for material transport in porous and solution-diffusion membranes ar calculate key parameters in the membrane separation process. They will be able to handle technical membrane processes usir available boundary data and provide recommendations for the sequence of different treatment processes. Through their ow experiments, students will be able to classify the separation efficiency, filtration characteristics and application of different membrane materials. Students will be able to characterise the formation of the fouling layer in different waters and apply technic measures to control this.			
Personal Competence				
Social Competence	Students will be able to work in diverse teams on tas within their group on laboratory experiments to be un			le to make decisior
Autonomy	Students will be in a position to solve homework on the topic of membrane technology independently. They will be capable finding creative solutions to technical questions.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	6		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Ele	ctive Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation A - General Bio		ry	
_	Bioprocess Engineering: Specialisation B - Industrial B	ioprocess Engineering: Elective Compuls	sory	
	Chemical and Bioprocess Engineering: Specialisation (			
	Chemical and Bioprocess Engineering: Specialisation (	General Process Engineering: Elective Co	ompulsory	
	Environmental Engineering: Specialisation Water: Elec	tive Compulsory		
	Joint European Master in Environmental Studies - Citie		er: Elective Com	oulsory
	Process Engineering: Specialisation Process Engineeri	ng: Elective Compulsory		-
	Process Engineering: Specialisation Environmental Pro			
	Water and Environmental Engineering: Specialisation			
		Water: Elective Compulsory		

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

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

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

Module M0822: Proce	ss Modeling in Water Technolo	рду		
Courses				
Title		Тур	Hrs/wk	СР
Process Modelling of Wastewater T	reatment (L0522)	Project-/problem-based Learning	2	3
Process Modeling in Drinking Water	r Treatment (L0314)	Project-/problem-based Learning	2	3
Module Responsible	Dr. Klaus Johannsen			
Admission Requirements	None			
<b>Recommended Previous</b>	Knowledge of the most important processes	in drinking water and waste water treatment.		
Knowledge				
Educational Objectives	After taking part successfully, students have	reached the following learning results		
<b>Professional Competence</b>				
Knowledge	Students are able to explain selected proces	sses of drinking water and waste water treatment	in detail. The	y are able to explai
	basics as well as possibilities and limitations	of dynamic modeling.		
Skille	Students are able to use the most importan	t features Modelica offers. They are able to transpo	nsa salartad	processes in drinking
JKIIIS		hematical model in Modelica with respect to equilib		
	They are able to set up and apply models and		mann, kinetie	
	They are usic to see up and upply models and	a assess their possibilities and initiations.		
Personal Competence				
	Students are able to solve problems and des	ument solutions in a group with members of differe	nt tochnical l	ackground Thow ar
Social competence		ork constructively with feedback concerning their wo		ackground. They are
	able to give appropriate reeuback and carried	or constructively with reedback concerning their wo	JIK.	
A 1				
Autonomy	Students are able to define a problem, gain t	në required knowledge and set up a model.		
Workload in Hours	Independent Study Time 124, Study Time in	Lecture 56		
Credit points				
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water and T	raffic: Elective Compulsory		
Following Curricula	Environmental Engineering: Specialisation W			
-		ies - Cities and Sustainability: Specialisation Water:	Elective Com	oulsory
	Process Engineering: Specialisation Environm	nental Process Engineering: Elective Compulsory		-
	Process Engineering: Specialisation Process E			
	Water and Environmental Engineering: Speci			
	Water and Environmental Engineering: Speci	alisation Environment: Elective Compulsory		
	Water and Environmental Engineering: Speci	alisation Cities: Elective Compulsory		

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

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

Courses	
Title	Typ Hrs/wk CP
Integrated Transportation Planning	(L1068) Project-/problem-based Learning 4 6
Module Responsible	Prof. Carsten Gertz
Admission Requirements	None
<b>Recommended Previous</b>	some knowledge of transport planning, e.g. through taking the undergraduate class "Transport Planning and Traffic Engineerin
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to:
	describe interdependencies between land-use/location choice and transportation/mobility behaviour
	<ul> <li>explain and evaluate the social, ecological and economic effects of transport and land-use policy measures.</li> <li>relate surrent issues in the area of integrated transport planning and fermulate an explain an them.</li> </ul>
	<ul> <li>relate current issues in the area of integrated transport planning and formulate an opinion on them.</li> </ul>
Skille	Students are able to:
JKIIIS	
	<ul> <li>quantify important parameters, which influence travel demand or are influenced by it.</li> </ul>
	<ul> <li>comprehensively examine a pre-defined or self-selected topic from a transportation studies perspective and document to</li> </ul>
	results in accordance with scientific conventions.
Personal Competence	
Social Competence	Students are able to:
	<ul> <li>provide feedback on topical contents and their teaching.</li> </ul>
	<ul> <li>constructively handle feedback on their own work.</li> </ul>
	<ul> <li>produce results in group work and document these.</li> </ul>
Autonomy	Students are able to:
	assess potential consequences of their future professional activities
	<ul> <li>independently plan working on a pre-defined project topic, acquire the necessary knowledge and use appropriate means</li> </ul>
	its execution.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	
Course achievement	None
Examination	Written elaboration
Examination duration and	written assignment with presentation during the semester
scale	
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory
	Civil Engineering: Specialisation Water and Traffic: Compulsory
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure and Mobility: Elective Compulsory
	Water and Environmental Engineering: Specialisation Water: Elective Compulsory
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory
	Water and Environmental Engineering: Specialisation Cities: Compulsory

Course L1068: Integrated Tr	ansportation Planning
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Carsten Gertz, Dr. Philine Gaffron, Jacqueline Bianca Maaß
Language	DE
Cycle	WiSe
Content	The course will provide students with an understanding of interdependencies between land-use and transportation. Specific topics include a.o.:    interactions between transport and the environment and consequent limitations  characteristics of integrated planning  complex planning processes  interdependencies of location choice and mobility behaviour  transport and land-use policies  project on current issues in transportation studies
Literature	Kutter, Eckhard (2005) Entwicklung innovativer Verkehrsstrategien für die mobile Gesellschaft. Erich Schmidt Verlag. Berlin. Bracher, Tilman u. a. (Hrsg.) (68. Ergänzung 2013) Handbuch der kommunalen Verkehrsplanung. Herbert Wichmann Verlag. Berlin, Offenbach. (Loseblattsammlung mit kontinuierlichen Ergänzungen)

Module M0949: Rural	Development and Resources Oriented	d Sanitation for diffe	erent Climate Zon	les	
Courses					
Title		Тур	Hrs/wk	СР	
Rural Development and Resources	Oriented Sanitation for different Climate Zones (L0942)	Seminar	2	3	
Rural Development and Resources	Oriented Sanitation for different Climate Zones (L0941)	Lecture	2	3	
Module Responsible	Prof. Ralf Otterpohl				
Admission Requirements	None				
<b>Recommended Previous</b>	Basic knowledge of the global situation with rising poverty, soil degradation, lack of water resources and sanitation				
Knowledge					
Educational Objectives	After taking part successfully, students have reached the	ne following learning results			
Professional Competence					
Knowledge	Students can describe resources oriented wastewater	systems mainly based on sou	urce control in detail. Th	ey can comment or	
	techniques designed for reuse of water, nutrients and s	oil conditioners.			
	Students are able to discuss a wide range of proven ap	proaches in Rural Developmen	t from and for many region	ons of the world.	
		·	, ,		
Skills	Students are able to design low-tech/low-cost sanital		• •		
	rehabilitation of top soil quality combined with food and	•	consult on the basics of	soll building through	
	"Holisitc Planned Grazing" as developed by Allan Savor	у.			
Personal Competence					
Social Competence	The students are able to develop a specific topic in a te	am and to work out milestone	s according to a given pla	in.	
Autonomy	Students are in a position to work on a subject and	ta arganiza thair work flaw ir	dependently. They can	alea procont on this	
Autonomy	subject.	to organize their work now in	idependentiy. They can a	also present on this	
	Subject.				
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56				
Credit points	6				
Course achievement	None				
Examination	Subject theoretical and practical work				
Examination duration and	During the course of the semester, the students work	towards mile stones. The work	c includes presentations a	and papers. Detailed	
scale	information will be provided at the beginning of the small	ester.			
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elec	tive Compulsory			
Following Curricula	Bioprocess Engineering: Specialisation A - General Biop	rocess Engineering: Elective C	ompulsory		
	Chemical and Bioprocess Engineering: Specialisation Ge	eneral Process Engineering: Ele	ective Compulsory		
	Environmental Engineering: Specialisation Water: Election				
	International Management and Engineering: Specialisat				
	Joint European Master in Environmental Studies - Cities			ulsory	
	Process Engineering: Specialisation Environmental Proc		pulsory		
	Process Engineering: Specialisation Process Engineering				
	Water and Environmental Engineering: Specialisation W				
	Water and Environmental Engineering: Specialisation E		ory		
	Water and Environmental Engineering: Specialisation C	ities: Elective Compulsory			

Course L0942: Rural Development and Resources Oriented Sanitation for different Climate Zones		
Тур	Seminar	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Ralf Otterpohl	
Language	EN	
Cycle	WiSe	
Content		
	<ul> <li>Central part of this module is a group work on a subtopic of the lectures. The focus of these projects will be based on an interview with a target audience, practitioners or scientists.</li> <li>The group work is divided into several Milestones and Assignments. The outcome will be presented in a final presentation at the end of the semester.</li> </ul>	
Literature	<ul> <li>J. Lange, R. Otterpohl 2000: Abwasser - Handbuch zu einer zukunftsfähigen Abwasserwirtschaft. Mallbeton Verlag (TUHH Bibliothek)</li> <li>Winblad, Uno and Simpson-Hébert, Mayling 2004: Ecological Sanitation, EcoSanRes, Sweden (free download)</li> <li>Schober, Sabine: WTO/TUHH Award winning Terra Preta Toilet Design: http://youtu.be/w_R09cYq6ys</li> </ul>	

Course L0941: Rural Develop	ment and Resources Oriented Sanitation for different Climate Zones
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Ralf Otterpohl
Language	EN
Cycle	WiSe
Content	<ul> <li>Living Soil - THE key element of Rural Development</li> <li>Participatory Approaches</li> <li>Rainwater Harvesting</li> <li>Ecological Sanitation Principles and practical examples</li> <li>Permaculture Principles of Rural Development</li> <li>Performance and Resilience of Organic Small Farms</li> <li>Going Further: The TUHH Toolbox for Rural Development</li> <li>EMAS Technologies, Low cost drinking water supply</li> </ul>
Literature	<ul> <li>Miracle Water Village, India, Integrated Rainwater Harvesting, Water Efficiency, Reforestation and Sanitation: http://youtu.be/9hmkgn0nBgk</li> <li>Montgomery, David R. 2007: Dirt: The Erosion of Civilizations, University of California Press</li> </ul>

Courses	
litle	Typ Hrs/wk CP
Module Responsible	Dozenten des SD B
Admission Requirements	None
<b>Recommended Previous</b>	
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students are able to demonstrate their detailed knowledge in the field of Water and Environmental Engineering. They exemplify the state of technology and application and discuss critically in the context of actual problems and general condition science and society. The students can develop solving strategies and approaches for fundamental and practical problems in the field of Water and Environmental Engineering. They may apply theory based procedures and integrate safety-related, ecological, ethical, economic view points of science and society.
	Scientific work techniques that are used can be described and critically reviewed.
Skills	The students are able to independently select methods or planning approaches for the project work and to justify their cho They can explain how these methods or approaches relate to solutions in the field of work and how the context of application to be adjusted. General findings and further developments may essentially be outlined.
Personal Competence	
Social Competence	The students are able to condense the relevance and the structure of the project work, the work steps and the sub-problems the presentation and discussion in front of a bigger group. They can lead the discussion and give a feedback on the project to t colleagues.
Autonomy	The students are capable of independently planning and documenting the work steps and procedures while considering the gi deadlines. This includes the ability to accurately procure the newest scientific information. Furthermore, they can obtain feedb from experts with regard to the progress of the work, and to accomplish results on the state of the art in science and technolog
Workload in Hours	Independent Study Time 180, Study Time in Lecture 0
Credit points	6
Course achievement	None
Examination	Study work
Examination duration and	
scale	
Assignment for the	Water and Environmental Engineering: Specialisation Environment: Compulsory
Following Curricula	

Module M1716: Subsu	Irface Processes			
Courses				
Title		Тур	Hrs/wk	СР
Modeling of Subsurface Processes (	L2730)	Lecture	2	2
Modeling of Subsurface Processes (	L2731)	Recitation Section (small)	1	1
Modern Techniques for Subsurface		Lecture	2	2
Modern Techniques for Subsurface	Solute Transport (L2729)	Recitation Section (large)	1	1
Module Responsible				
Admission Requirements				
<b>Recommended Previous</b>	Basic Mathematics, Hydrology			
Knowledge				
Educational Objectives	After taking part successfully, students hav	e reached the following learning results		
Professional Competence				
Knowledge	Upon completion of this module, the stud	dents will understand the mechanisms contro	olling solute transpo	rt in soil and natu
	porous media and will be able to work with	the equations that govern the fate and transp	port of solutes in pore	ous media. Analytica
	numerical and experimental tools and tech	niques will be used in this module.		
Skills		dents will be exposed to analytical, experimen		
		cellent opportunity to improve their skills on i	multiple fronts which	will be useful in the
	future career.			
Personal Competence				
	Teamwork & problem solving			
Autonomy		individual reports and presentation. This wi	ll contribute to the	students' ability a
	willingness to work independently and resp	·		
Workload in Hours	Independent Study Time 96, Study Time in	Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	Report and Presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structural	Engineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnic	cal Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal En	gineering: Elective Compulsory		
	Civil Engineering: Specialisation Water and	Traffic: Elective Compulsory		
	Process Engineering: Specialisation Environ	mental Process Engineering: Elective Compute	sory	
	Process Engineering: Specialisation Process	Engineering: Elective Compulsory		
	Water and Environmental Engineering: Spe	cialisation Water: Compulsory		
		cialisation Water: Compulsory cialisation Environment: Elective Compulsory		

Course L2730: Modeling of Subsurface Processes		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Sonja Götz	
Language	EN	
Cycle	WiSe	
Content		
Literature		

Course L2731: Modeling of Subsurface Processes		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Sonja Götz	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L2728: Modern Techniques for Subsurface Solute Transport	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Nima Shokri
Language	EN
Cycle	WiSe
Content	
Literature	

Course L2729: Modern Techr	urse L2729: Modern Techniques for Subsurface Solute Transport		
Тур	Recitation Section (large)		
Hrs/wk	1		
СР	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Hannes Nevermann		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

C						
Courses						
Title			Тур		Hrs/wk	СР
Waste and Environmental Chemist	-			l Course	2	2
Biological Waste Treatment (L0318			Project-,	/problem-based Learning	3	4
Module Responsible						
Admission Requirements						
Recommended Previous	-	cal basics				
Knowledge						
Educational Objectives	After taking part succ	cessfully, students have re	eached the following learni	ing results		
Professional Competence						
Knowledge	-		ng the planning of biologic ste treatment plants in de			
	plants for biological w	vaste treatment plants an	d explain different methoo	ls for waste analytics.		
Skills	The students are able	e to discuss the compilati	on of design and layout of	plants. They can critical	ly evaluate tec	hniques and qual
	control measurement	ts. The students can rech	erché and evaluate literat	ture and date connected	to the tasks o	given in der mod
	and plan additional te	ests. They are capable of	reflecting and evaluating f	indings in the group.		
Personal Competence						
Social Competence	Students can participate in subject-specific and interdisciplinary discussions, develop cooperated solutions and defend their or					
	work results in front of others and promote the scientific development in front of colleagues. Furthermore, they			they can give a		
	accept professional constructive criticism.					
Autonomy	Students can indeper	ndently tap knowledge fr	om literature, business or	test reports and transfo	orm it to the co	ourse projects. Th
	are capable, in consu	Iltation with supervisors a	s well as in the interim pre	esentation, to assess the	ir learning leve	el and define furt
steps on this basis. Furthe		Furthermore, they can de	fine targets for new appli	cation-or research-orien	ted duties in a	ccordance with t
	potential social, econ	omic and cultural impact.				
Workload in Hours	Independent Study Ti	ime 110, Study Time in Le	ecture 70			
	6					
Credit points	Commuterent Domina	Form	Description			
Credit points	Yes None	Subject theoretical	and			
Credit points		practical work	and			
Credit points Course achievement Examination	Yes None Presentation	practical work				
Credit points Course achievement Examination Examination duration and	Yes None Presentation Elaboration and Prese	practical work				
Credit points Course achievement Examination Examination duration and scale	Yes None Presentation Elaboration and Prese	practical work entation (15-25 minutes in	n groups)			
Credit points Course achievement Examination Examination duration and scale Assignment for the	Yes None Presentation Elaboration and Prese Civil Engineering: Spe	practical work entation (15-25 minutes in ecialisation Structural Eng	n groups) ineering: Elective Compuls	5		
Credit points Course achievement Examination Examination duration and scale	Yes None Presentation Elaboration and Prese Civil Engineering: Spe Civil Engineering: Spe	practical work entation (15-25 minutes in ecialisation Structural Eng ecialisation Geotechnical	n groups) ineering: Elective Compuls Engineering: Elective Comp	pulsory		
Credit points Course achievement Examination Examination duration and scale Assignment for the	Yes None Presentation Elaboration and Prese Civil Engineering: Spe Civil Engineering: Spe Civil Engineering: Spe	practical work entation (15-25 minutes in ecialisation Structural Eng ecialisation Geotechnical ecialisation Coastal Engine	n groups) ineering: Elective Compuls Engineering: Elective Comp eering: Elective Compulsor	pulsory		
Credit points Course achievement Examination Examination duration and scale Assignment for the	Yes None Presentation Elaboration and Prese Civil Engineering: Spe Civil Engineering: Spe Civil Engineering: Spe Civil Engineering: Spe	practical work entation (15-25 minutes in ecialisation Structural Eng ecialisation Geotechnical ecialisation Coastal Engin- ecialisation Water and Tra	n groups) ineering: Elective Compuls Engineering: Elective Comp eering: Elective Compulsory ffic: Elective Compulsory	pulsory		
Credit points Course achievement Examination Examination duration and scale Assignment for the	Yes None Presentation Elaboration and Prese Civil Engineering: Spe Civil Engineering: Spe Civil Engineering: Spe Civil Engineering: Spe Environmental Engine	practical work entation (15-25 minutes in ecialisation Structural Eng ecialisation Geotechnical ecialisation Coastal Engine ecialisation Water and Tra eering: Core Qualification	n groups) ineering: Elective Compuls Engineering: Elective Comp eering: Elective Compulsory ffic: Elective Compulsory Compulsory	pulsory y		
Credit points Course achievement Examination Examination duration and scale Assignment for the	Yes None Presentation Elaboration and Prese Civil Engineering: Spe Environmental Engine International Manage	practical work entation (15-25 minutes in ecialisation Structural Eng ecialisation Geotechnical ecialisation Coastal Engin- ecialisation Water and Tra eering: Core Qualification ment and Engineering: Sp	n groups) ineering: Elective Compuls Engineering: Elective Comp eering: Elective Compulsory ffic: Elective Compulsory Compulsory pecialisation II. Energy and	y Environmental Enginee		
Credit points Course achievement Examination Examination duration and scale Assignment for the	Yes None Presentation Elaboration and Prese Civil Engineering: Spe Environmental Engine International Manage Joint European Maste	practical work entation (15-25 minutes in ecialisation Structural Eng- ecialisation Geotechnical ecialisation Coastal Engin- ecialisation Water and Tra eering: Core Qualification ement and Engineering: Sp r in Environmental Studie	n groups) ineering: Elective Compuls Engineering: Elective Compusor ffic: Elective Compulsory Compulsory pecialisation II. Energy and s - Cities and Sustainability	pulsory y Environmental Enginee y: Specialisation Energy:		
Credit points Course achievement Examination Examination duration and scale Assignment for the	Yes None Presentation Elaboration and Prese Civil Engineering: Spe Civil Engineering: Spe Civil Engineering: Spe Civil Engineering: Spe Civil Engineering: Spe Environmental Engine International Manage Joint European Maste Water and Environme	practical work entation (15-25 minutes in ecialisation Structural Eng ecialisation Geotechnical ecialisation Coastal Engin- ecialisation Water and Tra eering: Core Qualification ement and Engineering: Sp r in Environmental Studie ental Engineering: Special	n groups) ineering: Elective Compuls Engineering: Elective Comp eering: Elective Compulsory ffic: Elective Compulsory Compulsory pecialisation II. Energy and	pulsory Y Environmental Enginee y: Specialisation Energy: npulsory		

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

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

Module M1720: Emerg	ging Trends in Environmental	Engineering		
Courses				
Title		Тур	Hrs/wk	СР
Environmental Research Trends (L2	.752)	Seminar	2	2
Microplastics in Environment (L275	0)	Lecture	2	2
Scientific Communication and Meth	ods (L2751)	Lecture	1	2
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
<b>Recommended Previous</b>	Basic knowledge on water, soil and environr	mental research.		
Knowledge				
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge	The students will be exposed to up-to-date	research topics focused on soil, water and c	limate related challen	iges with a particula
	focus on the effects of microplastics in env	vironment. Data analysis, data measuremen	t, curation and prese	ntation will be othe
	skills that the students will develop in this m	nodule.		
	abstract, research paper and proposal will be discussed in this module. Moreover, through Research-Based Learning approach the students will be exposed to current research trends in environmental engineering.			earning approache.
Personal Competence				
Social Competence	Developing teamwork and problem solving	skills through Research-Based Teaching appro	oaches will be at the o	core of this module.
A	The students will be involved in writing i	adiated as a set and an extension. This wi		
Autonomy	-	individual reports and presentation. This wi	iii contribute to the s	students ability an
	willingness to work independently and respo	unsibly.		
Workload in Hours	Independent Study Time 110, Study Time in	Lecture 70		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Report and Presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Water and	Traffic: Elective Compulsory		
Following Curricula	Environmental Engineering: Specialisation V	Nater: Elective Compulsory		
	Environmental Engineering: Specialisation V	Naste and Energy: Elective Compulsory		
	Environmental Engineering: Specialisation B	Biotechnology: Elective Compulsory		
	Water and Environmental Engineering: Spec	cialisation Cities: Elective Compulsory		
	Water and Environmental Engineering: Spec	cialisation Environment: Elective Compulsory		
	Water and Environmental Engineering: Spec	cialisation Water: Elective Compulsory		

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

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

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

Courses				
<b>Title</b> Adaptation to climate change in hy	rdraulic engineering (L2291)	<b>Typ</b> Project-/problem-based Learning	Hrs/wk	<b>CP</b> 6
Module Responsible				
Admission Requirements				
Recommended Previous Knowledge	Hydrology, Hydraulic Engineering	od Protection		
Educational Objectives	After taking part successfully, students have reached the follo	wing learning results		
Professional Competence Knowledge Skills	<ul> <li>Climate protection and climate adaptation</li> <li>Insights into climate change and its regional characteri</li> <li>Impacts of climate change on the components of the re</li> <li>Fundamentals of analysis of climate data</li> <li>Consequences of the impact of the climate change</li> <li>Measures for climate adaptation</li> <li>Assessment, prioritization and communication of adapt</li> <li>Fundamentals of the analysis of hydrometeorological and</li> </ul>	gional hydrological cycle ation measures nd hydrological data sessment of needs for action s and adaptation measures		
<b>Personal Competence</b> Social Competence Autonomy	<ul> <li>Working in heterogenous groups</li> <li>Working with different scientific / non-scientific disciplir</li> <li>Self reflection</li> </ul>	nes		
Autonomy	<ul><li>Application oriented use of knowledge and skills</li><li>Autonomous work on complex tasks</li></ul>			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement				
Examination				
Examination duration and scale Assignment for the	······································			
Following Curricula				
	Civil Engineering: Specialisation Structural Engineering: Electi	ve Compulsory		
	Civil Engineering: Specialisation Water and Traffic: Elective Co	ompulsory		
	Water and Environmental Engineering: Specialisation Cities: E			
	Water and Environmental Engineering: Specialisation Environmental			
	Water and Environmental Engineering: Specialisation Water: E	Elective Compulsory		

Course L2291: Adaptation to	climate change in hydraulic engineering
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	WiSe
Content	<ul> <li>Climate protection and climate adaptation</li> <li>Findings on climate change and its regional characteristics: fundamentals of climate change, climate modelling / climate models</li> <li>Impacts of climate change on the components of the regional hydrological cycle(climate science view)</li> <li>Fundamentals of the analysis of climate data</li> <li>Concequences of the impacts of climate change (ingenieering science view)</li> <li>Measures for climate change adaptation</li> <li>Assessment, prioritization and communication of measures</li> <li>Fundamentals of analysis of hydrometeorological and hydrological data</li> </ul>
Literature	Bereitgestellte eLearning Plattform

Courses				
Title	Protection in a Changing Climate (SeaPiaC) (L2926)	<b>Typ</b> Project-/problem-based Learning	Hrs/wk	<b>CP</b> 6
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous Knowledge	<ul> <li>Hydraulic Engineering</li> <li>Hydromechanics, Hydraulics</li> <li>Fundamentals of Coastal Engineering, Coastal- and</li> </ul>	d Flood Protection		
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence Knowledge	<ul> <li>Climate and Climate Change</li> <li>General Impacts of Climate Change on Wind Regin</li> <li>Consequences of Climate Change for Coastal Proce</li> <li>Coastal Protection in Taiwan and Germany</li> <li>Fundamentals of Climate Adaptation</li> <li>Nature-based Solutions (NBS) for Coastal Protection</li> </ul>	esses		
Skills	<ul> <li>Critical thinking: analysis of processes and relation</li> <li>Creative thinking: development of adaptation strai</li> <li>Practical thinking: inclusion of restrictions, applimethods</li> <li>Consideration of complex tasks</li> </ul>	egies and adaptation measures	iods, numerica	al models, plannii
Personal Competence				
Social Competence	<ul> <li>Working in heterogenous groups</li> <li>Working in international groups</li> <li>Working with different scientific / non-scientific dis</li> <li>Self reflection</li> </ul>	ciplines		
Autonomy	<ul><li> Application oriented use of knowledge and skills</li><li> Autonomous work on complex tasks</li></ul>			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
	Preparation of a written report on a complex task with a	a presentation and subsequent discussion	on. The work o	on the complex ta
	happens in the course of the lecture.			
-	Civil Engineering: Specialisation Coastal Engineering: Ele Civil Engineering: Specialisation Geotechnical Engineerin Civil Engineering: Specialisation Structural Engineering: E Civil Engineering: Specialisation Water and Traffic: Election Water and Environmental Engineering: Specialisation Citi	g: Elective Compulsory Elective Compulsory ve Compulsory		
	Water and Environmental Engineering: Specialisation Env Water and Environmental Engineering: Specialisation Wa			

Course L2926: Sustainable N	Course L2926: Sustainable Nature-based Coastal Protection in a Changing Climate (SeaPiaC)		
Тур	Project-/problem-based Learning		
Hrs/wk	4		
СР	6		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Lecturer	Prof. Peter Fröhle		
Language	EN		
Cycle	WiSe		
Content	<ul> <li>Climate and Climate Change</li> <li>General Impacts of Climate Change on Wind Regime and Water Cycle</li> <li>Consequences of Climate Change for Coastal Processes</li> <li>Coastal Protection in Taiwan and Germany</li> <li>Fundamentals of Climate Adaptation</li> <li>Nature-Based Solutions (NBS) for Coastal Protection</li> </ul>		
Literature	Materials provided on eLearning Platform (HOOU Platform)		

#### **Specialization Water**

Module M0801: Water	r Resources and -Supply			
Courses				
Title		Тур	Hrs/wk	СР
Chemistry of Drinking Water Treatm	nent (L0311)	Lecture	2	1
Chemistry of Drinking Water Treatm	nent (L0312)	Recitation Section (large)	1	2
Water Resource Management (L040		Lecture	2	2
Water Resource Management (L040		Recitation Section (small)	1	1
Module Responsible	Prof. Mathias Ernst			
Admission Requirements	None			
<b>Recommended Previous</b>	Knowledge of water management and the	e key processes involved in water treatment.		
Knowledge				
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results		
Professional Competence				
Skills	water supply. They will understand relevant economic, environmental and social factors. Students will be able to explain an outline the organisational structures of water companies. They will be able to explain the available water treatment processes a the scope of their application. Students will be able to assess complex problems in drinking water production and establish solutions involving wat management and technical measures. They will be able to assess the evaluation methods that can be used for this. Students will be able to carry out chemical calculations for selected treatment processes and apply generally accepted technical rules a standards to these processes.			
Personal Competence				
Social Competence	Working in a diverse group of specialists, students will be able to develop and document complex solutions for the manageme and treatment of drinking water. They will be able to take an appropriate professional position, for example representing us interests. They will be able to develop joint solutions in teams of diverse experts and present these solutions to others.			
Autonomy	Students will be in a position to work on a	a subject independently and present on this subjec	t.	
Workload in Hours	Independent Study Time 96, Study Time	in Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 min (chemistry) + presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structura	al Engineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotech			
	Civil Engineering: Specialisation Water an			
	Civil Engineering: Specialisation Coastal E			
		ng: Specialisation II. Energy and Environmental En	gineering: Elective	Compulsory
	Water and Environmental Engineering: Sp			
		pecialisation Environment: Elective Compulsory		
	Water and Environmental Engineering: Sp			

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

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

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

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

2.1.9.1.000				
Module M1716: Subs	urface Processes			
Courses				
Title		Тур	Hrs/wk	СР
Modeling of Subsurface Processes	(L2730)	Lecture	2	2
Modeling of Subsurface Processes	(L2731)	Recitation Section (small)	1	1
Nodern Techniques for Subsurface		Lecture	2	2
Modern Techniques for Subsurface	- -	Recitation Section (large)	1	1
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
<b>Recommended Previous</b>				
Knowledge				
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
	Independent Study Time 96, Study Time in Lecture 84			
Credit points				
Course achievement				
Examination				
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Eng	ineering: Elective Compulsory		
Following Curricula				
-	Civil Engineering: Specialisation Coastal Engine			
	Civil Engineering: Specialisation Water and Tra	• • •		
	Process Engineering: Specialisation Environme	ntal Process Engineering: Elective Compulsory		
	Process Engineering: Specialisation Process En	gineering: Elective Compulsory		
	Water and Environmental Engineering: Special	isation Water: Compulsory		
	Water and Environmental Engineering: Special			
	Water and Environmental Engineering: Special			

Course L2730: Modeling of S	ourse L2730: Modeling of Subsurface Processes	
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	dependent Study Time 32, Study Time in Lecture 28	
Lecturer	Sonja Götz	
Language	EN	
Cycle	WiSe	
Content		
Literature		

Course L2731: Modeling of S	rse L2731: Modeling of Subsurface Processes	
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Sonja Götz	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L2728: Modern Techniques for Subsurface Solute Transport	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Nima Shokri
Language	EN
Cycle	WiSe
Content	
Literature	

Course L2729: Modern Techr	urse L2729: Modern Techniques for Subsurface Solute Transport	
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Hannes Nevermann	
Language	EN	
Cycle	Cycle WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Engineering					
Module M1403: Const	truction and Simulation of S	ewerage Systems			
-					
Courses					
Title		Тур	Hrs/wk	СР	
Construction and renovation of urb		Seminar	3	3 3	
Simulation of sewerage systems (L		Seminar	3	3	
Module Responsible					
Admission Requirements	None				
Recommended Previous	Hydraulics in pipes and gravity-set	wers			
Knowledge	Mechanics				
	Soil mechanics and foundation en	gineering			
	Knowledge about urban sewerage	e systems and water management			
	5	,			
Educational Objectives	After taking part successfully, students h	nave reached the following learning results			
Professional Competence					
Knowledge	Students can describe urban wastewater	r systems by means of software-based modeli	ing. In case studies they	v can perform syste	
	and weak point analyzes. In addition, the	ey can analyze the hydraulic effects quantitati	ively. Furthermore, they	have the knowled	
	to comprehend flow events in gravity-sewers based on the St. Venant equations.				
	Students have knowledge of static and structural requirements of the sower system. Cases of damage are investigated and the				
	Students have knowledge of static and structural requirements of the sewer system. Cases of damage are investigated and the knowledge regarding different renovation technologies for sewer systems is acquired.				
	knowledge regarding different renovation	in technologies for sewer systems is acquired.			
Skills	The students can simulate different run	n-off events in sewer systems and are able to	dimension the sewer	systems according	
	Moreover, they can determine suitable construction materials and static requirements for different cases of applicati		oplication.		
Personal Competence					
Social Competence	Students are able to apply the acquired skills in a team and can impart this knowledge.				
Autonomy	Students can solve problems in the field of wastewater systems independently, concerning in particular dimensioning ar				
simulation of sewer systems. Furthermore, they are able to present and justify their solutions.		5			
	-				
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84				
Credit points	6				
Course achievement		Description			
Evanination					
	Written elaboration				
Examination duration and	nach Absprache				
scale					
•	Civil Engineering: Specialisation Water a				
Following Curricula	Water and Environmental Engineering: S				
	Water and Environmental Engineering: S	pecialisation Environment: Elective Compulso	ry		

Course L1998: Construction	and renovation of urban sewer systems			
Тур	Seminar			
Hrs/wk	3			
СР	3			
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42			
Lecturer	Prof. Ingo Weidlich			
Language				
Cycle				
Content	<ul> <li>The lecture focusses on construction and renovation of urban s</li> <li>Construction: <ul> <li>Pipe materials, types and joint technology</li> <li>Open trenches</li> </ul> </li> </ul>	ewer pipelines.		
	Trenchless technologies Pipe Statics:			
	<ul> <li>Design of sewers according to ATV A 127</li> <li>Earth pressure on pipes, pipe deformation, cutting forces</li> <li>Comparison with other international calculation approact</li> </ul>			
	<ul> <li>Failure case study</li> <li>Overview on the different renovation technologies</li> <li>Liner design according to DWA-A 143</li> </ul>			
Literature	Nr. 1 2	Titel ATV A 127, Abwassertechnische Vereinigung e.V., Arbeitsblatt A 127, Regelwerk Abwasser-Abfall, Vertrieb: GFA, DK 628.22 (083),A 127, 2000 DIN EN 1610, Verlegung und Prüfung von Abwasserleitungen und		
	3	-kanälen, Beuth Verlag, Berlin, 1997 Arbeitsblatt DWA-A 143-1, Sanierung von Entwässerungssystemen außerhalb von Gebäuden, Teil 1: Planung und Überwachung von Sanierungsmaßnahmen Februar		
	4	2015 Arbeitsblatt DWA-A 143-2, Sanierung von Entwässerungssystemen außerhalb von Gebäuden Teil 2: Statische Berechnung zur Sanierung von Abwasserleitungen und -kanälen mit Lining und Montageverfahren, Juli 2015		
	5	DIN EN 752:2008, 2008: Entwässerungssysteme außerhalb von Gebäuden - Kanalmanagement. Zeitschrift 3R, Fachzeitschrift für sichere und effiziente		
	7	Rohrleitungssysteme Handbuch für den Rohrleitungsbau Band 1 und 2, 4. Auflage,		
	8 9	Günter Wossog, 2015 Rohrleitungstechnik, Walter Wagner, Vogel Buchverlag, 2006 Stein D., Stein R., "Instandhaltung von Kanalisationen", 1008 S., ISBN 978-3-9810648-4-1   Verlag Prof. DrIng. Stein & Partner		
	10	GmbH, 2014 Stein, D., "Grabenloser Leitungsbau", 1. Auflage, Gebundene Ausgabe - 1166 Seiten, Ernst & Sohn Verlag, 2003, ISBN: 3433017786		
	11	Willoughby D:A: "Horizontal Directional Drilling: Utility and Pipeline Applications" Digital Engineering Library @ McGraw-Hill The McGraw-Hill Companies, Inc., 2005		
	12	Weidlich I., "Erddruck auf Rohre", 1. Auflage, ISBN 3-89999-027 7, 227 Seiten, 2012		

Course L2006: Simulation of	sewerage systems	
Тур	minar	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Prof. Ralf Otterpohl	
Language	EN	
Cycle	WiSe	
Content	<ul> <li>Modeling of sewer systems:</li> <li>Modeling approaches in wastewater management, especially approaches to integrated modeling</li> <li>Planning processes, calculations and design approaches for elements of gravity-sewers</li> <li>Model setup</li> <li>St. Venant equation and simplifications of models (kinematic wave etc.)</li> <li>Calculation &amp; modeling of solids transport (advection, diffusion, dispersion and sales processes)</li> </ul>	
Literature	Examples for modeling with SWMM (EPA, USA)	

Module M0513: Svste	m Aspects of Renewable Energies			
······································	······································			
Courses				
Title		Тур	Hrs/wk	СР
Fuel Cells, Batteries, and Gas Stora	ge: New Materials for Energy Production and Storage (L0021)	Lecture	2	2
Energy Trading (L0019)		Lecture	1	1
Energy Trading (L0020)		Recitation Section (small)	1	1
Deep Geothermal Energy (L0025)		Lecture	2	2
-	Prof. Martin Kaltschmitt			
Admission Requirements				
	Module: Technical Thermodynamics I			
Knowledge	Module: Technical Thermodynamics II			
Educational Objectives	After taking part successfully, students have reached the fo	llowing learning results		
Professional Competence				
Skills	relation to current subject specific problems. Furthermore, they are able to explain the basics of thermodynamics of electrochemical energy conversion in fuel cells and can establish and explain the relationship to different types of fuel cells and their respective structure. Students can compare this technology with other energy storage options. In addition, students can give an overview of the procedure and the energetic involvement of deep geothermal energy. Students can apply the learned knowledge of storage systems for excessive energy to explain for various energy systems different approaches to ensure a secure energy supply. In particular, they can plan and calculate domestic, commercial and industrial heating equipment using energy storage systems in an energy-efficient way and can assess them in relation to complex power systems. In this context, students can assess the potential and limits of geothermal power plants and explain their operating mode. Furthermore, the students are able to explain the procedures and strategies for marketing of energy and apply it in the context of other modules on renewable energy projects. In this context they can unassistedly carry out analysis and evaluations of energie markets and energy trades.			
Personal Competence				
Social Competence	Students are able to discuss issues in the thematic fields in the renewable energy sector addressed within the module.			
Autonomy	Students can independently exploit sources , acquire the particular knowledge about the subject area and transform it to new questions.			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and				
scale				
Assignment for the	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory			
Following Curricula				
	International Management and Engineering: Specialisation I	I. Energy and Environmental Engir	neering: Elective	Compulsory
	International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory			
	Renewable Energies: Core Qualification: Compulsory			
	Process Engineering: Specialisation Environmental Process I	Engineering: Elective Compulsory		
	Process Engineering: Specialisation Process Engineering: Ele	ective Compulsory		
	Water and Environmental Engineering: Specialisation Water	: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Enviro	nment: Elective Compulsory		

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

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

Course L0020: Energy Tradir	Course L0020: Energy Trading	
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Michael Sagorje, Dr. Sven Orlowski	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

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

Module M0827: Mode	ling in Water Management			
Courses				
Title		Тур	Hrs/wk	СР
Groundwater Modeling using Modfl		Lecture Recitation Section (small)	1 2	1 2
Groundwater Modeling using Modfl Modeling of Water Supply and Sew		Project-/problem-based Learning	2	3
Module Responsible				
Admission Requirements				
Recommended Previous	Groundwater			
Knowledge				
	<ul> <li>groundwater hydraulics and transport of substanc</li> </ul>	es		
	Pipe Systems			
	Knowledge on urban water infrastructures, in particular drinking water systemsand urban drainage systems includir			
	special structures	anticular annihing match systemsana a	insun aramag	
	Hydraulics of drinking water supply systems and sewer systems			
	Basic knowledge on water management			
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence	The taking part succession, stadents have reached the			
	The students are able to describe the modelling of groun	dwater flow and transport as well as urb	an water infra	astructures. They c
	carry out systems analyses and can detect technical and conceptual weak points within the systems in case studies. Besides the			
	are able to analyse interdependencies of hydraulic and toxic phenomena in soil and water.			
Skills	s The students are able to construct and apply scientific groundwater models indipendently. They can work on different scenarios			
	and can compare or assess different solutions for existing problems by application of selected software products. The students are			
	able to use different software solutions (e.g. EPANET, EPA-SWMM).			
Personal Competence				
Social Competence	Wird nicht vermittelt.			
Autonomy	Wird nicht vermittelt.			
Autonomy				
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points				
Course achievement				
Examination				
Examination duration and scale	20 min			
Assignment for the	Civil Engineering: Specialisation Structural Engineering: I	Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Scructural Engineering.			
	Civil Engineering: Specialisation Coastal Engineering: Ele			
	Civil Engineering: Specialisation Water and Traffic: Electi			
	Water and Environmental Engineering: Specialisation Wa			
	Water and Environmental Engineering: Specialisation Environmental	vironment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Cit	ies: Elective Compulsory		

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

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

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

	nemical Engineering			
Courses				
Title		Tun	Hrs/wk	СР
Contaminated Sites and Landfilling	(10906)	<b>Typ</b> Lecture	2	2
Contaminated Sites and Landfilling		Recitation Section (large)	1	2
Geochemical Engineering (L0904)	,	Lecture	2	2
Module Responsible	Dr. Marco Ritzkowski			
Admission Requirements	None			
<b>Recommended Previous</b>	Module: General and Inorganic Chemistry,			
Knowledge	Module:Organic Chemistry,			
	Biology (Basic Knowledge)			
-	After taking part successfully, students have reac	ned the following learning results		
Professional Competence				
Knowledge	With the completion of this module students acc			
	soil and groundwater, and techniques to deposit contaminated waste material. They are able to describe in principle the behaviour			
	of chemicals in the environment. Students can ex	plain and report the approach to remediate	contaminated sit	es.
Skills	With the completion of this module students can apply the acquired theoretical knowledge to model cases of site pollution and			
	critically assess the situation technically and conceptually. They are able to draw comparisons on different remediation strategies			
	and techniques. Model projects can be devised and treated.			
Personal Competence				
Social Competence	Students can discuss technical and scientific task	s within a seminar subject specific and inte	rdisciplinary .	
Autonomy	Students can independently exploit sources , acqu	uire the particular knowledge of the subject	and apply it to ne	ew problems.
Workload in Hours	Independent Study Time 110, Study Time in Lectu	ure 70		
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and	2 hours			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic	: Elective Compulsory		
-	Environmental Engineering: Core Qualification: El			
<b>-</b>	Water and Environmental Engineering: Specialisa			
	Water and Environmental Engineering: Specialisa			
	Water and Environmental Engineering: Specialisa			

Course L0906: Contaminated	l Sites and Landfilling
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Marco Ritzkowski, Dr. Joachim Gerth
Language	EN
Cycle	SoSe
Content	The part Contaminated Sites gives an introduction into different scales of pollution and identifies key pollutants. Geochemical attenuation mechanisms and the role of organisms are highlighted affecting the fate of pollutants in leachate and groundwater. Techniques for site characterization and remediation are discussed including economical aspects. The part Landfilling is introduced by discussing fundamental aspects and the worldwide situation of waste management. The lecture highlights transformation processes in landfill bodies, emissions of gases and leachate, and the long-term behaviour of landfill sites with measures of aftercare.
Literature	<ol> <li>Waste Management. Bernd Bilitewski; Georg Härdtle; Klaus Marek (Eds.), ISBN: 9783540592105, Springer Verlag Lehrbuchsammlung der TUB, Signatur USH-305</li> <li>Solid Waste Technology and Management. Thomas Christensen (Ed.), ISBN: 978-1-4051-7517-3, Wiley Verlag Lesesaal 2: US - Umweltschutz, Signatur USH-332</li> <li>Natural attenuation of fuels and chlorinated solvents in the subsurface. Todd H. Wiedemeier(Ed.), ISBN: 0471197491 Lesesaal 2: US - Umweltschutz, Signatur USH-844</li> </ol>

Course L0907: Contaminated	ourse L0907: Contaminated Sites and Landfilling	
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Dr. Marco Ritzkowski, Dr. Joachim Gerth	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0904: Geochemical	Engineering
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Joachim Gerth
Language	EN
Cycle	SoSe
	As an introduction cases are presented in which geochemical engineering was used to solve environmental problems. Environmentally important minerals are discussed and methods for their detection. It is demonstrated how solution equilibria can be modified to eliminate elevated concentrations of unwanted species in solution and how carbon dioxide concentration affects pH and the dissolution of carbonate minerals. Modifications of redox conditions, pH, and electrolyte concentration are shown to be effective tools for controlling the mobility and fate of hazardous species in the environment.
Literature	<b>Geochemistry, groundwater and pollution.</b> C. A. J. Appelo; D. Postma Leiden [u.a.] Balkema 2005 Lehrbuchsammlung der TUB, Signatur GWC-515

Module M1717: Adva	nced Vadose Zone Hydrolog	1V		
	inced valuose zone riyurolog	<i>3</i>		
Courses				
<b>Fitle</b>		Тур	Hrs/wk	СР
Modeling Processes in Vadose Zone	e (L2734)	Lecture	1	1
Modeling Processes in Vadose Zone	e (L2735)	Recitation Section (small)	1	1
Vadose Zone Hydrology (L2732)		Lecture	2	2
/adose Zone Hydrology (L2733)		Recitation Section (large)	2	2
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
<b>Recommended Previous</b>				
Knowledge				
Educational Objectives	After taking part successfully, students	have reached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 96, Study Time	e in Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water a	and Traffic: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Water a	and Traffic: Elective Compulsory		
	Environmental Engineering: Specialisati	on Water: Elective Compulsory		
	Environmental Engineering: Specialisati	on Water: Elective Compulsory		
	Water and Environmental Engineering:	Specialisation Water: Elective Compulsory		
	Water and Environmental Engineering:	Specialisation Environment: Elective Compulsory		
	Water and Environmental Engineering:	Specialisation Cities: Elective Compulsory		
	Water and Environmental Engineering:	Specialisation Cities: Elective Compulsory		
	Water and Environmental Engineering:	Specialisation Environment: Elective Compulsory		
	Water and Environmental Engineering:	Specialisation Water: Elective Compulsory		

Course L2734: Modeling Processes in Vadose Zone		
Тур	Lecture	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Hannes Nevermann, Prof. Nima Shokri	
Language	EN	
Cycle	SoSe	
Content		
Literature		

Course L2735: Modeling Processes in Vadose Zone		
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Hannes Nevermann	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L2732: Vadose Zone Hydrology		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Nima Shokri	
Language	EN	
Cycle	SoSe	
Content		
Literature		

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

Madula M1710, Multi	shaas Flam in Danses Madia			
Module M1718: Multi	phase Flow in Porous Media			
Courses				
		-		
<b>Fitle</b> Advanced Medeling Techniques for	Multiphase Flow in Porous Media (L2738)	<b>Typ</b> Recitation Section (small)	Hrs/wk 2	<b>СР</b> 2
Fundamentals of Multiphase Flow i	•	Lecture	2	2
Fundamentals of Multiphase Flow i		Recitation Section (large)	2	2
Module Responsible			_	
Admission Requirements				
Recommended Previous				
Knowledge				
2	After taking part successfully, students have read	hed the following learning results		
Professional Competence	······, ·····, ······, ······, ······	····· ································		
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
	Independent Study Time 96, Study Time in Lectur	re 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic	c: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Eng	gineering: Elective Compulsory		
	Civil Engineering: Specialisation Geotechnical Eng	gineering: Elective Compulsory		
	Civil Engineering: Specialisation Water and Traffic	c: Elective Compulsory		
	Environmental Engineering: Specialisation Water:	: Elective Compulsory		
	Environmental Engineering: Specialisation Water:	: Elective Compulsory		
	Water and Environmental Engineering: Specialisa	tion Cities: Elective Compulsory		
	Water and Environmental Engineering: Specialisa	tion Cities: Elective Compulsory		
	Water and Environmental Engineering: Specialisa	tion Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialisa	tion Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialisa	tion Water: Elective Compulsory		
	Water and Environmental Engineering: Specialisa	tion Water: Elective Compulsory		

Course L2738: Advanced Modeling Techniques for Multiphase Flow in Porous Media		
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Nima Shokri	
Language	EN	
Cycle	SoSe	
Content		
Literature		

Course L2736: Fundamentals of Multiphase Flow in Porous Media		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Nima Shokri	
Language	EN	
Cycle	SoSe	
Content		
Literature		

Course L2737: Fundamentals	ourse L2737: Fundamentals of Multiphase Flow in Porous Media		
Тур	Recitation Section (large)		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Hannes Nevermann		
Language	EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Module M1721: Wate	r and Environment: Theory and A	pplication		
Courses				
Title		Тур	Hrs/wk	СР
Water and Environment: Applicatio		Project-/problem-based Learning	3	4
Water and Environment: Theory (L	2753)	Lecture	1	2
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
<b>Recommended Previous</b>				
Knowledge				
Educational Objectives	After taking part successfully, students have read	ched the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 124, Study Time in Lect	ure 56		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Report (about 5-10 pages) and Presentation (abo	ut 15 min)		
scale				
Assignment for the	Civil Engineering: Specialisation Coastal Engineer	ring: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Water and Traffic	c: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineer	ring: Elective Compulsory		
	Civil Engineering: Specialisation Water and Traffic	c: Elective Compulsory		
	Environmental Engineering: Specialisation Water	: Elective Compulsory		
	Environmental Engineering: Specialisation Water	: Elective Compulsory		
	Water and Environmental Engineering: Specialisa	tion Cities: Elective Compulsory		
	Water and Environmental Engineering: Specialisa	tion Cities: Elective Compulsory		
	Water and Environmental Engineering: Specialisa	tion Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialisa	tion Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialisa			
	Water and Environmental Engineering: Specialisa	tion Water: Elective Compulsory		

Course L2754: Water and Environment: Application and Field Work	
Тур	Project-/problem-based Learning
Hrs/wk	3
СР	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Anna Luisa Hemshorn de Sánchez, Dr. Salome Shokri-Kuehni
Language	EN
Cycle	SoSe
Content	
Literature	

Course L2753: Water and Environment: Theory		
Тур	Lecture	
Hrs/wk	1	
СР	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Nima Shokri	
Language	EN	
Cycle	SoSe	
Content		
Literature		

Module M1702: Proce	ss Imaging			
Courses				
Title		Тур	Hrs/wk	СР
Process Imaging (L2723)		Lecture	2	3
Process Imaging (L2724)		Project-/problem-based Learning	2	3
Module Responsible	Prof. Alexander Penn			
Admission Requirements	None			
<b>Recommended Previous</b>				
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follow	ving learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	Bioprocess Engineering: Specialisation A - General Bioprocess E	Engineering: Elective Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation A - General Bioprocess E			
3	Bioprocess Engineering: Specialisation B - Industrial Bioprocess		/	
	Bioprocess Engineering: Specialisation B - Industrial Bioprocess			
	Bioprocess Engineering: Specialisation C - Bioeconomic Proce			Technology: Elective
	Compulsory		·	57
	Bioprocess Engineering: Specialisation C - Bioeconomic Proce	ss Engineering, Focus Energy and	d Bioprocess	Technology: Elective
	Compulsory			
	Chemical and Bioprocess Engineering: Specialisation General P	rocess Engineering: Elective Comp	oulsory	
	Chemical and Bioprocess Engineering: Specialisation General P			
	Chemical and Bioprocess Engineering: Specialisation Bioproces	s Engineering: Elective Compulsor	'y	
	Chemical and Bioprocess Engineering: Specialisation Bioproces			
	Chemical and Bioprocess Engineering: Specialisation Chemical	Process Engineering: Elective Con	npulsory	
	Chemical and Bioprocess Engineering: Specialisation Chemical	Process Engineering: Elective Con	npulsory	
	Computer Science: Specialisation II: Intelligence Engineering: E	lective Compulsory		
	Information and Communication Systems: Specialisation Comm	nunication Systems, Focus Signal F	Processing: Ele	ective Compulsory
	International Management and Engineering: Specialisation II. Pr	rocess Engineering and Biotechnol	logy: Elective	Compulsory
	Theoretical Mechanical Engineering: Specialisation Robotics and	d Computer Science: Elective Com	pulsory	
	Theoretical Mechanical Engineering: Specialisation Robotics and	d Computer Science: Elective Com	pulsory	
	Process Engineering: Specialisation Process Engineering: Election	ve Compulsory		
	Process Engineering: Specialisation Process Engineering: Election	ve Compulsory		
	Process Engineering: Specialisation Chemical Process Engineer	ing: Elective Compulsory		
	Process Engineering: Specialisation Chemical Process Engineer	ing: Elective Compulsory		
	Process Engineering: Specialisation Environmental Process Eng	ineering: Elective Compulsory		
	Process Engineering: Specialisation Environmental Process Eng	ineering: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Environm	ent: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Environm	ent: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Water: El	ective Compulsory		
	Water and Environmental Engineering: Specialisation Water: El	ective Compulsory		

Course L2723: Process Imaging	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Alexander Penn
Language	EN
Cycle	SoSe
Content	
Literature	

Course L2724: Process Imag	Course L2724: Process Imaging	
Тур	Project-/problem-based Learning	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Alexander Penn, Dr. Stefan Benders	
Language	EN	
Cycle	SoSe	
Content		
Literature		

<u> </u>				
Module M0870: Mana	gement of Surface Water			
Courses				
Title		Тур	Hrs/wk	СР
Modelling of Flow in Rivers and Estu		Lecture	3	4
Nature-Oriented Hydraulic Enginee	ring / Integrated Flood Protection (L0961)	Project-/problem-based Lear	ning 2	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
<b>Recommended Previous</b>	Fundamentals of Hydromechanics, Hydraulics, Hyd	rology and Hydraulic Engineering; I	Hydraulic Engineer	ing I and Hydraulic
Knowledge	Engineering II			
<b>Educational Objectives</b>	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	Students are able to define in detail the basic pro	cesses that are related to the mode	lling of flows in hy	draulic engineering.
	Besides, they can describe the basic aspects of num	erical modelling and actual numerical	models for the sin	nulation of flows and
	waves. They can also depict the concepts of nature o	riented hydraulic engineering.		
Chille				
SKIIIS	Students are able to apply hydrodynamic-numerical r able to set up flood-risk management concepts and a		-	
	able to set up noou-lisk management concepts and a	Te able to apply basic concepts of rem		ai problems.
Personal Competence				
Social Competence	The students are able to deploy their gained knowle	dge in applied problems of the practi	cal nature-based hy	draulic engineering.
	Additionaly, they will be able to work in team with en	gineers of other disciplines.		
Autonomy	The students will be able to independently extend the	eir knowledge and apply it to new prob	lems.	
Workload in Hours	Independent Study Time 110, Study Time in Lecture	70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	The duration of the examination is 150 min. The examination is 150 min.	kamination includes tasks with respe	ct to the general u	understanding of the
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Co	ompulsory		
Following Curricula	Environmental Engineering: Core Qualification: Election	ve Compulsory		
	Joint European Master in Environmental Studies - Citie	es and Sustainability: Core Qualificatio	n: Compulsory	
	Water and Environmental Engineering: Specialisation	Water: Compulsory		
	Water and Environmental Engineering: Specialisation	Environment: Compulsory		
	Water and Environmental Engineering: Specialisation	Cities: Elective Compulsory		

Course L0910: Madelline C	Flow in Divorc and Ectuaries
Course L0810: Modelling of I	
Тур	
Hrs/wk CP	
Workload in Hours	
Lecturer	
Language	
Cycle	
	Introduction to numerical flow modelling
	<ul> <li>Processes affecting tht flow</li> <li>Examples and applications of numerical models</li> <li>Procedure of numerical modelling</li> <li>Model concept</li> </ul> Basic equations of hydrodynamics <ul> <li>Saint-Venant equations</li> <li>Euler Equations</li> <li>Navier-Stokes equations</li> <li>Reynolds-averaged Navier-Stokes equations</li> <li>Shallow water equations</li> </ul>
	Solving schemes   Numerical discretization  Solution algorithms  Convergence
Literature	Vorlesungsskript
	<ul> <li>Bund der Ingenieure für Wasserwirtschaft, Abfallwirtschaft und Kulturbau (1997): Hydraulische Berechnung von naturnahen Fließgewässern. Düsseldorf: BWK (BWK-Merkblatt).</li> <li>Chow, Ven-te (1959): Open-channel Hydraulics. New York usw.: McGraw-Hill (McGraw-Hill Civil Engineering Series).</li> <li>Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische Modelle, DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019a): Merkblatt DWA-M 543-2 Geodaten in der Fließgewässermodellierung Teil 1: Geodaten in der Fließgewässermodellierung. Februar 2019. Hennef: Deutsche Vereinigung für Wasser und Abfall (DWA-Regelwerk, 543-1).</li> <li>Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019b): Merkblatt DWA-M 543-2 Geodaten in der Fließgewässermodellierung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019b): Merkblatt DWA-M 543-2 Geodaten in der Fließgewässermodellierung Teil 2: Bedarfsgerechte Datenerfassung und -aufbereitung. Februar 2019. Hennef: Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019b): Merkblatt DWA-M 543-2 Geodaten in der Fließgewässermodellierung Teil 2: Bedarfsgerechte Datenerfassung und -aufbereitung. Februar 2019. Hennef: Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019c): Merkblatt DWA-M 543-3 Geodaten in der Fließgewässermodellierung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019c): Merkblatt DWA-M 543-3 Geodaten in der Fließgewässermodellierung - Teil 3: Aspekte der Strömungsmodellierung und Fallbeispiele. Februar 2019. Hennef: Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (DWA-Regelwerk, 543-3).</li> <li>Hervouet, Jean-Michel</li></ul>
	<ul> <li>IAHR (2015): Professional Specifications for Physical and Numerical Studies in Environmental Hydraulics. In: Hydrolink (3/2015), S. 90-92.</li> <li>Olsen, Nils Reidar B. (2012): Numerical Modelling and Hydraulics. 3. Aufl. Department of Hydraulic and Environmental Engineering, The Norwegian University of Science and Technology.</li> <li>Szymkiewicz, Romuald (2010): Numerical modeling in open channel hydraulics. Dordrecht: Springer (Water science and technology library, 83).</li> <li>van Waveren, Harold (1999-): Good modelling practice handbook. [Utrecht], Lelystad, Den Haag: STOWA; Rijkswaterstaat-RIZA; SDU, afd. SEO/RIZA [etc. distr.] (Nota, nr. 99.036).</li> <li>Zielke, Werner (Hq.) (1999): Numerische Modelle von Flüssen, Seen und Küstengewässern. Deutscher Verband für</li> </ul>
	Wasserwirtschaft und Kulturbau. Bonn: Wirtschafts- und VerlGes. Gas und Wasser (Schriftenreihe des Deutschen Verbandes für Wasserwirtschaft und Kulturbau, 127).

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

Ligineering				
Module M0871: Hydro	logical Systems			
Courses				
Title		Тур	Hrs/wk	СР
Applied Surface Hydrology (L0289)		Lecture	2	2
Applied Surface Hydrology (L1412)		Project-/problem-based Learning	1	2
Interaction Water - Environment in	Fluvial Areas (L0295)	Project-/problem-based Learning	1	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
<b>Recommended Previous</b>	Fundamentals of Hydromechanics and Hydra	aulic Engineering: Hydraulic Engineering I and Hydra	ulic Engineeri	ng II
Knowledge				
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
Knowledge	The students are able to define the basic co	oncepts of hydrology and water management. They	are able to d	lescribe and quantify
	the relevant processes of the hydrological w	ater cycle. Besides, the students know the main as	pects of rainfa	ll-run-off-models and
	are able to theoretically derive established r	eservoir / storage models and a unit-hydrograph.		
Skills	The students are able to use the basic hyperbolic students are able	drological concepts and approaches and are able	to theoreticall	y derive established
	reservoir / storage models or a unit-hydrogi	raph as the basis for rainfall-run-off-models. The stu	ident are able	to explain the basic
	concepts of measurements of hydrological	and hydrodynamic values in nature and are able to	perform, ana	lyze and statistically
	assess these measurements. Furthermore, t	hey are able to apply a hydrological model to basic l	nydrological p	roblems.
Personal Competence				
	The students are able to deploy their gained	knowledge in applied problems of the hydrology an	d water mana	gement. Additionalv
	they will be able to work in team with engine			5
Autonomv	,	xtend their knowledge and apply it to new problems		
,				
Workload in Hours	Independent Study Time 124, Study Time in	Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	The duration of the examination is 90 min. T	he examination includes tasks with respect to the g	eneral underst	anding of the lecture
scale	contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Water and T	raffic: Elective Compulsory		
Following Curricula	Environmental Engineering: Core Qualification	on: Elective Compulsory		
	Joint European Master in Environmental Stud	lies - Cities and Sustainability: Core Qualification: Co	mpulsory	
	Water and Environmental Engineering: Spec	ialisation Water: Elective Compulsory		
	Water and Environmental Engineering: Spec			
	Water and Environmental Engineering: Spec			
		· · · · · · · · · · · · · · · · · · ·		

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

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

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

Engineering				
Module M0874: Wastewater Systems				
Courses				
Title		Тур	Hrs/wk	СР
Wastewater Systems - Collection, T	reatment and Reuse (L0934)	Lecture	2	2
Wastewater Systems - Collection, T		Recitation Section (large)	1	1
Advanced Wastewater Treatment (		Lecture	2	2
Advanced Wastewater Treatment (	L0358)	Recitation Section (large)	1	1
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
<b>Recommended Previous</b>	Knowledge of wastewater management and the k	ey processes involved in wastewater treatm	ient.	
Knowledge				
Educational Objectives	After taking part successfully, students have read	hed the following learning results		
Professional Competence				
Knowledge	Students are able to outline key areas of the full	range of treatment systems in waste water	management, as	well as their mutua
5	dependence for sustainable water protection. The			
Skills	Students are able to pre-design and explain the	available wastewater treatment processes	and the scope of	of their application in
	municipal and for some industrial treatment plant	ts.		
Developed Competence				
Personal Competence				
Social Competence	Social skills are not targeted in this module.			
Autonomy	Students are in a position to work on a subject	and to organize their work flow independ	ently. They can	also present on this
	subject.			
Workload in Hours	Independent Study Time 96, Study Time in Lectur	-e 84		
Credit points				
Course achievement	None			
Examination				
Examination duration and				
scale	120 (1)(1)			
Assignment for the	Civil Engineering: Specialisation Structural Engine	pering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engine	• • •		
ronowing curricula	Civil Engineering: Specialisation Coastal Engineer			
	Civil Engineering: Specialisation Water and Traffic	• • •		
	Bioprocess Engineering: Specialisation Water and Trans		201	
	Environmental Engineering: Specialisation & Ceneral		лу	
	• • •		analogy: Elective	Compulson
	International Management and Engineering: Spec			
	International Management and Engineering: Spec	•, •	ieering: Elective	Compulsory
	Process Engineering: Specialisation Environmenta			
	Process Engineering: Specialisation Process Engin			
	Water and Environmental Engineering: Specialisa			
	Water and Environmental Engineering: Specialisa			
	Water and Environmental Engineering: Specialisa	tion Cities: Compulsory		

#### Course L0934: Wastewater Systems - Collection, Treatment and Reuse

Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Ralf Otterpohl
Language	EN
Cycle	SoSe
Content	•Understanding the global situation with water and wastewater
	•Regional planning and decentralised systems
	•Overview on innovative approaches
	•In depth knowledge on advanced wastewater treatment options for different situations, for end-of-pipe and reuse
	•Mathematical Modelling of Nitrogen Removal
	•Exercises with calculations and design
Literature	Henze, Mogens:
	Wastewater Treatment: Biological and Chemical Processes, Springer 2002, 430 pages
	George Tchobanoglous, Franklin L. Burton, H. David Stensel:
	Wastewater Engineering: Treatment and Reuse, Metcalf & Eddy
	McGraw-Hill, 2004 - 1819 pages

Course L0943: Wastewater S	Course L0943: Wastewater Systems - Collection, Treatment and Reuse	
Тур	Recitation Section (large)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Ralf Otterpohl	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

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

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

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

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

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

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

Course L1066: City Planning	
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Carsten Gertz
Language	DE
Cycle	SoSe
Content	"Principles of Urban Planning" deals with the determinants of urban development and their interactions. Topics include:
	<ul> <li>legal framework,</li> <li>instruments and methods of planning,</li> <li>functional requirements,</li> <li>stakeholders and actors</li> <li>basic design requirements</li> <li>different planning levels and</li> <li>historical contexts.</li> </ul> The objective of the course is for students to acquire a basic understanding of urban development problems and approaches for solving them. They will also be able to comprehend the process of urban planning. The course also covers the various functional and aesthetic requirements for designing streetscape as the most important elements of public space. The project work deals with a real life scenario and includes drawing up a development plan, an urban design concept, a building masterplan and a street redesign.
Literature	Albers, Gerd; Wekel, Julian (2009) Stadtplanung: Eine illustrierte Einführung. Primus Verlag. Darmstadt. Frick, Dieter (2008) Theorie des Städtebaus: Zur baulich-räumlichen Organisation von Stadt. Wasmuth-Verlag. Tübingen Jonas, Carsten (2009) Die Stadt und ihr Grundriss. Wasmuth-Verlag. Tübingen
	Kostof, Spiro; Castillo, Greg (1998) Die Anatomie der Stadt. Geschichte städtischer Strukturen. Campus-Verlag. Frankfurt/New York.

Engineering"				
Module M0663: Marin	e Geotechnics			
Courses				
Title		Тур	Hrs/wk	СР
Marine Geotechnics (L0548)		Lecture	1	2
Marine Geotechnics (L0549)		Recitation Section (large)	2	2
Steel Structures in Foundation and		Lecture	2	2
Module Responsible				
Admission Requirements	None			
<b>Recommended Previous</b>	complete modules: Geotechnics I-III, Mathematics	i I-III		
Knowledge	courses: Soil laboratory course			
Educational Objectives	After taking part successfully, students have reach	hed the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 110, Study Time in Lectu	ure 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Geotechnical Eng	ineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Structural Engine	ering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineeri	ing: Compulsory		
	Theoretical Mechanical Engineering: Specialisation	n Maritime Technology: Elective Compulsory		
	Water and Environmental Engineering: Specialisat	tion Cities: Elective Compulsory		
	Water and Environmental Engineering: Specialisat			
	Water and Environmental Engineering: Specialisat	tion Water: Elective Compulsory		

Course L0548: Marine Geotechnics			
Тур	cture		
Hrs/wk	1		
СР	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Jürgen Grabe		
Language	DE		
Cycle	SoSe		
Content	<ul> <li>Geotechnical investigation an description of the seabed</li> <li>Foundations of Offshore-Constructions</li> <li>cCliff erosion</li> <li>Sea dikes</li> <li>Port structures</li> <li>Flood protection structures</li> </ul>		
Literature	<ul> <li>EAK (2002): Empfehlungen für Küstenschutzbauwerke</li> <li>EAU (2004): Empfehlungen des Arbeitsausschusses Uferbauwerke</li> <li>Poulos H.G. (1988): Marine Geotechnics. Unwin Hyman, London</li> <li>Wagner P. (1990): Meerestechnik: Eine Einführung für Bauingenieure. Ernst &amp; Sohn, Berlin</li> </ul>		

Course L0549: Marine Geotechnics	
Тур	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1146: Steel Structur	ourse L1146: Steel Structures in Foundation and Hydraulic Engineering		
Тур	Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	ank Feindt		
Language	E		
Cycle	Cycle SoSe		
Content	Design of a sheet pile wall, design of a combined sheet pile wall, piles, walings, connections, fatigue		
Literature	EAU 2012, EA-Pfähle, EAB		

Engineering"				
Module M1724: Smar	t Monitoring			
Courses				
<b>Fitle</b>		Тур	Hrs/wk	СР
Smart Monitoring (L2762)		Integrated Lecture	2	2
Smart Monitoring (L2763)		Recitation Section (small)	2	4
Module Responsible	Prof. Kay Smarsly			
Admission Requirements	None			
<b>Recommended Previous</b>	Basic knowledge or interest in object-oriented modeling, p	programming, and sensor technol	ogies are helpfu	I. Interest in mod
Knowledge	research and teaching areas, such as Internet of Things, I	ndustry 4.0 and cyber-physical sy	stems, as well a	is the will to deep
	skills of scientific working, are required. Basic knowledge in	scientific writing and good English	n skills.	
Educational Objectives	After taking part successfully, students have reached the fol	llowing learning results		
	Arter taking part successiony, students have reached the fo			
Professional Competence	The shudents will be seen from the with the spin inter and		The students	
Knowledge	The students will become familiar with the principles and			
	decentralized smart systems to be applied for continuo			
	environment. In addition, the students will learn to design a			
	analysis techniques, modern software design concepts, and		-	
	also part of this module. In small groups, the students "intelligent" sensors to be implemented by the students		-	•
	techniques. The smart monitoring systems will be mounted on scaled lab structures for validation purposes. The outco			
	module will "automatically" participate with their smart n			
	written papers and oral examinations form the final grades.			
	whiteh papers and oral examinations form the initial grades.	The module will be taught in Engl	ISH. EINICED CITO	inferte.
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	10 pages of work with 15-minute oral presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elective	Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: I	Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Electiv	e Compulsory		
	Civil Engineering: Specialisation Structural Engineering: Elec	ctive Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Electiv	ve Compulsory		
	Civil Engineering: Specialisation Geotechnical Engineering: I	Elective Compulsory		
	Civil Engineering: Specialisation Structural Engineering: Elec	ctive Compulsory		
	Civil Engineering: Specialisation Water and Traffic: Elective	Compulsory		
	Environmental Engineering: Specialisation Waste and Energ	y: Elective Compulsory		
	Environmental Engineering: Specialisation Biotechnology: El	ective Compulsory		
	Environmental Engineering: Specialisation Water: Elective C	ompulsory		
	Environmental Engineering: Specialisation Waste and Energ	y: Elective Compulsory		
	Environmental Engineering: Specialisation Biotechnology: El	ective Compulsory		
	Environmental Engineering: Specialisation Water: Elective C	ompulsory		
	Water and Environmental Engineering: Specialisation Cities:	Elective Compulsory		
	Water and Environmental Engineering: Specialisation Cities:			
	Water and Environmental Engineering: Specialisation Enviro	1 5		
	Water and Environmental Engineering: Specialisation Enviro			
	Water and Environmental Engineering: Specialisation Water			
	Water and Environmental Engineering: Specialisation Water	Elective Compulson		

Course L2762: Smart Monitoring		
Тур	Integrated Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Kay Smarsly	
Language	EN	
Cycle	WiSe/SoSe	
Content	In this course, principles of smart monitoring will be taught, focusing on modern concepts of data acquisition, data storage, and data analysis. Also, fundamentals of intelligent sensors and embedded computing will be illuminated. Autonomous software and decentralized data processing are further crucial parts of the course, including concepts of the Internet of Things, Industry 4.0 and cyber-physical systems. Furthermore, measuring principles, data acquisition systems, data management and data analysis algorithms will be discussed. Besides the theoretical background, numerous practical examples will be shown to demonstrate how smart monitoring may advantageously be used for assessing the condition of systems in the built or natural environment.	
Literature		

Course L2763: Smart Monito	ring
Тур	Recitation Section (small)
Hrs/wk	2
СР	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Kay Smarsly
Language	EN
Cycle	WiSe/SoSe
Content	The contents of the exercises are based on the lecture contents. In addition to the exercises, project work will be conducted, which will consume the majority of the workload. As part of the project work, students will design smart monitoring systems that will be tested in the laboratory or in the field. As mentioned in the module description, the students will participate in the "Smart Monitoring" competition, hosted annually by the Institute of Digital and Autonomous Construction. Students are encouraged to contribute their own ideas. The tools required to implement the smart monitoring systems will be taught in the group exercises as well as through external sources, such as video tutorials and literature.
Literature	

Module M1123: Selec	ted Topics in Environmental Eng	Jineering		
Courses				
Title		Тур	Hrs/wk	СР
Environmental Aquatic Chemistry (	L1444)	Lecture	2	3
Excellence in International Project	Delivery (L2387)	Integrated Lecture	2	2
Sludge Treatment (L0520)		Lecture	2	3
Thermal Biomass Utilization (L1767		Lecture	2	2
Thermal Biomass Utilization (L2386	5)	Practical Course	1	1
Module Responsible	Prof. Mathias Ernst			
Admission Requirements	None			
<b>Recommended Previous</b>				
Knowledge				
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
, Autonomy				
Workload in Hours	Depends on choice of courses			
Credit points	6			
Assignment for the	Environmental Engineering: Core Qualification:	Elective Compulsory		
Following Curricula	Water and Environmental Engineering: Special	isation Cities: Elective Compulsory		
	Water and Environmental Engineering: Special	isation Environment: Elective Compulsory		
	Water and Environmental Engineering: Special	isation Water: Elective Compulsorv		

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

Course L2387: Excellence in	International Project Delivery
Тур	Integrated Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	2 h
scale	
Lecturer	Dr. Jens Huckfeldt
Language	EN
Cycle	SoSe
Content	Simply and easy to avoid mistake in project delivery can deliver projects within budget and as per schedule.You
	have to attend if you see yourself in project execution and potentially even abroad.
Literature	

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

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

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

Linginieering							
Module M0620: Speci	al Aspec	ts of W	aste Resource Ma	anagement			
Courses							
Title					Тур	Hrs/wk	СР
Advanced Topics in Waste Resource	e Manageme	nt (L1055)			Project-/problem-based Learning	3	3
International Waste Management (I	L0317)				Project-/problem-based Learning	2	3
Module Responsible	Prof. Kersti	n Kuchta					
Admission Requirements	None						
<b>Recommended Previous</b>	basics in w	aste treatn	nent technologies				
Knowledge							
Educational Objectives	After taking	g part succ	essfully, students have rea	ached the followi	ng learning results		
Professional Competence							
Knowledge	The studer	nts are able	e to describe waste as a r	esource as well	as advanced technologies for re	ecycling and r	ecovery of resources
	from waste	e in detail.	This covers collection, trar	isport, treatment	and disposal in national and inte	ernational con	texts.
Chille	Ctudopto o	ra abla ta c	alast suitable processos f	or the treatment	with respect to the national or c	ultural and do	volonmontal contaut
SKIIIS					of different technologies and m		
	They can e				tor unreferit technologies and m	anagement sy	stems.
Personal Competence							
Social Competence	Students c	an work to	ogether as a team of 2-5	persons, partici	pate in subject-specific and inte	erdisciplinary	discussions, develop
	cooperated solutions and defend their own work results in front of others and promote the scientific development of colleagues						
	Furthermo	re, they car	n give and accept professi	onal constructive	e criticisms.		
Autonomy	Studente e	an indono	adoptly gain additional k	awladge of the	subject area and apply it in so	alving the giv	on course tasks and
Autonomy	projects.	an mueper		lowledge of the	subject area and apply it in so	Jivilig the giv	en course tasks and
	projects.						
Workload in Hours	Independe	nt Study Ti	me 110, Study Time in Leo	cture 70			
Credit points	6						
Course achievement	Compulsory		Form	Description			
	Yes	20 %	Written elaboration				
Examination	Presentatio	on					
Examination duration and	PowerPoint	presentat	ion (10-15 minutes)				
scale							
Assignment for the	-	•	cialisation Water and Traf				
Following Curricula			ering: Specialisation Wast				
					tainability: Specialisation Energy	: Elective Com	pulsory
			ntal Engineering: Specialis				
			ntal Engineering: Specialis				
	Water and	Environme	ntal Engineering: Specialis	sation Cities: Elec	ctive Compulsory		

Course L1055: Advanced Top	pics in Waste Resource Management
Тур	Project-/problem-based Learning
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Rüdiger Siechau
Language	EN
Cycle	WiSe
Content	<ul> <li>Focus of the course "Advanced topics of waste resource management" lies on the organisational structures in waste management - such as planning, financing and logistics. One excursion will be offered to take part in (incineration plant, vehicle fleet and waste collection systems).</li> <li>The course is split into two parts: <ol> <li>part: "Conventional" lecture (development of waste management, legislation, collection, transportation and organisation of waste management, costs, fees and revenues).</li> <li>part: Project base learning: You will get a project to work out in groups of 4 to 6 students; all tools and data you need to work out the project were given before during the conventional lecture. Course documents are published in StudIP and communication during project work takes place via StudIP.</li> </ol> </li> <li>The results of the project work are presented at the end of the semester. The final mark for the course consists of the grade for the presentation.</li> </ul>
Literature	Einführung in die Abfallwirtschaft; Martin Kranert, Klaus Cord-Landwehr (Hrsg.); Vieweg + Teubner Verlag; 2010 PowerPoint slides in Stud IP

Course L0317: International	Waste Management
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Kerstin Kuchta
Language	EN
Cycle	WiSe
Content	Waste avoidance and recycling are the focus of this lecture. Additionally, waste logistics ( Collection, transport, export, fees and taxes) as well as international waste shipment solutions are presented. Other specific wastes, e.g. industrial waste, treatment concepts will be presented and developed by students themselves Waste composition and production on international level, wast eulogistic, collection and treatment in emerging and developing countries. Single national projects and studies will be prepared and presented by students
Literature	Basel convention

Module M0802: Memb	orane Technology			
Courses				
Title		Тур	Hrs/wk	СР
Membrane Technology (L0399) Membrane Technology (L0400)		Lecture Recitation Section (small)	2 1	3 2
Membrane Technology (L0400)		Practical Course	1	1
Module Responsible	Prof Mathias Ernst			_
	None			
Recommended Previous	Basic knowledge of water chemistry. Knowledge of th	e core processes involved in water, gas	and steam treat	nent
Knowledge				
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	Students will be able to rank the technical application the different driving forces behind existing membra membrane filtration and their advantages and disad	ne separation processes. Students wil	I be able to nam	ne materials used i
	membranes in water, other liquid media, gases and ir			erences in the use t
Skills	Students will be able to prepare mathematical equa	tions for material transport in porous a	nd solution-diffu	sion membranes an
	calculate key parameters in the membrane separation	on process. They will be able to handle	technical memb	rane processes usin
	available boundary data and provide recommendat	ions for the sequence of different trea	tment processes	. Through their ow
	experiments, students will be able to classify the			
	membrane materials. Students will be able to charact	erise the formation of the fouling layer i	n different water	s and apply technic
	measures to control this.			
Personal Competence				
Social Competence	Students will be able to work in diverse teams on tas	sks in the field of membrane technology	. They will be ab	le to make decision
	within their group on laboratory experiments to be un	dertaken jointly and present these to ot	hers.	
Autonomy	Students will be in a position to solve homework or	the topic of membrane technology in	dependently. The	w will be capable (
Autonomy	finding creative solutions to technical questions.	The topic of memorane technology in	dependentiy. The	
	Independent Study Time 124, Study Time in Lecture 5	56		
Credit points Course achievement				
Examination				
Examination duration and				
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Ele	ective Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation A - General Bio		ory	
-	Bioprocess Engineering: Specialisation B - Industrial B			
	Chemical and Bioprocess Engineering: Specialisation	Chemical Process Engineering: Elective	Compulsory	
	Chemical and Bioprocess Engineering: Specialisation	General Process Engineering: Elective C	ompulsory	
	Environmental Engineering: Specialisation Water: Elec	ctive Compulsory		
	Joint European Master in Environmental Studies - Citie	es and Sustainability: Specialisation Wat	er: Elective Com	oulsory
	Process Engineering: Specialisation Process Engineeri	ng: Elective Compulsory		
	Process Engineering: Specialisation Environmental Pro			
	Water and Environmental Engineering: Specialisation			
	Water and Environmental Engineering: Specialisation			
	Water and Environmental Engineering: Specialisation	Cities: Elective Compulsory		

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

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

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

Module M0822: Proce	ss Modeling in Water Technolo	ду		
Courses				
Title		Тур	Hrs/wk	СР
Process Modelling of Wastewater T	reatment (L0522)	Project-/problem-based Learning	2	3
Process Modeling in Drinking Water		Project-/problem-based Learning	2	3
Module Responsible	Dr. Klaus Johannsen			
Admission Requirements	None			
<b>Recommended Previous</b>	Knowledge of the most important processes in	n drinking water and waste water treatment.		
Knowledge				
Educational Objectives	After taking part successfully, students have i	reached the following learning results		
<b>Professional Competence</b>				
Knowledge	Students are able to explain selected proces	ses of drinking water and waste water treatment	in detail. The	y are able to explair
	basics as well as possibilities and limitations of	of dynamic modeling.		
Skille	Students are able to use the most important	fostures Medalics offers. They are able to transp	aca calacted	processes in drinking
SKIIIS		features Modelica offers. They are able to transponematical model in Modelica with respect to equilib		
	They are able to set up and apply models and		mum, kinetic	
	They are able to set up and apply models and	assess their possibilities and initiations.		
Personal Competence				
	Students are able to calve problems and doe	ment colutions in a group with members of differs	nt to choical k	ackaround Thou or
Social Competence		Students are able to solve problems and document solutions in a group with members of different technical background. They are able to give appropriate feedback and can work constructively with feedback concerning their work.		
	able to give appropriate reedback and can we	in constructively with reedback concerning their w	JIK.	
A 1				
Autonomy	Students are able to define a problem, gain the	he required knowledge and set up a model.		
Workload in Hours	Independent Study Time 124, Study Time in L	octuro 56		
Credit points				
Course achievement				
Examination				
Examination duration and				
scale				
	Civil Engineering: Specialisation Water and Tr	affic: Elective Compulsory		
-	Environmental Engineering: Specialisation Wa			
		es - Cities and Sustainability: Specialisation Water:	Elective Com	pulsory
		ental Process Engineering: Elective Compulsory		
	Process Engineering: Specialisation Process E			
	Water and Environmental Engineering: Specia			
	Water and Environmental Engineering: Specia			
	Water and Environmental Engineering: Specia	lisation Cities: Elective Compulsory		

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

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

Module M0902: Wast	ewater Treatment and Air Po	Shuton Abatement		
Courses				
Title		Тур	Hrs/wk	СР
Biological Wastewater Treatment (	_0517)	Lecture	2	3
Air Pollution Abatement (L0203)		Lecture	2	3
Module Responsible	Dr. Swantje Pietsch-Braune			
Admission Requirements	None			
<b>Recommended Previous</b>	Basic knowledge of biology and chemistr	у		
Knowledge	Pacie knowledge of colide process onein	paring and constation technology		
	Basic knowledge of solids process engine	eering and separation technology		
Educational Objectives	After taking part successfully, students h	ave reached the following learning results		
Professional Competence				
	After successful completion of the modul	le students are able to		
	<ul> <li>name and explain biological processes for waste water treatment,</li> </ul>			
	characterize waste water and sewage sludge,			
	discuss legal regulations in the area of emissions and air quality			
	explain the effects of air pollutants on the environment,			
	<ul> <li>name and explan off gas tretamer</li> </ul>	nt processes and to define their area of applica	ition	
Skills	Students are able to			
<ul> <li>choose and design processs steps for the biological waste water treatment</li> </ul>				
	<ul> <li>combine processes for cleaning of</li> </ul>	off-gases depending on the pollutants contain	ied in the gases	
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 124, Study Time	e in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water and	nd Traffic: Elective Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation A	- General Bioprocess Engineering: Elective Co	mpulsory	
	Chemical and Bioprocess Engineering: Specialisation General Process Engineering: Elective Compulsory			
	Environmental Engineering: Specialisation Waste and Energy: Elective Compulsory			
	International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory			
	Joint European Master in Environmental S	Studies - Cities and Sustainability: Specialisation	on Water: Elective Comp	oulsory
	Renewable Energies: Specialisation Bioer	nergy Systems: Elective Compulsory		
	Process Engineering: Specialisation Envir	ronmental Process Engineering: Elective Comp	ulsory	
	Process Engineering: Specialisation Proce			
		pecialisation Water: Elective Compulsory		
	Water and Environmental Engineering: S			
	Water and Environmental Engineering: S	pecialisation Cities: Compulsory		

ourse L0517: Biological Wa	rse L0517: Biological Wastewater Treatment		
Тур	Lecture		
Hrs/wk	2		
CP	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Dr. Joachim Behrendt		
Language	DE/EN		
Cycle	WiSe		
Content	Charaterisation of Wastewater		
	Metobolism of Microorganisms		
	Kinetic of mirobiotic processes		
	Calculation of bioreactor for wastewater treatment		
	Concepts of Wastewater treatment		
	Design of WWTP		
	Excursion to a WWTP		
	Biofilms		
	Biofim Reactors		
	Anaerobic Wastewater and sldge treatment		
	resources oriented sanitation technology		
	Future challenges of wastewater treatment		

Literature	Gujer, Willi
	Siedlungswasserwirtschaft : mit 84 Tabellen
	ISBN: 3540343296 (Gb.) URL: http://www.gbv.de/dms/bs/toc/516261924.pdf URL: http://deposit.d-nb.de/cgi-bin/dokserv?
	id=2842122&prov=M&dok_var=1&dok_ext=htm
	Berlin [u.a.] : Springer, 2007
	TUB_HH_Katalog
	Henze, Mogens
	Wastewater treatment : biological and chemical processes
	ISBN: 3540422285 (Pp.)
	Berlin [u.a.] : Springer, 2002
	TUB HH Katalog
	Imhoff, Karl (Imhoff, Klaus R.;)
	Taschenbuch der Stadtentwässerung : mit 10 Tafeln
	ISBN: 3486263331 ((Gb.))
	München [u.a.] : Oldenbourg, 1999
	TUB_HH_Katalog
	Lange, Jörg (Otterpohl, Ralf; Steger-Hartmann, Thomas;)
	Abwasser : Handbuch zu einer zukunftsfähigen Wasserwirtschaft
	ISBN: 3980350215 (kart.) URL: http://www.gbv.de/du/services/agi/52567E5D44DA0809C12570220050BF25/000000700334
	Donaueschingen-Pfohren : Mall-Beton-Verl., 2000
	TUB_HH_Katalog
	Mudrack, Klaus (Kunst, Sabine;)
	TUB_HH_Katalog
	Tchobanoglous, George (Metcalf & Eddy, Inc., ;)
	Wastewater engineering : treatment and reuse
	ISBN: 0070418780 (alk. paper) ISBN: 0071122508 (ISE (*pbk))
	Boston [u.a.] : McGraw-Hill, 2003
	TUB_HH_Katalog
	Henze, Mogens
	Activated sludge models ASM1, ASM2, ASM2d and ASM3
	ISBN: 1900222248
	London : IWA Publ., 2002
	TUB_HH_Katalog
	Kunz, Peter
	Umwelt-Bioverfahrenstechnik
	Vieweg, 1992
	Bauhaus-Universität., Arbeitsgruppe Weiterbildendes Studium Wasser und Umwelt (Deutsche Vereinigung für
	Wasserwirtschaft, Abwasser und Abfall, ;)
	Abwasserbehandlung : Gewässerbelastung, Bemessungsgrundlagen, Mechanische Verfahren, Biologische Verfahren, Reststoffe
	aus der Abwasserbehandlung, Kleinkläranlagen
	ISBN:         3860682725         URL:         http://www.gbv.de/dms/weimar/toc/513989765_toc.pdf         URL:
	http://www.gbv.de/dms/weimar/abs/513989765_abs.pdf
	Weimar : Universitätsverl, 2006
	TUB_HH_Katalog
	Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall
	DWA-Regelwerk
	Hennef : DWA, 2004
	TUB_HH_Katalog
	Wiesmann, Udo (Choi, In Su; Dombrowski, Eva-Maria;)
	Fundamentals of biological wastewater treatment
	ISBN: 3527312196 (Gb.) URL: http://deposit.ddb.de/cgi-bin/dokserv?id=2774611&prov=M&dok_var=1&dok_ext=htm
	Weinheim : WILEY-VCH, 2007
	TUB_HH_Katalog
	Tchobanoglous, George (Metcalf & Eddy, Inc., ;)   Wastewater engineering : treatment and reuse   ISBN: 0070418780 (alk, paper) ISBN: 0071122508 (iSE (*pbk))   Boston (u.a.] : McGraw-Hill, 2003   TUB_HH_katalog   Henze, Mogens   Activated sludge models ASM1, ASM2, ASM2d and ASM3   ISBN: 190022248   London : IWA Publ., 2002   TUB_HH_Katalog   Kunz, Peter   Umwelt-Bioverfahrenstechnik   Vieweg, 1992   Bauhau-Universität, Arbeitsgruppe Weiterbildendes Studium Wasser und Umwelt (Deutsche Vereinigung fü   Wasserwirtschaft, Abwasser und Abfall, :)   Abwasserbehandlung : Gewässerbelastung, Bemessungsgrundlagen, Mechanische Verfahren, Biologische Verfahren, Reststoffe   aus der Abwasserbehandlung : Gewässerbelastung, Bemessungsgrundlagen, Mechanische Verfahren, Biologische Verfahren, Reststoffe   aus der Abwasserbehandlung : Gewässerbelastung, Bemessungsgrundlagen, Mechanische Verfahren, Biologische Verfahren, Reststoffe   Bankau-Universitätsverl, 2006   TUB_HH_katalog   Duetsche Vereinigung für Wasservirtschaft, Abwasser und Abfall   DWA-Regelwerk   Hennef : DWA, 2004   TUB_HH_katalog   Weismann, Udo (Choi, In Su; Dombrowski, Eva-Maria;)   Fundamentals of biological wastewater treatment   ISBN: 3257312196 (Gb.) URL: http://deposit.ddb.de/cgi-bin/dokserv?id=2774611&prov=M&dok_var=1&dok_ext=htm   Weinheim : WILEY-VCH, 2007

Course L0203: Air Pollution	Abatement
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Swantje Pietsch-Braune, Christian Eichler
Language	EN
Cycle	WiSe
Content	In the lecture methods for the reduction of emissions from industrial plants are treated. At the beginning a short survey of the different forms of air pollutants is given. In the second part physical principals for the removal of particulate and gaseous pollutants form flue gases are treated. Industrial applications of these principles are demonstrated with examples showing the removal of specific compounds, e.g. sulfur or mercury from flue gases of incinerators.
Literature	Handbook of air pollution prevention and control, Nicholas P. Cheremisinoff Amsterdam [u.a.] : Butterworth-Heinemann, 2002 Atmospheric pollution : history, science, and regulation, Mark Zachary Jacobson Cambridge [u.a.] : Cambridge Univ. Press, 2002 Air pollution control technology handbook, Karl B. Schnelle Boca Raton [u.a.] : CRC Press, c 2002 Air pollution, Jeremy Colls 2. ed London [u.a.] : Spon, 2002

	rated Transportation Planning
Courses	
Title	Typ Hrs/wk CP
Integrated Transportation Planning	(L1068) Project-/problem-based Learning 4 6
Module Responsible	Prof. Carsten Gertz
Admission Requirements	None
Recommended Previous	some knowledge of transport planning, e.g. through taking the undergraduate class "Transport Planning and Traffic Engineerin
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to:
-	
	describe interdependencies between land-use/location choice and transportation/mobility behaviour
	• explain and evaluate the social, ecological and economic effects of transport and land-use policy measures.
	<ul> <li>relate current issues in the area of integrated transport planning and formulate an opinion on them.</li> </ul>
Skills	Students are able to:
	<ul> <li>quantify important parameters, which influence travel demand or are influenced by it.</li> </ul>
	• comprehensively examine a pre-defined or self-selected topic from a transportation studies perspective and document t
	results in accordance with scientific conventions.
Personal Competence	
Social Competence	Students are able to:
	<ul> <li>provide feedback on topical contents and their teaching.</li> <li>constructively bandle feedback on their own work.</li> </ul>
	<ul> <li>constructively handle feedback on their own work.</li> <li>produce results in group work and document these.</li> </ul>
	• produce results in group work and document these.
Autonomy	Students are able to:
	assess potential consequences of their future professional activities
	<ul> <li>independently plan working on a pre-defined project topic, acquire the necessary knowledge and use appropriate means</li> </ul>
	its execution.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written elaboration
Examination duration and	written assignment with presentation during the semester
scale	
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory
	Civil Engineering: Specialisation Water and Traffic: Compulsory
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure and Mobility: Elective Compulsory
	Water and Environmental Engineering: Specialisation Water: Elective Compulsory
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory
	Water and Environmental Engineering: Specialisation Cities: Compulsory

Course L1068: Integrated Tr	ansportation Planning
Тур	Project-/problem-based Learning
Hrs/wk	4
CP	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Carsten Gertz, Dr. Philine Gaffron, Jacqueline Bianca Maaß
Language	DE
Cycle	WiSe
Content	The course will provide students with an understanding of interdependencies between land-use and transportation. Specific topics include a.o.:    interactions between transport and the environment and consequent limitations  characteristics of integrated planning  complex planning processes  interdependencies of location choice and mobility behaviour  transport and land-use policies  project on current issues in transportation studies
Literature	Kutter, Eckhard (2005) Entwicklung innovativer Verkehrsstrategien für die mobile Gesellschaft. Erich Schmidt Verlag. Berlin. Bracher, Tilman u. a. (Hrsg.) (68. Ergänzung 2013) Handbuch der kommunalen Verkehrsplanung. Herbert Wichmann Verlag. Berlin, Offenbach. (Loseblattsammlung mit kontinuierlichen Ergänzungen)

Courses			
Title	Тур	Hrs/wk CP	
Module Responsible	Dozenten des SD B		
Admission Requirements	None		
<b>Recommended Previous</b>			
Knowledge			
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
Knowledge	<i>ledge</i> The students are able to demonstrate their detailed knowledge in the field of Water and Environmental Engineering. exemplify the state of technology and application and discuss critically in the context of actual problems and general conscience and society.		
	The students can develop solving strategies and approaches for fundamental and Environmental Engineering. They may apply theory based procedures and integ economic view points of science and society.		
	Scientific work techniques that are used can be described and critically reviewed.		
Skills	The students are able to independently select methods or planning approaches for the project work and to justify their choice. They can explain how these methods or approaches relate to solutions in the field of work and how the context of application ha to be adjusted. General findings and further developments may essentially be outlined.		
Personal Competence			
Social Competence	The students are able to condense the relevance and the structure of the project we the presentation and discussion in front of a bigger group. They can lead the discussion colleagues.		
Autonomy	The students are capable of independently planning and documenting the work steps and procedures while considering the give deadlines. This includes the ability to accurately procure the newest scientific information. Furthermore, they can obtain feedbac from experts with regard to the progress of the work, and to accomplish results on the state of the art in science and technology.		
Workload in Hours	Independent Study Time 180, Study Time in Lecture 0		
Credit points	6		
Course achievement	None		
Examination	Study work		
Examination duration and			
scale			
Assignment for the	Water and Environmental Engineering: Specialisation Water: Compulsory		
Following Curricula			

Module M0949: Rural	Development and Resources Oriented	I Sanitation for diffe	erent Climate Zon	es
Courses				
Title		Тур	Hrs/wk	СР
Rural Development and Resources	Oriented Sanitation for different Climate Zones (L0942)	Seminar	2	3
Rural Development and Resources	Oriented Sanitation for different Climate Zones (L0941)	Lecture	2	3
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
<b>Recommended Previous</b>	Basic knowledge of the global situation with rising poverty, soil degradation, lack of water resources and sanitation			
Knowledge				
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
<b>Professional Competence</b>				
Knowledge	Students can describe resources oriented wastewater	systems mainly based on sou	urce control in detail. The	ey can comment or
	techniques designed for reuse of water, nutrients and so	oil conditioners.		
	Students are able to discuss a wide range of proven app	roaches in Pural Developmen	t from and for many regio	ons of the world
	students are able to discuss a wide range of proven app	rodenes in Nara Developmen	c nom and for many regic	ins of the world.
Skills	Students are able to design low-tech/low-cost sanitat	ion, rural water supply, rainv	water harvesting systems	s, measures for the
	rehabilitation of top soil quality combined with food and	water security. Students can	consult on the basics of s	soil building through
	"Holisitc Planned Grazing" as developed by Allan Savory	ι.		
Personal Competence				
•	The students are able to develop a specific topic in a tea	am and to work out milestones	s according to a given pla	n.
,	· · · · · · · · · · · · · · · · · · ·		, , , , , , , , , , , , , , , , , , ,	
Autonomy	Students are in a position to work on a subject and t	o organize their work flow in	ndependently. They can a	also present on this
	subject.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	During the course of the semester, the students work t	owards mile stones. The work	c includes presentations a	and papers. Detailed
scale	information will be provided at the beginning of the sme	ester.		
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elect	ive Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation A - General Biopr	ocess Engineering: Elective C	ompulsory	
	Chemical and Bioprocess Engineering: Specialisation Ge	neral Process Engineering: Ele	ective Compulsory	
	Environmental Engineering: Specialisation Water: Election	ve Compulsory		
	International Management and Engineering: Specialisati	on II. Energy and Environment	tal Engineering: Elective (	Compulsory
	Joint European Master in Environmental Studies - Cities	and Sustainability: Specialisat	ion Water: Elective Comp	ulsory
	Process Engineering: Specialisation Environmental Proce	ess Engineering: Elective Com	pulsory	
	Process Engineering: Specialisation Process Engineering	: Elective Compulsory		
	Water and Environmental Engineering: Specialisation W	ater: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Er	vironment: Elective Compulso	ory	
	Water and Environmental Engineering: Specialisation Ci	ties: Elective Compulsory		

Course L0942: Rural Development and Resources Oriented Sanitation for different Climate Zones		
Тур	Seminar	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Ralf Otterpohl	
Language	EN	
Cycle	WiSe	
Content		
	<ul> <li>Central part of this module is a group work on a subtopic of the lectures. The focus of these projects will be based on an interview with a target audience, practitioners or scientists.</li> <li>The group work is divided into several Milestones and Assignments. The outcome will be presented in a final presentation at the end of the semester.</li> </ul>	
Literature	<ul> <li>J. Lange, R. Otterpohl 2000: Abwasser - Handbuch zu einer zukunftsfähigen Abwasserwirtschaft. Mallbeton Verlag (TUHH Bibliothek)</li> <li>Winblad, Uno and Simpson-Hébert, Mayling 2004: Ecological Sanitation, EcoSanRes, Sweden (free download)</li> <li>Schober, Sabine: WTO/TUHH Award winning Terra Preta Toilet Design: http://youtu.be/w_R09cYq6ys</li> </ul>	

Course L0941: Rural Develop	ment and Resources Oriented Sanitation for different Climate Zones
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Ralf Otterpohl
Language	EN
Cycle	WiSe
Content	<ul> <li>Living Soil - THE key element of Rural Development</li> <li>Participatory Approaches</li> <li>Rainwater Harvesting</li> <li>Ecological Sanitation Principles and practical examples</li> <li>Permaculture Principles of Rural Development</li> <li>Performance and Resilience of Organic Small Farms</li> <li>Going Further: The TUHH Toolbox for Rural Development</li> <li>EMAS Technologies, Low cost drinking water supply</li> </ul>
Literature	<ul> <li>Miracle Water Village, India, Integrated Rainwater Harvesting, Water Efficiency, Reforestation and Sanitation: http://youtu.be/9hmkgn0nBgk</li> <li>Montgomery, David R. 2007: Dirt: The Erosion of Civilizations, University of California Press</li> </ul>

Engineering"				
Module M0581: Wate	r Protection			
Courses				
Title		Тур	Hrs/wk	СР
Water Protection and Wastewater I	Management (L0226)	Lecture	3	3
Water Protection and Wastewater I	Management (L2008)	Project Seminar	3	3
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
<b>Recommended Previous</b>	. Desis luceula des in weber secondatement			
Knowledge	<ul> <li>Basic knowledge in water management</li> <li>Good knowledge in urban drainage;</li> </ul>	,		
	<ul><li>Good knowledge in urban drainage;</li><li>Good knowledge of wastewater treatment</li></ul>	ant techniques:		
	<ul> <li>Good knowledge of pollutants (e.g. COE</li> </ul>			
	e coou knowledge of politicants (e.g. cor			
Educational Objectives	After taking part successfully, students have r	eached the following learning results		
Professional Competence				
Knowledge	The students can describe the basic principles	s of the regulatory framework related to the	international and Eu	ropean water secto
	They can explain limnological processes, su			
	problems related to water protection, such a		tment with a special	focus on innovati
	solutions, remediation measures as well as co	nceptual approaches.		
Skills	Students can accurately assess current proble	ems and situations in a country-specific or	local context. They o	an suggest concre
	actions to contribute to the planning of ton	norrow's urban water cycle. Furthermore,	they can suggest a	opropriate technica
	administrative and legislative solutions to solu	ve these problems.		
Personal Competence				
Personal Competence	The students can work together in internation	al groups		
Social Competence		al groups.		
Autonomy	Students are able to organize their work flow	to prepare presentations and discussions.	They can acquire ap	propriate knowled
	by making enquiries independently.			
Workload in Hours	Independent Study Time 06 Study Time in Le	cture 94		
	Independent Study Time 96, Study Time in Le			
Credit points Course achievement				
Examination	Presentation			
	Term paper plus presentation			
scale				
Scale				
Assignment for the	Civil Engineering: Specialisation Structural Eng	gineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical	Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engin	eering: Elective Compulsory		
	Civil Engineering: Specialisation Water and Tra	affic: Elective Compulsory		
	Environmental Engineering: Specialisation Wa			
	International Management and Engineering: S			
	Joint European Master in Environmental Studie		Water: Elective Comp	oulsory
	Water and Environmental Engineering: Specia			
	Water and Environmental Engineering: Specia			
	Water and Environmental Engineering: Specia	insation Environment: Compulsory		

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

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

Module M1720: Emerg	ging Trends in Environmental	Engineering		
Courses				
Title		Тур	Hrs/wk	СР
Environmental Research Trends (L2	752)	Seminar	2	2
Microplastics in Environment (L275	0)	Lecture	2	2
Scientific Communication and Meth	ods (L2751)	Lecture	1	2
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
<b>Recommended Previous</b>	Basic knowledge on water, soil and environ	mental research.		
Knowledge				
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge	The students will be exposed to up-to-date	research topics focused on soil, water and c	limate related challen	ges with a particula
-		vironment. Data analysis, data measuremen		
	skills that the students will develop in this n			
	s Students' research skills will be improved in this module. How to prepare and deliver an effective presentation, how to write a abstract, research paper and proposal will be discussed in this module. Moreover, through Research-Based Learning approaches the students will be exposed to current research trends in environmental engineering.			
Personal Competence				
Social Competence	Developing teamwork and problem solving	skills through Research-Based Teaching appr	oaches will be at the o	core of this module.
Autonomy	The students will be involved in writing i	ndividual reports and presentation. This wi	ill contribute to the s	students' ability an
	willingness to work independently and respo			,
		,		
Workload in Hours	Independent Study Time 110, Study Time in	n Lecture 70		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Report and Presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Water and	Traffic: Elective Compulsory		
Following Curricula	Environmental Engineering: Specialisation V	Nater: Elective Compulsory		
	Environmental Engineering: Specialisation V	Naste and Energy: Elective Compulsory		
	Environmental Engineering: Specialisation E	Biotechnology: Elective Compulsory		
	Water and Environmental Engineering: Spec	cialisation Cities: Elective Compulsory		
	Water and Environmental Engineering: Spec	cialisation Environment: Elective Compulsory		
	Water and Environmental Engineering: Spec	cialisation Water: Elective Compulsory		

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

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

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

Courses				
Гitle		Тур	Hrs/wk	СР
Sustainable Nature-based Coastal I	Protection in a Changing Climate (SeaPiaC) (L2926)	Project-/problem-based Learning	4	6
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
<b>Recommended Previous</b>	Hydraulic Engineering			
Knowledge	Hydradic Engliseting     Hydromechanics, Hydraulics			
	<ul> <li>Fundamentals of Coastal Engineering, Coastal- ar</li> </ul>	d Flood Protection		
	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	Climate and Climate Change			
	General Impacts of Climate Change on Wind Regi	me and Water Cycle		
	Consequences of Climate Change for Coastal Pro	esses		
	Coastal Protection in Taiwan and Germany			
	Fundamentals of Climate Adaptation			
	Nature-based Solutions (NBS) for Coastal Protecti	on		
Skills				
	<ul> <li>Critical thinking: analysis of processes and relation</li> </ul>			
	Creative thinking: development of adaptation stra	•		
	<ul> <li>Practical thinking: inclusion of restrictions, appl</li> </ul>	cation of calculation approaches, meth	iods, numerica	al models, plannir
	methods			
	Consideration of complex tasks			
Personal Competence				
Social Competence	Working in hotorogonous groups			
	<ul><li>Working in heterogenous groups</li><li>Working in international groups</li></ul>			
	Working in international groups     Working with different scientific / non-scientific di	sciplines		
	<ul> <li>Self reflection</li> </ul>			
Autonomy	<ul> <li>Application oriented use of knowledge and skills</li> </ul>			
	Autonomous work on complex tasks			
	· · · · · · · · · · · · · · · · · · ·			
	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement				
	Written elaboration			
	Preparation of a written report on a complex task with	a presentation and subsequent discussion	on. The work o	on the complex ta
	happens in the course of the lecture.			
-				
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Civil Engineering: Specialisation Structural Engineering:	5 1 5		
	Civil Engineering: Specialisation Vater and Traffic: Elect			
	Water and Environmental Engineering: Specialisation Ci			
	Water and Environmental Engineering: Specialisation En			
	Water and Environmental Engineering: Specialisation W			

Course L2926: Sustainable Nature-based Coastal Protection in a Changing Climate (SeaPiaC)	
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Peter Fröhle
Language	EN
Cycle	WiSe
Content	<ul> <li>Climate and Climate Change</li> <li>General Impacts of Climate Change on Wind Regime and Water Cycle</li> <li>Consequences of Climate Change for Coastal Processes</li> <li>Coastal Protection in Taiwan and Germany</li> <li>Fundamentals of Climate Adaptation</li> <li>Nature-Based Solutions (NBS) for Coastal Protection</li> </ul>
Literature	Materials provided on eLearning Platform (HOOU Platform)

Courses				
<b>Title</b> Adaptation to climate change in hy	draulic engineering (L2291)	<b>Typ</b> Project-/problem-based Learning	Hrs/wk 4	<b>СР</b> 6
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous Knowledge	<ul> <li>Hydrology, Hydraulic Engineering</li> <li>Hydromechanic, Hydraulics</li> <li>Fundamentals of Coastal Engineering</li> <li>Hydrological Systems</li> </ul>	, Coastal- and Flood Protection		
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Knowledge Skills	<ul> <li>Impacts of climate change on the cor</li> <li>Fundamentals of analysis of climate of</li> <li>Consequences of the impact of the cl</li> <li>Measures for climate adaptation</li> <li>Assessment, prioritization and comm</li> <li>Fundamentals of the analysis of hydri</li> <li>Critical thinking: analysis of processe</li> <li>Creative thinking: development of ad</li> </ul>	egional characteristics - fundamentals, climate model nponents of the regional hydrological cycle data imate change unication of adaptation measures		
<b>Personal Competence</b> Social Competence Autonomy	<ul> <li>Working in heterogenous groups</li> <li>Working with different scientific / non</li> <li>Self reflection</li> <li>Application oriented use of knowledge</li> </ul>			
	Autonomous work on complex tasks			
Workload in Hours	Independent Study Time 124, Study Time in	1 Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and scale	Preparation of a written report and a presen	tation of a complex task.		
Assignment for the	Civil Engineering: Specialisation Coastal Eng			
Following Curricula	Civil Engineering: Specialisation Geotechnic			
	Civil Engineering: Specialisation Structural E			
	Civil Engineering: Specialisation Water and			
	Water and Environmental Engineering: Spec	cialisation Cities: Elective Compulsory cialisation Environment: Elective Compulsory		
	water and Environmental Engineering: Spec			

Course L2291: Adaptation to	climate change in hydraulic engineering
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	WiSe
Content	<ul> <li>Climate protection and climate adaptation</li> <li>Findings on climate change and its regional characteristics: fundamentals of climate change, climate modelling / climate models</li> <li>Impacts of climate change on the components of the regional hydrological cycle(climate science view)</li> <li>Fundamentals of the analysis of climate data</li> <li>Concequences of the impacts of climate change (ingenieering science view)</li> <li>Measures for climate change adaptation</li> <li>Assessment, prioritization and communication of measures</li> <li>Fundamentals of analysis of hydrometeorological and hydrological data</li> </ul>
Literature	Bereitgestellte eLearning Plattform

Thesis

	r Thesis			
Courses				
Title	Тур	Hrs/wk CP		
Module Responsible	Professoren der TUHH			
Admission Requirements	According to Consul Devulations \$21 (1).			
	According to General Regulations §21 (1):			
	At least 60 credit points have to be achieved in study programme. The examinati	ions board decides on exceptions.		
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge				
	<ul> <li>The students can use specialized knowledge (facts, theories, and methods) o issues.</li> </ul>	f their subject competently on special		
	<ul> <li>The students can explain in depth the relevant approaches and terminologie</li> </ul>	es in one or more areas of their sub		
	describing current developments and taking up a critical position on them.			
	• The students can place a research task in their subject area in its context and	I describe and critically assess the stat		
	research.			
Skills	The students are able:			
	• To select, apply and, if necessary, develop further methods that are suitable for s	solving the specialized problem in quest		
	• To apply knowledge they have acquired and methods they have learnt in the	• • • •		
	incompletely defined problems in a solution-oriented way.			
	• To develop new scientific findings in their subject area and subject them to a criti	ical assessment.		
Devenuel Composition of				
Personal Competence Social Competence	Students can			
Social competence				
	Both in writing and orally outline a scientific issue for an expert audience accu	rately, understandably and in a struct		
	way.			
	<ul> <li>Deal with issues competently in an expert discussion and answer them in a manufacture to the insure operation of the insure operation.</li> </ul>	inner that is appropriate to the address		
	while upholding their own assessments and viewpoints convincingly.			
Autonomy	Students are able:			
	• To structure a project of their own in work packages and to work them off accord			
	<ul> <li>To work their way in depth into a largely unknown subject and to access the infor</li> </ul>			
	<ul> <li>To apply the techniques of scientific work comprehensively in research of their or</li> </ul>	wn.		
Workload in Hours	Independent Study Time 900, Study Time in Lecture 0			
Credit points	30			
Course achievement	None			
Examination	Thesis			
Examination duration and	According to General Regulations			
scale				
•	Civil Engineering: Thesis: Compulsory			
Following Curricula	Bioprocess Engineering: Thesis: Compulsory			
	Chemical and Bioprocess Engineering: Thesis: Compulsory			
	Computer Science: Thesis: Compulsory Electrical Engineering: Thesis: Compulsory			
	Electrical Engineering: Thesis: Compulsory Energy Systems: Thesis: Compulsory			
	Energy Systems: Thesis: Compulsory Environmental Engineering: Thesis: Compulsory			
	Aircraft Systems Engineering: Thesis: Compulsory			
	Global Innovation Management: Thesis: Compulsory			
	Computer Science in Engineering: Thesis: Compulsory			
	Information and Communication Systems: Thesis: Compulsory			
	Interdisciplinary Mathematics: Thesis: Compulsory			
	International Production Management: Thesis: Compulsory			
	International Management and Engineering: Thesis: Compulsory			
	Joint European Master in Environmental Studies - Cities and Sustainability: Thesis: Comp	JUISOTV		
	Logistics Infrastructure and Mobility Thesis: Compulser:			
	Logistics, Infrastructure and Mobility: Thesis: Compulsory Materials Science: Thesis: Compulsory			
	Logistics, Infrastructure and Mobility: Thesis: Compulsory Materials Science: Thesis: Compulsory Mechanical Engineering and Management: Thesis: Compulsory			

Module Man	nual M.Sc. "Water and Environmental	
Engineering		
	Mechatronics: Thesis: Compulsory	
	Biomedical Engineering: Thesis: Compulsory	
	Microelectronics and Microsystems: Thesis: Compulsory	
	Product Development, Materials and Production: Thesis: Compulsory	
	Renewable Energies: Thesis: Compulsory	
	Naval Architecture and Ocean Engineering: Thesis: Compulsory	
	Ship and Offshore Technology: Thesis: Compulsory	
	Teilstudiengang Lehramt Metalltechnik: Thesis: Compulsory	
	Theoretical Mechanical Engineering: Thesis: Compulsory	
	Process Engineering: Thesis: Compulsory	
	Water and Environmental Engineering: Thesis: Compulsory	
	Certification in Engineering & Advisory in Aviation: Thesis: Compulsory	