

Module Manual

Master of Science (M.Sc.)

Water and Environmental Engineering

Cohort: Winter Term 2021

Updated: 31st May 2023

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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 and 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	Prof. Matthias Meyer
Admission Requirements	None
Recommended Previous	None
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	 Students are able to find their way around selected special areas of management within the scope of business managemer Students are able to explain basic theories, categories, and models in selected special areas of business management. Students are able to interrelate technical and management knowledge.
Skills	 Students are able to apply basic methods in selected areas of business management. Students are able to explain and give reasons for decision proposals on practical issues in areas of business management.
Personal Competence	
Social Competence	Students are able to communicate in small interdisciplinary groups and to jointly develop solutions for complex problems
Autonomy	Students are capable of acquiring necessary knowledge independently by means of research and preparation of material.
Workload in Hours	Depends on choice of courses
Credit points	6

Courses

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

Module M0524: Non-technical Courses for Master

Module	Responsible	Dagmar	Rich

Admission Requirements None

Recommended Previous None

Knowledge

Educational Objectives After taking part successfully, students have reached the following learning results

Professional 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 fully. Self-reliance, self-management, collaboration and professional and personnel management competences. The department implements these training objectives in its teaching architecture, in its teaching and learning arrangements, in teaching areas and by means of teaching offerings in which students can qualify by opting for specific competences and a competence level at the Bachelor's or Master's level. The teaching offerings are pooled in two different catalogues for nontechnical complementary courses.

The Learning Architecture

consists of a cross-disciplinarily study offering. The centrally designed teaching offering ensures that courses in the nontechnical academic programms follow the specific profiling of TUHH degree courses.

The learning architecture demands and trains independent educational planning as regards the individual development of 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 one to two semesters. In view of the adaptation problems that individuals commonly face in their first semesters after making the transition from school to university and in order to encourage individually planned semesters abroad, there is no obligation to 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 dealing with interdisciplinarity and a variety of stages of learning in courses are part of the learning architecture and are deliberately 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 winter semester 2014/15 students on all Bachelor's courses will have the opportunity to learn about business management and start-ups 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 goaloriented 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. These differences are reflected in the practical examples used, in content topics that refer to different professional application contexts, 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 leadership functions of Bachelor's and Master's graduates in their future working life.

Specialized Competence (Knowledge)

Students can

- · explain specialized areas in context of the relevant non-technical disciplines,
- outline basic theories, categories, terminology, models, concepts or artistic techniques in the disciplines represented in the learning area.
- different specialist disciplines relate to their own discipline and differentiate it as well as make connections,
- sketch the basic outlines of how scientific disciplines, paradigms, models, instruments, methods and forms of representation in the specialized sciences are subject to individual and socio-cultural interpretation and historicity,
- Can communicate in a foreign language in a manner appropriate to the subject.

Skills Professional Competence (Skills)

In selected sub-areas students can

· apply basic and specific methods of the said scientific disciplines,

- · aquestion a specific technical phenomena, models, theories from the viewpoint of another, aforementioned specialist discipline,
- · to handle simple and advanced questions in aforementioned scientific disciplines in a sucsessful manner,
- justify their decisions on forms of organization and application in practical questions in contexts that go beyond the technical relationship to the subject.

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

Courses

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

	Typ Lecture Lecture	Hrs/wk	СР
	Lecture Lecture		СР
	Lecture	2	· ·
		-	2
		2	1
	Lecture	2	3
othea Rechtenbach			
nentals of inorganic/organic che	mistry and biology (knowledge acquired at school)		
After taking part successfully, students have reached the following learning results			
With the completion of this module students acquire profound knowledge of the geo- and pedosphere, biogeochemical processes			
and the face of migrating composition in son and groundwater. They rearn about methods to investigate sites for different asc.			
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. Model			
s can be devised and treated.			
ts can discuss technical and scie	entific tasks within a seminar subject specific and in	terdisciplinary .	
	, ,		
ts can independently exploit sou	irces , acquire the particular knowledge of the subje	ect and apply it to ne	ew problems.
ndent Study Time 96, Study Time	e in Lecture 84		
exam			
L5 Min.			
gineering: Specialisation Water	and Traffic: Elective Compulsory		
3 3 1	' '		
1 1 1	king part successfully, students e completion of this module students fate of migrating compounds in e completion of this module students and conceptually. They are so can be devised and treated. Es can discuss technical and scients can independently exploit soundent Study Time 96, Study Time exam Exam Es Min. Gineering: Specialisation Water	e completion of this module students acquire profound knowledge of the geo- and a fate of migrating compounds in soil and groundwater. They learn about methods to be completion of this module students can apply the acquired theoretical knowledge ally and conceptually. They are able to draw comparisons on different investigns can be devised and treated. Its can discuss technical and scientific tasks within a seminar subject specific and integrated in the second secon	king part successfully, students have reached the following learning results e completion of this module students acquire profound knowledge of the geo- and pedosphere, bioger fate of migrating compounds in soil and groundwater. They learn about methods to investigate sites for the ecompletion of this module students can apply the acquired theoretical knowledge to model sites and ally and conceptually. They are able to draw comparisons on different investigation strategies and is can be devised and treated. Es can discuss technical and scientific tasks within a seminar subject specific and interdisciplinary and the second independently exploit sources, acquire the particular knowledge of the subject and apply it to need the study Time 96, Study Time in Lecture 84 exam 5 Min. gineering: Specialisation Water and Traffic: Elective Compulsory

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	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
	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

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

Engineering				
Module M0962: Susta	inability and Risk Management			
Courses				
Title		Тур	Hrs/wk	СР
Safety, Reliability and Risk Assessn	nent (L1145)	Seminar	2	3
Environment and Sustainability (L0	319)	Lecture	2	3
Module Responsible	Prof. Kerstin Kuchta			
Admission Requirements	None			
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students have reac	hed 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 as	sessment as well as
	environmental and sustainable engineering, in de	tail:		
	basics in safety and reliability of technical	facilities		
	safety and reliability analysis methods	demacs		
	risk assessment			
	 Production and usage of bio-char 			
	energy production and supply			
	sustainable product design			
Skills	Students are able apply interdisciplinary systemevaluate the effort and costs for processes and se			reporting. They can
Personal Competence				
Social Competence				
•	Students can gain knowledge of the subject are	a from given sources and transform it	to new guestions. Fu	rthermore, they can
,	define targets for new application or research-oriented duties in for risk management and sustainability concepts accordance with			
	the potential social, economic and cultural impac	t.		
Workload in Hours	Independent Study Time 124, Study Time in Lector	ure 56		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Elaboration and presentation (45 minutes in grou	ps)		
scale				
Assignment for the	Civil Engineering: Core Qualification: Compulsory			
Following Curricula	Bioprocess Engineering: Specialisation C - Bio	economic Process Engineering, Focu	s Management and	Controlling: Elective
	Compulsory			
	International Management and Engineering: Spec	•		
	Product Development, Materials and Production:	·		
	Product Development, Materials and Production:	·		
	Product Development, Materials and Production:	·	ulsory	
	Water and Environmental Engineering: Core Qual	itication: Compulsory		

Committee Color Bulliot	The contract Account of		
Course L1145: Safety, Reliab			
	Seminar		
Hrs/wk			
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Dr. Marco Ritzkowski		
Language	DE		
Cycle	WiSe		
	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/ sicherheit _und_zuverlaessigkeit.pdf		

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: Environmental Protection and Management					
Courses					
Title		Тур	Hrs/wk	СР	
Integrated Pollution Control (L0502)	Lecture	2	2	
Health, Safety and Environmental M		Lecture	2	3	
Health, Safety and Environmental M		Recitation Section (small)	1	1	
Module Responsible	·				
Admission Requirements	None				
Recommended Previous	 Good knowledge in Technologies for Environment. 	al Protection (end-of-pipe, integrated	d solutions)		
Knowledge	Good knowledge of the relevant Environmental Le		,		
	Basic knowledge of instruments for Environmenta	Assessment			
Educational Objectives	After taking part successfully, students have reached the	e following learning results			
Professional Competence					
Knowledge	The students are able to describe the basics of regular				
	legislation ISO 14001, EMAS and Responsible Care ISO substance cycles and approaches from end-of-pipe to			·	
	knowledge of complex industry related problems. They			_	
	carry out innovative technical solutions, remediation m	, ,			
	approaches in the full range of problems in different indu		as well as collect	taar problem soming	
	3				
Skills	Students are able to assess current problems and situa	tions in the field of environmental p	protection. They ca	an consider the best	
	available techniques and to plan and suggest concrete				
	solve problems on a technical, administrative and legisla		,	, , , , ,	
Personal Competence					
Social Competence	The students can work together in international groups.				
Autonomy	Students are able to organize their work flow to prepare	e themselves for presentations and	contributions to t	he discussions. They	
	can acquire appropriate knowledge by making enquiries	independently.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70				
Credit points					
Course achievement					
Examination					
Examination duration and	90 min				
scale					
-	Civil Engineering: Specialisation Water and Traffic: Electi			Controlling, Floative	
Following Curricula	Bioprocess Engineering: Specialisation C - Bioeconor Compulsory	nic Process Engineering, Focus M	anagement and	Controlling: Elective	
	Environmental Engineering: Core Qualification: Compulsi	orv			
	Joint European Master in Environmental Studies - Cities a	•	ter: Elective Comp	pulsory	
	Joint European Master in Environmental Studies - Cities a			-	
	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 Environment: Compulsory				
	Water and Environmental Engineering: Specialisation Cit	ies: Compulsory			

Course L0502: Integrated Po	illution 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
Content	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	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	 Objectives of and benefit from HSE management From dilution and end-of-pipe technology to eco-efficiency and eco-effectiveness Behaviour control: regulations, economic instruments and voluntary initiatives 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 Crisis management
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	ourse 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			

Engineering					
Iodule M0902: Wasto	ewater Treatment and Air Po	ollution Abatement			
ourses					
Title		Тур	Hrs/wk	CP	
Biological Wastewater Treatment (L0517)		Lecture	2	3	
ir Pollution Abatement (L0203)		Lecture	2	3	
Module Responsible	Dr. Swantje Pietsch-Braune				
	None				
Recommended Previous	Basic knowledge of biology and chemistry	у			
Knowledge	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					
Knowledge	After successful completion of the module	e students are able to			
	name and explain biological process				
	 characterize waste water and sewa discuss legal regulations in the are 				
	 explain the effects of air pollutants on the environment, name and explan off gas tretament processes and to define their area of application 				
	- name and explain on gas detainen	is processes and to define their area or applicat			
Skills	Students are able to				
	choose and design processs steps for the biological waste water treatment				
	 choose and design processs steps for the biological waste water treatment. combine processes for cleaning of off-gases depending on the pollutants contained in the gases 				
	,	3	J. T.		
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 an	nd Traffic: Elective Compulsory			
Following Curricula	Bioprocess Engineering: Specialisation A	- General Bioprocess Engineering: Elective Con	npulsory		
		pecialisation General Process Engineering: Elect	tive Compulsory		
		n Waste and Energy: Elective Compulsory			
	International Management and Engineeri	ng: Specialisation II. Energy and Environmental			
I	Tartist Electrical States of the first term of the	studios - Citios and Sustainability: Specialisation	n water: Elective Comp	IIISOTV	
	Joint European Master in Environmental S	· ·		uisory	
	Renewable Energies: Specialisation Bioen	nergy Systems: Elective Compulsory	·	ulsor y	
	Renewable Energies: Specialisation Bioen Process Engineering: Specialisation Enviro	nergy Systems: Elective Compulsory conmental Process Engineering: Elective Compu	·	alsol y	
	Renewable Energies: Specialisation Bioen Process Engineering: Specialisation Envir Process Engineering: Specialisation Proce	nergy Systems: Elective Compulsory conmental Process Engineering: Elective Compu ess Engineering: Elective Compulsory	·	uisory	
	Renewable Energies: Specialisation Bioen Process Engineering: Specialisation Enviro	nergy Systems: Elective Compulsory conmental Process Engineering: Elective Compu ess Engineering: Elective Compulsory pecialisation Water: Elective Compulsory	·	usory	

Тур	Lecture
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	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;)
	Biologie der Abwasserreinigung : 18 Tabellen
	ISBN: 382741427X URL: http://www.gbv.de/du/services/agi/94B581161B6EC747C1256E3F005A8143/420000114903
	Heidelberg [u.a.] : Spektrum, Akad. Verl., 2003
	TUB_HH_Katalog
	Tchobanoglous, George (Metcalf & Eddy, Inc., ;)
	Wastewater engineering : treatment and reuse
	ISBN: 0070418780 (alk. paper) ISBN: 0071122508 (ISE (*pbk))
	Boston [u.a.] : McGraw-Hill, 2003
	TUB_HH_Katalog
	Henze, Mogens
	Activated sludge models ASM1, ASM2, ASM2d and ASM3
	ISBN: 1900222248
	London: IWA Publ., 2002
	TUB_HH_Katalog
	Kunz, Peter
	Umwelt-Bioverfahrenstechnik
	Vieweg, 1992
	Bauhaus-Universität., Arbeitsgruppe Weiterbildendes Studium Wasser und Umwelt (Deutsche Vereinigung für
	Wasserwirtschaft, Abwasser und Abfall, ;)
	Abwasserbehandlung : Gewässerbelastung, Bemessungsgrundlagen, Mechanische Verfahren, Biologische Verfahren, Reststoffe
	aus der Abwasserbehandlung, Kleinkläranlagen
	ISBN: 3860682725 URL: http://www.gbv.de/dms/weimar/toc/513989765_toc.pdf URL:
	http://www.gbv.de/dms/weimar/abs/513989765_abs.pdf
	Weimar : Universitätsverl, 2006
	TUB_HH_Katalog
	Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall
	DWA-Regelwerk
	Hennef: DWA, 2004
	TUB_HH_Katalog
	Wiesmann, Udo (Choi, In Su; Dombrowski, Eva-Maria;)
	Fundamentals of biological wastewater treatment
	ISBN: 3527312196 (Gb.) URL: http://deposit.ddb.de/cgi-bin/dokserv?id=2774611&prov=M&dok_var=1&dok_ext=htm
	Weinheim: WILEY-VCH, 2007
	TUB_HH_Katalog

Course 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	
litle	Typ Hrs/wk CP
ntegrated Transportation Planning	
Module Responsible	
Admission Requirements	
	some knowledge of transport planning, e.g. through taking the undergraduate class "Transport Planning and Traffic Engineerin
Knowledge	g
	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.
	 relate current issues in the area of integrated transport planning and formulate an opinion on them.
	Federe current issues in the area of integrated datispore planning and formulate an opinion on atems.
Skills	Students are able to:
	quantify important parameters, which influence travel demand or are influenced by it.
	comprehensively examine a pre-defined or self-selected topic from a transportation studies perspective and document to the comprehensively examine a pre-defined or self-selected topic from a transportation studies perspective and document to the comprehensively examine a pre-defined or self-selected topic from a transportation studies perspective and document to the comprehensively examine a pre-defined or self-selected topic from a transportation studies perspective and document to the comprehensively examine a pre-defined or self-selected topic from a transportation studies perspective and document to the comprehensive and the comprehensive accordance to the comprehensive and the comprehensive accordance to the compre
	results in accordance with scientific conventions.
Personal Competence	
	Students are able to:
Social Competence	Stauchts and able to.
	provide feedback on topical contents and their teaching.
	constructively handle feedback on their own work.
	produce results in group work and document these.
Autonomy	Students are able to:
	assess potential consequences of their future professional activities
	 independently plan working on a pre-defined project topic, acquire the necessary knowledge and use appropriate means
	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 Transportation 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 M0511: Electi	rical Energy from Solar Radiation an	d 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		Lecture	1	1	
Module Responsible					
Admission Requirements	None				
Recommended Previous	Module: Technical Thermodynamics I,				
Knowledge	Module: Technical Thermodynamics II,				
	Module: Fundamentals of Fluid Mechanics				
Educational Objectives	After taking part successfully, students have reache	d the following learning results			
Professional Competence					
Knowledge	By ending this module students can explain in det	ail knowledge of wind turbines w	ith a particular focus of	wind energy use in	
	offshore conditions and can critical comment these				
	to describe fundamentally the use of water power to	·	s reproduce and explain	the basic procedure	
	in the implementation of renewable energy projects	in countries outside Europe.			
	Through active discussions of various topics within	n the seminar of the module, stu	dents improve their un-	derstanding and the	
	application of the theoretical background and are th	us able to transfer what they have	learned in practice.		
CI:II-	Charles and the control of the contr	-1 6			
Skills	Students are able to apply the acquired theoretic assess technically the resulting relationships in the				
	compare critically the special procedure for the implementation of renewable energy projects in countries outside Europe with t in principle applied approach in Europe and can apply this procedure on exemplary theoretical projects.				
		,, p			
Personal Competence					
Social Competence	Students can discuss scientific tasks subjet-specific	ly and multidisciplinary within a se	minar.		
Autonomy	Students can independently exploit sources in the	context of the emphasis of the le	ecture material to clear	the contents of the	
	lecture and to acquire the particular knowledge about	ut the subject area.			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 8	84			
Credit points		J-T			
Course achievement					
Examination	Written exam				
	2.5 hours written exam + written elaboration (incl. p	presentation) in sustainability man	agement		
scale	215 Hours Witten exam 1 Witten diaboration (man)	nesentation, in sustainasint, main	agement		
Assignment for the	Civil Engineering: Specialisation Structural Engineeri	ing: Elective Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnical Engine				
-	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory				
	International Management and Engineering: Special	isation II. Energy and Environment	al Engineering: Elective	Compulsory	
	International Management and Engineering: Special	sation II. Renewable Energy: Elect	ive Compulsory		
	Product Development, Materials and Production: Spe	ecialisation Product Development:	Elective Compulsory		
	Product Development, Materials and Production: Spe	ecialisation Production: Elective Co	mpulsory		
	Product Development, Materials and Production: Spe	ecialisation Materials: Elective Com	npulsory		
	Renewable Energies: Core Qualification: Compulsory				
	Theoretical Mechanical Engineering: Specialisation E		•		
	Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory				
	Water and Environmental Engineering: Specialisation				
	Water and Environmental Engineering: Specialisation	n 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:
	 What is "sustainability"? Why is this concept an important topic for companies? What opportunities and business risks are addressed or are associated with it? 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? What concepts or frameworks exist for the implementation of sustainability management in companies? Which sustainability labels exist for products or companies? What do they have in common, and where do they differ? 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. 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.
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	 Introduction, importance of water power in the national and global context Physical basics: Bernoulli's equation, usable height of fall, hydrological measures, loss mechanisms, efficiencies Classification of Hydropower: Flow and Storage hydropower, low and high pressure systems Construction of hydroelectric power plants: description of the individual components and their technical system interaction Structural engineering components; representation of dams, weirs, dams, power houses, computer systems, etc. Energy Technical Components: Illustration of the different types of hydraulic machinery, generators and grid connection Hydropower and the Environment Examples from practice
Literature	 Schröder, W.; Euler, G.; Schneider, K.: Grundlagen des Wasserbaus; Werner, Düsseldorf, 1999, 4. Auflage Quaschning, V.: Regenerative Energiesysteme: Technologie - Berechnung - Simulation; Carl Hanser, München, 2011, 7. Auflage Giesecke, J.; Heimerl, S.; Mosony, E.: Wasserkraftanlagen - Planung, Bau und Betrieb; Springer, Berlin, Heidelberg, 2009, 5. Auflage von König, F.; Jehle, C.: Bau von Wasserkraftanlagen - Praxisbezogene Planungsunterlagen; C. F. Müller, Heidelberg, 2005, 4. Auflage Strobl, T.; Zunic, F.: Wasserbau: Aktuelle Grundlagen - Neue Entwicklungen; Springer, Berlin, Heidelberg, 2006

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

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

Engineering"				
Module M0827: Modeling in Water Management				
Courses				
Title		Тур	Hrs/wk	СР
Groundwater Modeling using Modflow (L0543)		Lecture	1	1
Groundwater Modeling using Modfle	Groundwater Modeling using Modflow (L0544)		2	2
Modeling of Water Supply and Sewe	er Network (L0875)	Project-/problem-based Learning	2	3
Module Responsible	Dr. Klaus Johannsen			
Admission Requirements	None			
Recommended Previous	Groundwater			
Knowledge	• groundwater hydraulics and transport of substances			
	Pipe Systems			
	 Knowledge on urban water infrastructures, in par 	ticular drinking water systemsand ι	urban drainag	je systems including
	special structures			
	 Hydraulics of drinking water supply systems and sev 	ver systems		
	Basic knowledge on water management			
Educational Objectives	After taking part successfully, students have reached the fo	ollowing learning results		
Professional Competence				
Knowledge	The students are able to describe the modelling of grounds	vater flow and transport as well as urb	oan water infra	astructures. They can
	carry out systems analyses and can detect technical and c	conceptual weak points within the sys	tems in case	studies. Besides they
	are able to analyse interdependencies of hydraulic and tox	ic phenomena in soil and water.		
Skills	The students are able to construct and apply scientific gr	oundwater models indipendently. The	y can work o	n different scenarios
	and can compare or assess different solutions for existing	problems by application of selected so	oftware produ	cts. The students are
	able to use different software solutions (e.g. EPANET, EPA-S	SWMM).		
Personal Competence				
· ·	Wird nicht vermittelt.			
Social competence	The many verification			
Autonomy	Wird nicht vermittelt.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 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 Engineering:			
	Civil Engineering: Specialisation Coastal Engineering: Elect			
	Civil Engineering: Specialisation Water and Traffic: Elective			
	Water and Environmental Engineering: Specialisation Water			
	Water and Environmental Engineering: Specialisation Envir Water and Environmental Engineering: Specialisation Cities			
	water and Environmental Engineering: Specialisation Cities	ь. Елесиме Сотприіѕогу		

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	t Introduction and application of the groundwater model MODFLOW (PMWIN); theoretical backround of the modell, students do wor	
	with the model PMWIN for practical case studies.	
Literature	MODFLOW-Handbuch	
	Chiang, Wen Hsien: PMWIN	

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

Course L0875: Modeling of V	ourse 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.		

=::9:::00:::19				
Module M1717: Advanced Vadose Zone Hydrology				
Courses				
Title		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)		Recitation Section (large)	2	2
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 96, Study Time in L	ecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water and 1	Fraffic: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Water and 1	Fraffic: Elective Compulsory		
	Environmental Engineering: Specialisation W	later: Elective Compulsory		
	Environmental Engineering: Specialisation W	later: Elective Compulsory		
	Water and Environmental Engineering: Spec	ialisation Water: Elective Compulsory		
	Water and Environmental Engineering: Spec	ialisation Environment: Elective Compulsory		
	Water and Environmental Engineering: Spec	ialisation Cities: Elective Compulsory		
	Water and Environmental Engineering: Spec	ialisation Cities: Elective Compulsory		
	Water and Environmental Engineering: Spec	ialisation Environment: Elective Compulsory		
	Water and Environmental Engineering: Spec	ialisation Water: Elective Compulsory		

Course L2734: Modeling Prod	ourse 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	

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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: Multip	ohase Flow in Porous Media			
Courses				
Title		Тур	Hrs/wk	СР
Advanced Modeling Techniques for	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	Prof. Nima Shokri			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have reach	ed 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 Engi	neering: Elective Compulsory		
	Civil Engineering: Specialisation Geotechnical Engin	neering: Elective Compulsory		
	Civil Engineering: Specialisation Water and Traffic:	Elective Compulsory		
	Environmental Engineering: Specialisation Water: E	Elective Compulsory		
	Environmental Engineering: Specialisation Water: E	Elective Compulsory		
	Water and Environmental Engineering: Specialisati	on Cities: Elective Compulsory		
	Water and Environmental Engineering: Specialisati	on Cities: Elective Compulsory		
	Water and Environmental Engineering: Specialisati	on Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialisati	on Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialisati	on Water: Elective Compulsory		
	Water and Environmental Engineering: Specialisati	on Water: Elective Compulsory		

Course L2738: Advanced Mo	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	

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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: Water	and Environment: Theory and Applica	ation		
Courses				
Title		Тур	Hrs/wk	СР
Water and Environment: Application	n and Field Work (L2754)	Project-/problem-based Learning	3	4
Water and Environment: Theory (L2	7753)	Lecture	1	2
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	e 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 (about 15 m	nin)		
scale				
Assignment for the	Civil Engineering: Specialisation Coastal Engineering: Ele	ective Compulsory		
Following Curricula	Civil Engineering: Specialisation Water and Traffic: Election	ive Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Ele	ective Compulsory		
	Civil Engineering: Specialisation Water and Traffic: Election	ive Compulsory		
	Environmental Engineering: Specialisation Water: Electiv	ve Compulsory		
	Environmental Engineering: Specialisation Water: Electiv	ve Compulsory		
	Water and Environmental Engineering: Specialisation Cit	ties: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Cit	ties: Elective Compulsory		
	Water and Environmental Engineering: Specialisation En	vironment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation En	· · ·		
	Water and Environmental Engineering: Specialisation Wa	• •		
	Water and Environmental Engineering: Specialisation Wa	ater: Elective Compulsory		

Course L2754: Water and En	urse 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	

Liigiileeiilig				
Module M0749: Waste	e Treatment and Solid Matter Proces	s Technology		
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			
Recommended Previous	Basics of			
Knowledge				
	thermo dynamics			
	fluid dynamics			
	• chemistry			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence	Their taking pare successionly, students have reached	are following rearring results		
·	The students can name, describe current issue an	d problems in the field of thermal w	vasta traatmant :	and particle process
Knowieage			vaste treatment a	and particle process
	engineering and contemplate them in the context of t	neir field.		
	The industrial application of unit operations as part o	f process engineering is explained by	actual examples	of waste incineration
	technologies and solid biomass processes. Compost	on, particle sizes, transportation and	dosing, drying a	nd agglomeration of
	renewable resources and wastes are described as imp	ortant unit operations when producing	g solid fuels and b	ioethanol, producing
	and refining edible oils, electricity , heat and mineral r	ecyclables.		
Skills	The students are able to select suitable processes for			
	and the process aims. They can evaluate the efforts a	nd costs for processes and select econ	omically feasible t	reatment concepts.
Personal Competence				
Social Competence	Students can			
	 respectfully work together as a team and discuss 	ss technical tasks		
	participate in subject-specific and interdisciplinary discussions,			
	 develop cooperated solutions 			
	 promote the scientific development and accept 	professional constructive criticism.		
Autonomy	Students can independently tap knowledge of the	subject area and transform it to r	new questions Th	nev are canable in
Autonomy	consultation with supervisors, to assess their learning			
	targets for new application-or research-oriented duties	•		•
	targets for new application-of research-oriented datie.	in accordance with the potential soci	ai, economic ana c	alturur impact.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 7	0		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Ele	ctive Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation A - General Bio	process Engineering: Elective Compuls	ory	
	International Management and Engineering: Specialisa	ition II. Process Engineering and Biotec	chnology: Elective	Compulsory
	International Management and Engineering: Specialisa	ition II. Renewable Energy: Elective Co	mpulsory	
	Renewable Energies: Specialisation Bioenergy System	s: Elective Compulsory		
	Process Engineering: Specialisation Chemical Process	Engineering: Elective Compulsory		
	Process Engineering: Specialisation Process Engineering	ng: Elective Compulsory		
	Process Engineering: Specialisation Environmental Pro	cess Engineering: Elective Compulsory	,	
	Water and Environmental Engineering: Specialisation	Environment: Compulsory		
	Water and Environmental Engineering: Specialisation			

Course L0052: Solid Matter 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	te 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	 Introduction, actual state-of-the-art of waste incineration, aims. legal background, reaction principals basics of incineration processes: waste composition, calorific value, calculation of air demand and flue gas composition Incineration techniques: grate firing, ash transfer, boiler Flue gas cleaning: Volume, composition, legal frame work and emission limits, dry treatment, scrubber, de-nox techniques, dioxin elimination, Mercury elimination Ash treatment: Mass, quality, treatment concepts, recycling, disposal
Literature	Thomé-Kozmiensky, K. J. (Hrsg.): Thermische Abfallbehandlung Bande 1-7. EF-Verlag für Energie- und Umwelttechnik, Berlin, 196 - 2013.

Course L1177: Thermal Wast	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	

Linginicering				
Module M0828: Urbai	n Environmental Management			
Courses				
Title	Тур		Hrs/wk	СР
Noise Protection (L1109)	Lecture		2	2
Urban Infrastructures (L0874)		n-based Learning	2	4
Module Responsible	Dr. Dorothea Rechtenbach			
Admission Requirements	None			
Recommended Previous				
Knowledge				
	Knowledge on measures for climate protection			
	General knowledge of scientific writing/working			
Educational Objectives	After taking part successfully, students have reached the following learning resu	ults		
Professional Competence				
Knowledge	Students can describe urban development corridors as well as current and futu	re urban environn	nental probler	ms. They are able
	explain the causes of environmental problems (like noise).			
	Students can specify applications for various technical innovations and explain	why these contrib	oute to the im	provement of urba
	life. They can, for example, derive and discuss measures for effective noise aba	tement.		
Skills	Students are able to develop specific solutions for correcting existing o	r future environ	ment-related	nroblems of urb
Skins	development. They can define a range of conceptual and technical solutions for			•
	paths. To solve specific urban environmental problems they can select techni			•
	context.			
Personal Competence				
	The students can work together in international groups.			
Autonomy		ntations and cont	ributions to th	ne discussions. The
	can acquire appropriate knowledge by making enquiries independently.			
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 Compulsory			
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory			
	Environmental Engineering: Core Qualification: Elective Compulsory			
	Joint European Master in Environmental Studies - Cities and Sustainability: Core	Qualification: Cor	mpulsory	
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure and Mobility:	Elective Compulso	ory	
	Water and Environmental Engineering: Specialisation Environment: Elective Cor	npulsory		
	Water and Environmental Engineering: Specialisation Cities: Compulsory			

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

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

Module M0857: Geoch	hemical Engineering			
Courses				
Title		Тур	Hrs/wk	СР
Contaminated Sites and Landfilling		Lecture	2	2
Contaminated Sites and Landfilling Geochemical Engineering (L0904)	(L0907)	Recitation Section (large) Lecture	1 2	2
	B. M. a. Pit I. al.	Lecture	2	2
Module Responsible				
	Module: General and Inorganic Chemistry,			
Knowledge	Module:Organic Chemistry,			
	Biology (Basic Knowledge)			
	3, 1			
Educational Objectives	After taking part successfully, students have reached t	he following learning results		
Professional Competence				
Knowledge	With the completion of this module students acquire profound knowledge of biogeochemical processes, the fate of pollutants in			
	soil and groundwater, and techniques to deposit conta	minated waste material. They are able	to describe in pri	nciple the behaviour
	of chemicals in the environment. Students can explain	and report the approach to remediate	contaminated sit	es.
Skills	With the completion of this module students can app	ly the acquired theoretical knowledge	to model cases	of site pollution and
	critically assess the situation technically and conceptu			·
	and techniques. Model projects can be devised and tre			
Personal Competence				
Social Competence	Students can discuss technical and scientific tasks wit	hin a seminar subject specific and inter	disciplinary .	
Autonomy	Students can independently exploit sources , acquire t	he particular knowledge of the subject a	and apply it to ne	w problems.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70	0		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	2 hours			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elec	ctive Compulsory		
Following Curricula	Environmental Engineering: Core Qualification: Elective	e Compulsory		
	Water and Environmental Engineering: Specialisation V	Vater: Elective Compulsory		
	Water and Environmental Engineering: Specialisation E	Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation (Cities: Elective Compulsory		

Course L0906: Contaminated	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	1) Waste Management. Bernd Bilitewski; Georg Härdtle; Klaus Marek (Eds.), ISBN: 9783540592105, Springer Verlag Lehrbuchsammlung der TUB, Signatur USH-305 2) Solid Waste Technology and Management. Thomas Christensen (Ed.), ISBN: 978-1-4051-7517-3, Wiley Verlag Lesesaal 2: US - Umweltschutz, Signatur USH-332 3) Natural attenuation of fuels and chlorinated solvents in the subsurface. Todd H. Wiedemeier(Ed.), ISBN: 0471197491 Lesesaal 2: US - Umweltschutz, Signatur USH-844

Course 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	

S	
Course L0904: Geochemical	
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	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			
	3			
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 Learning	2	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous	Fundamentals of Hydromechanics, Hydraulics, Hydro	logy and Hydraulic Engineering; Hydra	aulic Engineer	ing I and Hydraulic
Knowledge	Engineering II			
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	Students are able to define in detail the basic proce	sses that are related to the modelling	of flows in hy	draulic engineering.
	Besides, they can describe the basic aspects of numerical modelling and actual numerical models for the simulation of flows			nulation of flows and
	waves. They can also depict the concepts of nature orie	nted hydraulic engineering.		
Skille	Students are able to apply hydrodynamic-numerical mo	dels to practical hydraulic engineering ta	seks Furtherm	ore the students are
Skills	able to set up flood-risk management concepts and are			
	able to set up nood risk management concepts and are	able to apply basic concepts of renatura	tion to practice	ar problems.
Personal Competence				
Social Competence	The students are able to deploy their gained knowledg	e in applied problems of the practical n	ature-based hy	draulic engineering
	Additionaly, they will be able to work in team with engin	neers of other disciplines.		
Autonomy	The students will be able to independently extend their	knowledge and apply it to new problems	·.	
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	The duration of the examination is 150 min. The exa	mination 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: Com	pulsory		
Following Curricula	Environmental Engineering: Core Qualification: Elective	Compulsory		
	Joint European Master in Environmental Studies - Cities	and Sustainability: Core Qualification: Co	mpulsory	
	Water and Environmental Engineering: Specialisation W	ater: Compulsory		
	Water and Environmental Engineering: Specialisation En	nvironment: Compulsory		
	Water and Environmental Engineering: Specialisation C	ties: Elective Compulsory		

Course L0810: Modelling of I	Flow in Rivers and Estuaries				
Тур	Lecture				
Hrs/wk	3				
СР	4				
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42				
Lecturer	Dr. 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. Februar 2019. Hennef: Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (DWA-Regelwerk, 543-1).				
	Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische Modelle, DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019b): Merkblatt DWA-M 543-2 Geodaten in der Fließgewässermodellierung Teil 2: Bedarfsgerechte Datenerfassung und -aufbereitung. Februar 2019. Hennef: Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (DWA-Regelwerk, 543-2).				
	Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA); DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische Modelle, DWA-Arbeitsgruppe WW-3.2 Mehrdimensionale numerische (2019c): Merkblatt DWA-M 543-3 Geodaten in der Fließgewässermodellierung - Teil 3: Aspekte der Strömungsmodellierung und Fallbeispiele. Februar 2019. Hennef: Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (DWA-Regelwerk, 543-3).				
	Hervouet, Jean-Michel (2007): Hydrodynamics of free surface flows. Modelling with the finite element method. Chichester: Wiley Online verfügbar unter http://www.loc.gov/catdir/enhancements/fy0741/2007296953-b.html.				
	IAHR (2015): Professional Specifications for Physical and Numerical Studies in Environmental Hydraulics. In: Hydrolink (3/2015), S 90-92.				
	Olsen, Nils Reidar B. (2012): Numerical Modelling and Hydraulics. 3. Aufl. Department of Hydraulic and Environmental Engineering The Norwegian University of Science and Technology.				
	Szymkiewicz, Romuald (2010): Numerical modeling in open channel hydraulics. Dordrecht: Springer (Water science and technology library, 83).				
	van Waveren, Harold (1999-): Good modelling practice handbook. [Utrecht], Lelystad, Den Haag: STOWA; Rijkswaterstaat-RIZA SDU, afd. SEO/RIZA [etc. distr.] (Nota, nr. 99.036).				
	Zielke, Werner (Hg.) (1999): Numerische Modelle von Flüssen, Seen und Küstengewässern. Deutscher Verband für Wasserwirtschaft und Kulturbau. Bonn: Wirtschafts- und VerlGes. Gas und Wasser (Schriftenreihe des Deutschen Verbandes für				

Wasserwirtschaft und Kulturbau, 127).

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

3 3				
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	Fluvial Areas (L0295)	Project-/problem-based Learning	1	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous	Fundamentals of Hydromechanics and Hydrau	lic Engineering: Hydraulic Engineering I and Hydra	ulic Engineeri	ng II
Knowledge				
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
Professional Competence				
Knowledge	The students are able to define the basic con	cepts of hydrology and water management. They	are able to d	lescribe and quantify
	the relevant processes of the hydrological wat	er cycle. Besides, the students know the main asp	ects of rainfa	ll-run-off-models and
	are able to theoretically derive established res	ervoir / storage models and a unit-hydrograph.		
Skills	· ·	ological concepts and approaches and are able t		•
		oh as the basis for rainfall-run-off-models. The stu		
		d hydrodynamic values in nature and are able to	•	
	assess these measurements. Furthermore, the	ey are able to apply a hydrological model to basic h	ydrological p	roblems.
Personal Competence				
Social Competence	The students are able to deploy their gained k	nowledge in applied problems of the hydrology an	d water mana	gement. Additionaly,
•	they will be able to work in team with enginee			,
Autonomy	,	end their knowledge and apply it to new problems		
	, ,			
Workload in Hours	Independent Study Time 124, Study Time in Le	ecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	The duration of the examination is 90 min. The	e examination includes tasks with respect to the ge	eneral unders	tanding of the lecture
scale	contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elective 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: Special	lisation Water: Elective Compulsory		
	Water and Environmental Engineering: Special	lisation Environment: Elective Compulsory		
	Water and Environmental Engineering: Special	lisation Cities: Elective Compulsory		

Course L0289: Applied Surfa	ce 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:
	 Hydrological cycle Data acquisition Data analyses and statistical assessment Statistics of extremes Regionalization methods for hydrological values Rainfall-run-off modelling on the basis of a unit hydrograph conceps Application of rainfall-run-off models on the basis of Kalypso-Hydrology which is an OpenSource Software Tool.
Literature	http://de.wikipedia.org/wiki/Kalypso_(Software)
	http://kalypso.bjoernsen.de/
	http://sourceforge.net/projects/kalypso/

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

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

Module M0874: Wasto	ewater Systems				
Courses					
Title Typ Hrs/wk CP					
Wastewater Systems - Collection, T	reatment and Reuse (L0934)	Lecture	2	2	
Wastewater Systems - Collection, T		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				
Recommended Previous	Knowledge of wastewater management and the k	ey processes involved in wastewater treatm	ent.		
Knowledge					
Educational Objectives	After taking part successfully, students have reach	ned the following learning results			
Professional Competence					
Knowledge	Students are able to outline key areas of the full i	ange of treatment systems in waste water	management, as	well as their mutual	
	dependence for sustainable water protection. The	y can describe relevant economic, environm	nental and social	factors.	
Skills	Students are able to pre-design and explain the	available wastewater treatment processes	and the scene of	of their application in	
SKIIIS	Students are able to pre-design and explain the municipal and for some industrial treatment plant		and the scope c	л пен аррисации н	
	Thuricipal and for some industrial treatment plant	5.			
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	onthy They can	also procent on this	
Autonomy	Students are in a position to work on a subject subject.	and to organize their work now independ	entry. They can	also present on this	
	Subject.				
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	120 min				
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			
	Civil Engineering: Specialisation Water and Traffic	: Compulsory			
	Bioprocess Engineering: Specialisation A - General	Bioprocess Engineering: Elective Compulso	ry		
	Environmental Engineering: Specialisation Water:	Elective Compulsory			
	International Management and Engineering: Speci	• •			
	International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory				
	Process Engineering: Specialisation Environmenta				
	Process Engineering: Specialisation Process Engin				
	Water and Environmental Engineering: Specialisat				
	Water and Environmental Engineering: Specialisat				
	Water and Environmental Engineering: Specialisat	ion Cities: Compulsory			

	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				

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

Course L0358: Advanced Wa	stewater Treatment				
Тур	Recitation Section (large)				
Hrs/wk					
СР	1				
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14				
Lecturer	Dr. Joachim Behrendt				
Language	EN				
Cycle	SoSe 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: Nexus	s Engineering - Water, Soil, Food and	d Energy		
Courses				
Title		Тур	Hrs/wk	СР
Ecological Town Design - Water, En	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	Basic knowledge of the global situation with rising	poverty, soil degradation, migra	ation to cities, lack of v	vater resources and
Knowledge	sanitation			
Educational Objectives	After taking part successfully, students have reached	I the following learning results		
Professional Competence				
Knowledge	Students can describe the facets of the global water:	situation. Students can judge the	enormous potential of th	ne implementation of
	synergistic systems in Water, Soil, Food and Energy s	supply.		
Skille	Students are able to design ecological settlements f	for different geographic and socio	n-economic conditions fo	or the main climates
Skills	around the world.	ior different geographic and socie	recondinic conditions in	or the main climates
	diodria trie 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 pla	in.
Autonomy	Students are in a position to work on a subject an	d to organize their work flow inc	denendently They can a	also present on this
naconomy	subject.	a to organize their work now inc	dependently. They can t	also present on this
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 wor	k towards mile stones. The work	includes presentations a	and papers. Detailed
scale	information can be found at the beginning of the sme	ester in the StudIP course module	handbook.	
Assignment for the	Civil Engineering: Specialisation Water and Traffic: El	ective Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation A - General Bio	oprocess Engineering: Elective Co	mpulsory	
	Chemical and Bioprocess Engineering: Specialisation	General Process Engineering: Elec	ctive Compulsory	
	Environmental Engineering: Core Qualification: Electi	ve Compulsory		
	Joint European Master in Environmental Studies - Citic	es and Sustainability: Core Qualifi	cation: Compulsory	
	Process Engineering: Specialisation Environmental Pr	ocess Engineering: Elective Comp	oulsory	
	Process Engineering: Specialisation Process Engineer	ing: Elective Compulsory		
	Water and Environmental Engineering: Specialisation	Water: Elective Compulsory		
	Water and Environmental Engineering: Specialisation		ry	
	Water and Environmental Engineering: Specialisation	Cities: Elective Compulsory		

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

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

Module M0922: City F	Planning
Courses	
Title	Typ Hrs/wk CP
City Planning (L1066)	Project-/problem-based Learning 4 6
Module Responsible	Prof. Carsten Gertz
Admission Requirements	None
Recommended Previous	for "Principles of Urban Planning": none
Knowledge	for "Designing Urban Streetscapes": some knowledge of transport planning, e.g. through taking the undergraduate class "Tran Planning and Traffic Engineering"
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to:
	use technical terms of urban planning.
	describe the main determinants of urban development.
	explain and compare different possibilities of how urban development can be influenced.
	discuss requirements for public streetscapes.
	explain the importance of street design.
Skills	Students are able to:
	read and analyze urban development concepts and designs for streetscapes
	appraise such concepts in the context of competing requirements.
	design, justify and reflect their own solutions for concrete examples.
Personal Competence 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: • independently complete a written report including drawings following a broadly pre-defined process. • assess the consequences of their proposed solutions. • independently acquire knowledge and apply this to new issues or problem areas.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written elaboration
Examination duration and	written assignment, designwork during the semester
scale Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elective Compulsors
•	
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:
	 legal framework, instruments and methods of planning, functional requirements, stakeholders and actors basic design requirements different planning levels and historical contexts. The objective of the course is for students to acquire a basic understanding of urban development problems and approaches for solving them. They will also be able to comprehend the process of urban planning. The course also covers the various functional and aesthetic requirements for designing streetscape as the most important elements of public space. The project work deals with a real life scenario and includes drawing up a development plan, an urban design concept, a building masterplan and a street redesign.
Literature	Albers, Gerd; Wekel, Julian (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: Transportation Modelling		
Courses		
Title	Typ Hrs/wk CP	
Transportation Modelling (L1180)	Project-/problem-based Learning 4 6	
Module Responsible	Prof. Carsten Gertz	
Admission Requirements	None	
Recommended Previous	some knowledge of transport planning, e.g. through taking the undergraduate class "Transport Planning and Traffic Engineering"	
Knowledge		
Educational Objectives	After taking part successfully, students have reached the following learning results	
Professional Competence		
Knowledge	Students are able to understand the operation and potential applications of transport models.	
Skills	Students are able to:	
	 use travel demand modelling software packages for solving practical problems. design a database structure for travel demand models. assess modelling results. appraise potential applications and limitations of such models. 	
	Students are able to independently develop and document solutions. Students are able to: independently organise, manage and solve set tasks. independently prepare written reports.	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	
Credit points	6	
Course achievement	None	
Examination	Written elaboration	
Examination duration and scale		
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Compulsory	
Following Curricula		
	Water and Environmental Engineering: Specialisation Cities: Elective Compulsory	

Course L1180: Transportation	n Modelling		
Тур	Project-/problem-based Learning		
Hrs/wk	4		
СР	5		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Lecturer	Prof. Carsten Gertz		
Language	DE		
Cycle	SoSe		
Content	 Principles of transport modelling Role of transport modelling in the planning process Fundamentals of mobility behaviour Design and evaluation of transport/mobility surveys mode of operation and data requirements for different stages of modelling Forecasting and scenarios in the transport planning The range of model applications (from transport infrastructure planning over simulation of traffic flows to integrated landuse and transport models as well as the use of models for evaluating locations) Practice-oriented project for assessing consequences of infrastructure projects and changes in land-use 		
Literature	Lohse, Dieter und Schnabel, Werner (2011): Grundlagen der Straßenverkehrstechnik und der Verkehrsplanung – Band 2. 3. Auflage. Beuth. Ortúzar, Juan de Dios und Willumsen, Luis G. (2011): Modelling Transport. 4. Auflage. John Wiley & Sons.		

2.19.110011119				
Module M0663: Marine 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	Hydraulic Engineering (L1146)	Lecture	2	2
Module Responsible	Prof. Jürgen Grabe			
Admission Requirements	None			
Recommended Previous	complete modules: Geotechnics I-III, Mathema	tics I-III		
Knowledge	courses: Soil laboratory course			
	coarses. Son assoratory coarse			
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	Independent Study Time 110, Study Time in Le	ecture 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Geotechnical	Engineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Structural Eng	lineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engine	eering: Compulsory		
	Theoretical Mechanical Engineering: Specialisa	ation Maritime Technology: Elective Compulso	ry	
	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 Compulsory		

Course L0548: Marine Geotechnics			
Тур	ecture		
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	 Geotechnical investigation an description of the seabed Foundations of Offshore-Constructions cCliff erosion Sea dikes Port structures Flood protection structures 		
Literature	 EAK (2002): Empfehlungen für Küstenschutzbauwerke EAU (2004): Empfehlungen des Arbeitsausschusses Uferbauwerke Poulos H.G. (1988): Marine Geotechnics. Unwin Hyman, London Wagner P. (1990): Meerestechnik: Eine Einführung für Bauingenieure. Ernst & Sohn, Berlin 		

Course L0549: Marine Geote	ourse L0549: Marine Geotechnics	
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	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	

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

Course 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	

Module M1724: Smar	t Monitoring			
Courses				
Title		Тур	Hrs/wk	СР
Smart Monitoring (L2762)		Integrated Lecture	2	2
Smart Monitoring (L2763)	Dref You Smarth	Recitation Section (small)	2	4
Module Responsible				
Admission Requirements Recommended Previous				
Knowledge				
Kilowiedge	skills of scientific working, are required. Basic knowledge			s the will to dee
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
Knowledge	The students will become familiar with the principles	and practices of smart monitoring.	The students wi	Il be able to de
	decentralized smart systems to be applied for contin	nuous (remote) monitoring of syste	ms in the built	and in the nat
	environment. In addition, the students will learn to design	gn and to implement intelligent senso	or systems using	state-of-the-art of
	analysis techniques, modern software design concepts, a	and embedded computing methodolo	gies. Besides lect	tures, project wo
	also part of this module. In small groups, the stude	nts will design smart monitoring s	ystems that into	egrate a numbe
	"intelligent" sensors to be implemented by the stude	ents. Specific focus will be put on	the application	of machine lear
	techniques. The smart monitoring systems will be mour			
	on scaled lab structures for validation purposes. The ou			
	module will "automatically" participate with their small			
	written papers and oral examinations form the final grad	les. The module will be taught in Engl	ish. Limited enrol	llment.
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	Civil Engineering, Coorielisation Water and Traffic, Flact	va Campulaanu		
Assignment for the Following Curricula		, ,		
rollowing Curricula				
	Civil Engineering: Specialisation Coastal Engineering: Ele Civil Engineering: Specialisation Structural Engineering:			
	Civil Engineering: Specialisation Structural Engineering: Civil Engineering: Specialisation Coastal Engineering: Ele			
	Civil Engineering: Specialisation Geotechnical Engineerin			
	Civil Engineering: Specialisation Structural Engineering:			
	Civil Engineering: Specialisation Water and Traffic: Electi			
	Environmental Engineering: Specialisation Waste and En	ergy: Elective Compulsory		
	Environmental Engineering: Specialisation Biotechnology	: Elective Compulsory		
	Environmental Engineering: Specialisation Water: Electiv	e Compulsory		
	Environmental Engineering: Specialisation Waste and En	ergy: Elective Compulsory		
	Environmental Engineering: Specialisation Biotechnology	: Elective Compulsory		
	Environmental Engineering: Specialisation Water: Electiv	re Compulsory		
	Water and Environmental Engineering: Specialisation Cit	ies: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Cit	ies: Elective Compulsory		
	Water and Environmental Engineering: Specialisation En	vironment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation En	vironment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Wa	ater: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Wa	ater: Elective Compulsory		

Course L2762: Smart Monito	ring
Тур	Integrated Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Kay Smarsly
Language	EN
Cycle	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	

gg				
Module M1123: Selec	ted Topics in Environmental Engin	eering		
Courses				
Title Typ 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			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have reach	ned 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: Ele	ctive Compulsory	<u> </u>	
Following Curricula	Water and Environmental Engineering: Specialisat	ion Cities: Elective Compulsory		
	Water and Environmental Engineering: Specialisat	ion Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialisat	ion Water: Elective Compulsory		
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Course L1444: Environmenta	ll Aquatic Chemistry
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and	60 min
scale	
Lecturer	Dr. Klaus Johannsen
Language	EN
Cycle	SoSe
Content	 Concentration and activity Gas-water partitioning Acid/base equilibria Alkalinity and acidity Precipitation/dissolution equilibria Redox equilibria Complex formation Sorption
Literature	Worch, E.: Hydrochemistry. Basic Concepts and Exercises. De Gruyter, Berlin, 2015

Course 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 Treatm	nent
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

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

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

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				
Recommended Previous					
Knowledge	Basic knowledge in water management;				
	 Good knowledge in urban drainage; Good knowledge of wastewater treatment techniques; 				
	•	Good knowledge of wastewater treatment techniques, Good knowledge of pollutants (e.g. COD, BOD, TS, N, P) and their properties;			
	Good knowledge of pollutarits (e.g. COD,	BOD, 13, N, P) and their properties;			
Educational Objectives	After taking part successfully, students have rea	ached the following learning results			
Professional Competence					
Knowledge	The students can describe the basic principles of	f the regulatory framework related to th	e international and Eu	ropean water sector.	
	They can explain limnological processes, subs	tance cycles and water morphology in	detail. They are able	to assess complex	
	problems related to water protection, such as	ecosystem service and wastewater trea	atment with a special	focus on innovative	
	solutions, remediation measures as well as cond	eptual approaches.			
Skille	Students can accurately assess current problen	ns and situations in a country enecific of	r local context. They c	an suggest concrete	
Skills	actions to contribute to the planning of tomo				
	administrative and legislative solutions to solve		they can suggest ap	propriate teerimear,	
Personal Competence					
Social Competence	The students can work together in international groups.				
Autonomy	Students are able to organize their work flow to	prepare presentations and discussions	. They can acquire ap	propriate knowledge	
·	by making enquiries independently.				
Workload in Hours	Independent Study Time 96, Study Time in Lecti	ure 84			
Credit points	6				
Course achievement	None				
Examination	Presentation				
Examination duration and	Term paper plus presentation				
scale					
Assignment for the	Civil Engineering: Specialisation Structural Engir	, ,			
Following Curricula	Civil Engineering: Specialisation Geotechnical En				
	Civil Engineering: Specialisation Coastal Engineer				
	Civil Engineering: Specialisation Water and Traff				
	Environmental Engineering: Specialisation Wate	, ,	Compulsor		
	International Management and Engineering: Spe Joint European Master in Environmental Studies	• •		ulsory	
	Water and Environmental Engineering: Specialis	• •	acci. Liective Collip	y	
	Water and Environmental Engineering: Specialis				
	Water and Environmental Engineering: Specialis				
	sing Environmental Engineering. Specialis				

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: Regulatory Framework (e.g. WFD) Main instruments for the water management and protection In depth knowledge of relevant measures of water pollution control Urban drainage, treatment options in different regions on the world Rainwater management, improved management of heavy rainfalls, downpours, rainwater harvesting, rainwater infiltration Case Studies and Field Trips
Literature	 The literature listed below is available in the library of the TUHH. Water and wastewater technology Hammer, M. J. 1., & . (2012). (7. ed., internat. ed.). Boston [u.a.]: Pearson Education International. Water and wastewater engineering : design principles and practice: Davis, M. L. 1. (2011). New York, NY: McGraw-Hill. Biological wastewater treatment: (2011). C. P. Leslie Grady, Jr. (3. ed.). London, Boca Raton, Fla. [u.a.]: IWA Publ.

Course L2008: Water Protect	urse 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 M0620: Speci	al Aspects of Wast	te Resource Ma	anagement			
Courses						
Title				Тур	Hrs/wk	СР
Advanced Topics in Waste Resourc	e Management (L1055)			Project-/problem-based Learning	3	3
International Waste Management (.0317)			Project-/problem-based Learning	2	3
Module Responsible	Prof. Kerstin Kuchta					
Admission Requirements	None					
Recommended Previous	basics in waste treatment	technologies				
Knowledge						
Educational Objectives	After taking part successfu	ully, students have re	ached the following	ng learning results		
Professional Competence						
Knowledge	The students are able to	describe waste as a r	esource as well a	as advanced technologies for re	cycling and re	covery of resources
	from waste in detail. This	covers collection, trar	sport, treatment	and disposal in national and inte	ernational cont	exts.
CI:II-	Charleste and able to calco				بعام امتنا المتنطاب	
Skills Students are able to select suitable processes for the treatment with respect to the national or cultural and develop They can evaluate the ecological impact and the technical effort of different technologies and management system			•			
	They can evaluate the eco	ological impact and th	e technical effort	or different technologies and ma	anagement sys	stems.
Personal Competence						
Social Competence	Students can work togeth	ner as a team of 2-5	persons, particip	pate in subject-specific and inte	erdisciplinary o	liscussions, develop
	cooperated solutions and	defend their own wo	rk results in front	of others and promote the scient	entific develop	ment of colleagues.
	Furthermore, they can giv	e and accept professi	onal constructive	criticisms.		
Autonomy	Students can independen	thy gain additional k	nowlodge of the	subject area and apply it in so	lying the give	n course tacks and
Autonomy	projects.	itiy galil additiollal ki	lowledge of the	subject area and apply it in so	iving the give	iii course tasks and
	projects.					
Workload in Hours	Independent Study Time 1	10, Study Time in Led	cture 70			
Credit points	6					
Course achievement	Compulsory Bonus For	m	Description			
	Yes 20 % Wr	itten elaboration				
Examination	Presentation					
Examination duration and	PowerPoint presentation (10-15 minutes)				
scale						
Assignment for the	Civil Engineering: Specialis	sation Water and Traf	fic: Elective Comp	oulsory		
Following Curricula	Environmental Engineering					
	•			ainability: Specialisation Energy:	Elective Comp	oulsory
	Water and Environmental					
	Water and Environmental					
	Water and Environmental	Engineering: Specialis	sation Cities: Elec	tive Compulsory		

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
	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). The course is split into two parts: 1. part: "Conventional" lecture (development of waste management, legislation, collection, transportation and organisation of waste management, costs, fees and revenues). 2. 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. 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.
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
	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 M0619: Wasto	e Treatment Technologies				
Courses					
Fitle Waste and Environmental Chemistr			Typ Practical Course Project-/problem-based Learning	Hrs/wk 2 3	CP 2 4
Module Responsible			Troject /problem based Leanning		
Admission Requirements	None				
	chemical and biological basics				
Knowledge	enemeal and stological subject				
Educational Objectives	After taking part successfully, students hav	e reached the followi	ng learning results		
Professional Competence	31				
Knowledge	The module aims possess knowledge conce design and layout of anaerobic and aerobic plants for biological waste treatment plants	waste treatment pla	nts in detail, describe different to		
Skills	The students are able to discuss the compilation of design and layout of plants. They can critically evaluate techniques and quality control measurements. The students can recherché and evaluate literature and date connected to the tasks given in der module and plan additional tests. They are capable of reflecting and evaluating findings in the group.				
Personal Competence Social Competence	Students can 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 in front of colleagues. Furthermore, they can give and accept professional constructive criticism.				
Autonomy	Students can independently tap knowledge are capable, in consultation with supervisor steps on this basis. Furthermore, they can potential social, economic and cultural imp	rs as well as in the int define targets for ne	terim presentation, to assess the	ir learning leve	l and define furtl
Workload in Hours	Independent Study Time 110, Study Time in	a Lecture 70			
		. 2000010 70			
Course achievement	Compulsory Bonus Form Yes None Subject theoretics practical work	Description al and			
Examination	Presentation				
Examination duration and	Elaboration and Presentation (15-25 minute	es in groups)			
scale					
Assignment for the	Civil Engineering: Specialisation Structural	Engineering: Elective	Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnic	3	, ,		
	Civil Engineering: Specialisation Coastal Engineering				
	Civil Engineering: Specialisation Water and		pulsory		
	Environmental Engineering: Core Qualificat		eray and Environmental Engineer	ring: Elective C	ompulsor.
	International Management and Engineering Joint European Master in Environmental Stu				
	Water and Environmental Engineering: Spe			Ficcuse Comp	41301 y
	Water and Environmental Engineering: Spe				
			10.000		

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

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		Recitation Section (large)	1	2
Water Resource Management (L04)	·	Lecture	2	2
Water Resource Management (L04		Recitation Section (small)	1	1
Module Responsible				
Admission Requirements	None			
Recommended Previous	Knowledge of water management and the key pro	cesses involved in water treatment.		
Knowledge	After telling and acceptable at the second			
Educational Objectives	After taking part successfully, students have reach	ned the following learning results		
Professional Competence		g		
Knowledge	Students will be able to outline key areas of con			
	water supply. They will understand relevant econ			•
	outline the organisational structures of water com	panies. They will be able to explain the av	allable water trea	tment processes and
	the scope of their application.			
Skills	Students will be able to assess complex prob	olems in drinking water production and	establish soluti	ons involving water
	management and technical measures. They will b	e able to assess the evaluation methods t	:hat can be used f	or this. Students wil
	be able to carry out chemical calculations for se	elected treatment processes and apply go	enerally accepted	technical rules and
	standards to these processes.			
Personal Competence				
•	Working in a diverse group of specialists, student	s will be able to develop and desument s	ampley colutions	far tha managamant
Social Competence	Working in a diverse group of specialists, student and treatment of drinking water. They will be ab			
	interests. They will be able to develop joint solution			
	interests. They will be able to develop joint solution	ns in teams of diverse experts and present	. triese solutions to	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 Lecture	e 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 Engineer	ering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engi	ineering: Elective Compulsory		
	Civil Engineering: Specialisation Water and Traffic	Compulsory		
	Civil Engineering: Specialisation Coastal Engineeri	ng: Elective Compulsory		
	International Management and Engineering: Speci	alisation II. Energy and Environmental Eng	ineering: Elective	Compulsory
	Process Engineering: Specialisation Environmental	Process Engineering: Elective Compulsory	,	
	Process Engineering: Specialisation Process Engine	eering: Elective Compulsory		
	Water and Environmental Engineering: Specialisat	ion Water: Compulsory		
	Water and Environmental Engineering: Specialisat	ion Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialisat	ion Cities: Elective Compulsory		

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

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

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

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

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: Mem	hrane Technology			
Produce Product Premi	static recimiology			
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	Prof. Mathias Ernst			
Admission Requirements	None			
Recommended Previous	Basic knowledge of water chemistry. Knowledge of the o	ore processes involved in water, gas	and steam treatr	nent
Knowledge				
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	Students will be able to rank the technical applications	of industrially important membrane p	processes. They w	vill be able to explain
	the different driving forces behind existing membrane	separation processes. Students wil	I be able to nan	ne materials used in
	membrane filtration and their advantages and disadva	ntages. Students will be able to exp	lain the key diffe	rences in the use o
	membranes in water, other liquid media, gases and in li	quid/gas mixtures.		
Skills	Students will be able to prepare mathematical equatio	ns for material transport in porous a	nd solution-diffus	sion membranes and
	calculate key parameters in the membrane separation			
	available boundary data and provide recommendation			
	experiments, students will be able to classify the se			
	membrane materials. Students will be able to characteri			
	measures to control this.		amerene water	s and apply teemine
Personal Competence				
Social Competence	Students will be able to work in diverse teams on tasks in the field of membrane technology. They will be able to make decisions			
	within their group on laboratory experiments to be unde	rtaken jointly and present these to ot	hers.	
Autonomy	Students will be in a position to solve homework on the	ne tonic of membrane technology in	dependently. The	w will be capable o
Autonomy	finding creative solutions to technical questions.	le topic of membrane technology in	dependently. The	y will be capable o
	many creative solutions to teermen questions.			
Workload in Hours	Independent Study Time 124, Study Time 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 Traffic: Elect	ive Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation A - General Biopr	ocess Engineering: Elective Compulso	ory	
	Bioprocess Engineering: Specialisation B - Industrial Biop	process Engineering: Elective Compul	sory	
	Chemical and Bioprocess Engineering: Specialisation Ch	emical Process Engineering: Elective	Compulsory	
	Chemical and Bioprocess Engineering: Specialisation Ge	neral Process Engineering: Elective C	ompulsory	
	Environmental Engineering: Specialisation Water: Electiv	ve Compulsory		
	Joint European Master in Environmental Studies - Cities	and Sustainability: Specialisation Wat	er: Elective Comp	oulsory
	Process Engineering: Specialisation Process Engineering	: Elective Compulsory		
	Process Engineering: Specialisation Environmental Proce	ess Engineering: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Water	ater: Elective Compulsory		
	Water and Environmental Engineering: Specialisation En	vironment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Cit	ies: 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	 T. Melin, R. Rautenbach: Membranverfahren: Grundlagen der Modul- und Anlagenauslegung (2., erweiterte Auflage), Springer-Verlag, Berlin 2004. Marcel Mulder, Basic Principles of Membrane Technology, Kluwer Academic Publishers, Dordrecht, The Netherlands Richard W. Baker, Membrane Technology and Applications, Second Edition, John Wiley & Sons, Ltd., 2004

Course L0400: Membrane Te	Course 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 Technology			
Courses				
Title		Тур	Hrs/wk	СР
Process Modelling of Wastewater T	reatment (L0522)	Project-/problem-based Learning	2	3
Process Modeling in Drinking Water	Treatment (L0314)	Project-/problem-based Learning	2	3
Module Responsible	Dr. Klaus Johannsen			
Admission Requirements	None			
Recommended Previous	Knowledge of the most important processes in drinking	g water and waste water treatment.		
Knowledge				
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	Students are able to explain selected processes of de	rinking water and waste water treatment i	n detail. The	y are able to explain
	basics as well as possibilities and limitations of dynam	ic modeling.		
Skills	Students are able to use the most important features	Modelica offers. They are able to transpo	se selected i	processes in drinking
Skiiis	water and waste water treatment into a mathematica			_
	They are able to set up and apply models and assess	·	,	
		·		
Personal Competence				
Social Competence	Students are able to solve problems and document so	lutions in a group with members of differe	nt technical b	background. They are
,	able to give appropriate feedback and can work const			
Autonomy	Students are able to define a problem, gain the require	ed knowledge and set up a model.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	6		
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Ele	ctive Compulsory		
Following Curricula	Environmental Engineering: Specialisation Water: Elec	tive Compulsory		
	Joint European Master in Environmental Studies - Citie	s and Sustainability: Specialisation Water: I	Elective Comp	pulsory
	Process Engineering: Specialisation Environmental Pro	cess Engineering: Elective Compulsory		
	Process Engineering: Specialisation Process Engineering			
	Water and Environmental Engineering: Specialisation	• •		
	Water and Environmental Engineering: Specialisation			
	Water and Environmental Engineering: Specialisation	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)
	Studge Treatment (ADM, derobic autotrermal)
	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
1	

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
Courses	
Title	Typ Hrs/wk CP
Module Responsible	Dozenten des SD B
Admission Requirements	None
Recommended Previous	a Design of Lighan Diaming
Knowledge	Basics of Urban Planning Urban Infrastructures (Water, Energy, Heat)
	Environmental Technologies (Solid Waste Disposal, Air Quality Control, Wastewater Treatement, etc.)
	, , , , , , , , , , , , , , , , , , ,
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 can
	exemplify the state of technology and application and discuss critically in the context of actual problems and general conditions of
	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, and
	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 has
	to be adjusted. General findings and further developments may essentially be outlined.
Davisanal Campatanas	
Personal Competence	The students are able to condense the relevance and the structure of the project work, the work steps and the sub-problems for
30ciai competence	the presentation and discussion in front of a bigger group. They can lead the discussion and give a feedback on the project to their
	colleagues.
Autonomy	The students are capable of independently planning and documenting the work steps and procedures while considering the given
	deadlines. This includes the ability to accurately procure the newest scientific information. Furthermore, they can obtain feedback
	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	
Course achievement	
Examination	
Examination duration and	
scale	
Againment for the	Water and Environmental Engineering, Caecialization Cities, Computer vision
Assignment for the Following Curricula	Water and Environmental Engineering: Specialisation Cities: Compulsory
i ollowing curricula	

Module M0949: Rura	Development and Resources Oriented	Sanitation for diffe	erent Climate Zon	ies
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			
Recommended Previous	Basic knowledge of the global situation with rising pove	rty, soil degradation, lack of v	water resources and sanita	ation
Knowledge				
Educational Objectives	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 so	ource control in detail. Th	ey can comment o
	techniques designed for reuse of water, nutrients and so	oil conditioners.		
	Students are able to discuss a wide range of proven app	proaches in Rural Develonme	nt from and for many region	ons of the world
	Students are usic to discuss a wide range of proven app	orodenes in Raiai Developinei	it from and for many region	ons of the world.
Skills	Students are able to design low-tech/low-cost sanitat			
	rehabilitation of top soil quality combined with food and		consult on the basics of	soil building throug
	"Holisitc Planned Grazing" as developed by Allan Savory	ý.		
Personal Competence				
•	The students are able to develop a specific topic in a tea	am and to work out milestone	es according to a given pla	ın.
•				
Autonomy	·	to organize their work flow i	ndependently. They can a	also present on th
	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	towards mile stones. The wor	k includes presentations	and papers. Detaile
scale	information will be provided at the beginning of the sme	ester.		
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elect	tive Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation A - General Biopr	rocess Engineering: Elective (Compulsory	
	Chemical and Bioprocess Engineering: Specialisation Ge	eneral Process Engineering: E	lective Compulsory	
	Environmental Engineering: Specialisation Water: Electi	ve Compulsory		
	International Management and Engineering: Specialisati	ion II. Energy and Environmer	ntal Engineering: Elective	Compulsory
	Joint European Master in Environmental Studies - Cities	and Sustainability: Specialisa	tion Water: Elective Comp	ulsory
	Process Engineering: Specialisation Environmental Proce	ess Engineering: Elective Con	npulsory	
	Process Engineering: Specialisation Process Engineering			
	Water and Environmental Engineering: Specialisation W	ater: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Er	·	sory	
	Water and Environmental Engineering: Specialisation Ci	ties: Elective Compulsory		

Course L0942: Rural Develop	oment 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	
	 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. 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.
Literature	 J. Lange, R. Otterpohl 2000: Abwasser - Handbuch zu einer zukunftsfähigen Abwasserwirtschaft. Mallbeton Verlag (TUHH Bibliothek) Winblad, Uno and Simpson-Hébert, Mayling 2004: Ecological Sanitation, EcoSanRes, Sweden (free download) Schober, Sabine: WTO/TUHH Award winning Terra Preta Toilet Design: http://youtu.be/w_R09cYq6ys

	ment and Resources Oriented Sanitation for different Climate Zones
	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	 Living Soil - THE key element of Rural Development Participatory Approaches Rainwater Harvesting Ecological Sanitation Principles and practical examples Permaculture Principles of Rural Development Performance and Resilience of Organic Small Farms Going Further: The TUHH Toolbox for Rural Development EMAS Technologies, Low cost drinking water supply
Literature	 Miracle Water Village, India, Integrated Rainwater Harvesting, Water Efficiency, Reforestation and Sanitation: http://youtu.be/9hmkgn0nBgk Montgomery, David R. 2007: Dirt: The Erosion of Civilizations, University of California Press

Module M1716: Subsi	urface Processes			
Courses				
Courses				
Γitle	(4.0720)	Тур	Hrs/wk	СР
Modeling of Subsurface Processes Modeling of Subsurface Processes		Lecture Recitation Section (small)	2 1	2 1
Modern Techniques for Subsurface		Lecture	2	2
Modern Techniques for Subsurface	•	Recitation Section (large)	1	1
Module Responsible				
Admission Requirements	None			
Recommended Previous	Basic Mathematics, Hydrology			
Knowledge				
Educational Objectives	After taking part successfully, students have reach	ned the following learning results		
Professional Competence	31	3		
Knowledge	Upon completion of this module, the students w	vill understand the mechanisms controlling	solute transpor	t in soil and natura
	porous media and will be able to work with the eq	· · · · · · · · · · · · · · · · · · ·		
	numerical and experimental tools and techniques	·		
	4,11			
Skills	In addition to the physical insights, the students w	vill be exposed to analytical, experimental	and numerical to	ols and techniques
	this module. This provides them with an excellent	opportunity to improve their skills on mult	iple fronts which	will be useful in the
	future career.			
Personal Competence				
Social Competence	Teamwork & problem solving			
Autonomy	The students will be involved in writing individu	ual reports and presentation. This will co	ntribute to the	students' ability an
	willingness to work independently and responsibly			
Workload in Hours	Independent Study Time 96, Study Time in Lecture	e 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 Engineer	ering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engi	ineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineeri	ng: Elective Compulsory		
	Civil Engineering: Specialisation Water and Traffic	Elective Compulsory		
	Process Engineering: Specialisation Environmental	Process Engineering: Elective Compulsory		
	Process Engineering: Specialisation Process Engine	eering: Elective Compulsory		
	Water and Environmental Engineering: Specialisat	ion Water: Compulsory		
	Water and Environmental Engineering: Specialisat	ion Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialisat	in Cities Flority Committee		

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	ourse 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: Emer	ging Trends in Environmental Engi	neering		
Courses				
Title		Тур	Hrs/wk	СР
Environmental Research Trends (L2	2752)	Seminar	2	2
Microplastics in Environment (L275		Lecture	2	2
Scientific Communication and Meth	nods (L2751)	Lecture	1	2
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
Recommended Previous	Basic knowledge on water, soil and environmental	research.		
Knowledge				
Educational Objectives	After taking part successfully, students have reach	ned 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 particul focus on the effects of microplastics in environment. Data analysis, data measurement, curation and presentation will be otherwise 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 approache the students will be exposed to current research trends in environmental engineering.			
Personal Competence				
Social Competence	Developing teamwork and problem solving skills the	hrough Research-Based Teaching ap	proaches will be at the o	core of this module.
Autonomy	The students will be involved in writing individual	ual reports and presentation. This	will contribute to the	students' ability and
	willingness to work independently and responsibly			
Workload in Hours	Independent Study Time 110, Study Time in Lectu	ro 70		
Credit points	, , , , , , , , , , , , , , , , , , , ,	10 70		
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Report and Presentation			
scale	nepore and resentation			
Assignment for the	Civil Engineering: Specialisation Water and Traffic	Flective Compulsory		
Following Curricula	Environmental Engineering: Specialisation Water:			
. ccg carricula	Environmental Engineering: Specialisation Waste			
	Environmental Engineering: Specialisation Biotech			
	Water and Environmental Engineering: Specialisat			
	Water and Environmental Engineering: Specialisat	, ,	ry	
	Water and Environmental Engineering: Specialisat	ion Water: Elective Compulsory		

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

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

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

ourses	
itle peration of Public Transportation	Typ Hrs/wk CP Systems (L1179) Project-/problem-based Learning 4 6
Module Responsible	
Admission Requirements	
	some knowledge of transport planning, e.g. through taking the undergraduate class "Transport Planning and Traffic Engineeri
Knowledge	Some knowledge of transport planning, e.g. through taking the undergraduate class "Transport Flanning and Transc Engineers
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to:
	describe public transport (PT) systems in technical language.
	outline the entire PT system including the interdependencies of the different elements.
	explain the requirements for a PT system from different perspectives.
	explain the role of PT in the transport system.
Skills	Students are able to:
	systematically develop a public transport system when there are no clear cut correct or incorrect approaches.
	cope with imprecise and incomplete data.
	develop and appraise alternative solutions.
	distinguish or develop appropriate methods of analysis and modes of presentation.
	reflect and evaluate their own transport concept, considering competing requirements.
Personal Competence	
	Students are able to:
,	
	 carry out and complete a group project, inclusive of an appropriate allocation of tasks.
	constructively provide and accept feedback.
	present their own results to others.
•	
Autonomy	independently develop a bus PT concept within a given framework.
	determine and justify the focus of their work.
	organize and follow their work process regarding time and content.
	independently author a written report.
	assess the consequences of the solutions they develop.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	
	Written elaboration
Examination duration and	
scale	The second secon
Assignment for the	Logistics, Infrastructure and Mobility: Core Qualification: Compulsory
Following Curricula	

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

Module M1779: Susta	inable Nature-based Coastal Protectio	n in a Changing Climate (Se	eaPiaC)	
Courses				
Title Sustainable Nature-based Coastal F	Protection in a Changing Climate (SeaPiaC) (L2926)	Typ Project-/problem-based Learning	Hrs/wk	CP 6
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous Knowledge	Hydraulic Engineering Hydromechanics, Hydraulics Fundamentals of Coastal Engineering, Coastal- an	d Flood Protection		
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence Knowledge	 Climate and Climate Change General Impacts of Climate Change on Wind Regir Consequences of Climate Change for Coastal Proc Coastal Protection in Taiwan and Germany Fundamentals of Climate Adaptation Nature-based Solutions (NBS) for Coastal Protection 	esses		
Skills	 Critical thinking: analysis of processes and relation Creative thinking: development of adaptation stra Practical thinking: inclusion of restrictions, appli methods Consideration of complex tasks 	tegies and adaptation measures	ods, numerica	l models, plannin
Personal Competence Social Competence	 Working in heterogenous groups Working in international groups Working with different scientific / non-scientific dis 	sciplines		
Autonomy	 Self reflection Application oriented use of knowledge and skills Autonomous work on complex tasks 			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Preparation of a written report on a complex task with	a presentation and subsequent discussion	on. The work o	n the complex tas
scale	happens in the course of the lecture.			
Assignment for the	Civil Engineering: Specialisation Coastal Engineering: Ele	ective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Civil Engineering: Specialisation Structural Engineering: Civil Engineering: Specialisation Water and Traffic Electric	Elective Compulsory		
	Civil Engineering: Specialisation Water and Traffic: Electi Water and Environmental Engineering: Specialisation Cit Water and Environmental Engineering: Specialisation En Water and Environmental Engineering: Specialisation Wa	ies: Elective Compulsory vironment: Elective Compulsory		

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

Module M1505: Adapt	tation to Climate Change in Hy	draulic Engineering (AKWAS)		
Courses				
Title		Tim	Una hude	CD
Title Adaptation to climate change in hy	draulic engineering (L2291)	Typ Project-/problem-based Learning	Hrs/wk 4	CP 6
Module Responsible		reject/problem basea Leanning		
Admission Requirements				
Recommended Previous	None			
Knowledge	Hydrology, Hydraulic Engineering			
3	Hydromechanic, Hydraulics			
	Fundamentals of Coastal Engineering,	Coastal- and Flood Protection		
	Hydrological Systems			
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
Knowledge	Climate and alimate adapta	N. C.		
	 Climate protection and climate adapta Insights into climate change and its re- 	tion gional characteristics - fundamentals, climate model	ling / climate	models
		ponents of the regional hydrological cycle	iiig / ciiiilate	inoueis
	Fundamentals of analysis of climate da			
	Consequences of the impact of the clir			
	Measures for climate adaptation			
	 Assessment, prioritization and commu 	nication of adaptation measures		
	Fundamentals of the analysis of hydro	meteorological and hydrological data		
Skills				
Skins	 Critical thinking: analysis of processes 	and relations, assessment of needs for action		
	 Creative thinking: development of ada 	ptation strategies and adaptation measures		
		tions, application of calculation approaches, meth	ods, numeric	al models, plannin
	methods			
	Consideration of complex tasks			
Personal Competence				
Social Competence				
,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	Working in heterogenous groups			
	Working with different scientific / non-scientific /	scientific disciplines		
	Self reflection			
Autonomy	A It			
	Application oriented use of knowledge Autonomous work on sampley tasks	and skills		
	Autonomous work on complex tasks			
Workload in Hours	Independent Study Time 124, Study Time in	Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
	Preparation of a written report and a present	ation of a complex task.		
scale				
•	Civil Engineering: Specialisation Coastal Engi	• •		
Following Curricula	Civil Engineering: Specialisation Geotechnica			
	Civil Engineering: Specialisation Structural Er Civil Engineering: Specialisation Water and Ti			
	Water and Environmental Engineering: Specialisation water and in	· · ·		
	Water and Environmental Engineering: Special	• •		
	Water and Environmental Engineering: Specia			
	a.c. and Environmental Engineering. Speci	ansacion vvacci. Elective compaisory		

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

Specialization Environment

Module M0830: Enviro	onmental Protection and Management			
Courses				
Title		Тур	Hrs/wk	СР
Integrated Pollution Control (L0502	.)	Lecture	2	2
Health, Safety and Environmental N		Lecture	2	3
Health, Safety and Environmental N		Recitation Section (small)	1	1
Module Responsible	·			
Admission Requirements				
Recommended Previous	Good knowledge in Technologies for Environmental Pro	ection (end-of-pipe, integrated so	lutions)	
Knowledge	Good knowledge of the relevant Environmental Legislat			
	Basic knowledge of instruments for Environmental Asse			
Educational Objectives	After taking part successfully, students have reached the follo	wing learning results		
Professional Competence				
Knowledge	The students are able to describe the basics of regulations			
	legislation ISO 14001, EMAS and Responsible Care ISO 1400			*
	substance cycles and approaches from end-of-pipe technol			_
	knowledge of complex industry related problems. They are a carry out innovative technical solutions, remediation measure			
	approaches in the full range of problems in different industrial		veii as concept	dar problem solving
	approaches in the fair range of problems in amerene industrial	300013.		
Skille	Students are able to assess current problems and situations	in the field of environmental prot	ection They ca	an consider the hest
Skills	available techniques and to plan and suggest concrete action			
	solve problems on a technical, administrative and legislative le		ic context. by t	ins means they can
Personal Competence				
-	The students can work together in international groups.			
Social Competence	The statemes can from together in international groups.			
Autonomy	Students are able to organize their work flow to prepare ther	nselves for presentations and cor	tributions to th	ne discussions. They
,	can acquire appropriate knowledge by making enquiries indep			,
		,		
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: Elective Co	mpulsory		
Following Curricula	Bioprocess Engineering: Specialisation C - Bioeconomic P	ocess Engineering, Focus Mana	gement and (Controlling: Elective
	Compulsory			
	Environmental Engineering: Core Qualification: Compulsory			
	Joint European Master in Environmental Studies - Cities and Su	• •		•
	Joint European Master in Environmental Studies - Cities and Su			oulsory
	Product Development, Materials and Production: Specialisation	·		
	Product Development, Materials and Production: Specialisation			
	Product Development, Materials and Production: Specialisation			
	Process Engineering: Specialisation Environmental Process En			
	Water and Environmental Engineering: Specialisation Environmental Engineering: Specialisation Cities: C			
	Water and Environmental Engineering: Specialisation Cities: C	ompulsory		

Course L0502: Integrated Po	llution 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
Content	The lecture focusses on:
Literature	 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	 Objectives of and benefit from HSE management From dilution and end-of-pipe technology to eco-efficiency and eco-effectiveness Behaviour control: regulations, economic instruments and voluntary initiatives 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 Crisis management
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	

Engineering					
Module M0902: Wasto	ewater Treatment and Air Poll	lution Abatement			
Courses					
Γitle		Тур	Hrs/wk	CP	
Biological Wastewater Treatment (.0517)	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 chemistry				
Knowledge	Basic knowledge of solids process engineer	ing and separation technology			
Educational Objectives	After taking part successfully, students have	e reached the following learning results			
Professional Competence					
Knowledge	After successful completion of the module s	students are able to			
	 name and explain biological processe 	os for waste water treatment			
	characterize waste water and sewage				
	discuss legal regulations in the area of the discussion legal regulations in the discussion legal regulation legal regul	•			
	explain the effects of air pollutants or	• •			
		processes and to define their area of applicat	ion		
Skills	Students are able to				
	choose and design processs steps for the biological waste water treatment				
	combine processes for cleaning of of	f-gases depending on the pollutants containe	ed in the gases		
Dorgonal Compatones					
Personal Competence Social Competence					
Autonomy					
Workload in Hours	Independent Study Time 124, Study Time ir	n Lecture 56			
Credit points	6	T Lecture 30			
Course achievement	None				
Examination	Written exam				
Examination duration and	90 min				
scale	36 11111				
Assignment for the	Civil Engineering: Specialisation Water and	Traffic: Elective Compulsory			
Following Curricula		General Bioprocess Engineering: Elective Com	npulsory		
	Chemical and Bioprocess Engineering: Spec	cialisation General Process Engineering: Elect	rive Compulsory		
	Environmental Engineering: Specialisation V	Waste and Energy: Elective Compulsory			
	International Management and Engineering	: Specialisation II. Energy and Environmental	Engineering: Elective	Compulsory	
	Joint European Master in Environmental Stu	dies - Cities and Sustainability: Specialisation	n Water: Elective Comp	ulsory	
	Renewable Energies: Specialisation Bioener	rgy Systems: Elective Compulsory			
	Process Engineering: Specialisation Environ	mental Process Engineering: Elective Compu	Isory		
	Process Engineering: Specialisation Process				
	Water and Environmental Engineering: Spec				
	Water and Environmental Engineering: Spec				
	Water and Environmental Engineering: Spec	cialisation Cities: Compulsory			

Тур	Lecture
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	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

<u> </u>	
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;)
	Biologie der Abwasserreinigung : 18 Tabellen
	ISBN: 382741427X URL: http://www.gbv.de/du/services/agi/94B581161B6EC747C1256E3F005A8143/420000114903
	Heidelberg [u.a.] : Spektrum, Akad. Verl., 2003
	TUB_HH_Katalog
	Tchobanoglous, George (Metcalf & Eddy, Inc., ;)
	Wastewater engineering : treatment and reuse
	ISBN: 0070418780 (alk. paper) ISBN: 0071122508 (ISE (*pbk))
	Boston [u.a.] : McGraw-Hill, 2003
	TUB_HH_Katalog
	Henze, Mogens
	Activated sludge models ASM1, ASM2, ASM2d and ASM3
	ISBN: 1900222248
	London: IWA Publ., 2002
	TUB_HH_Katalog
	Kunz, Peter
	Umwelt-Bioverfahrenstechnik
	Vieweg, 1992
	Bauhaus-Universität., Arbeitsgruppe Weiterbildendes Studium Wasser und Umwelt (Deutsche Vereinigung für
	Wasserwirtschaft, Abwasser und Abfall, ;)
	Abwasserbehandlung : Gewässerbelastung, Bemessungsgrundlagen, Mechanische Verfahren, Biologische Verfahren, Reststoffe
	aus der Abwasserbehandlung, Kleinkläranlagen
	ISBN: 3860682725 URL: http://www.gbv.de/dms/weimar/toc/513989765_toc.pdf URL:
	http://www.gbv.de/dms/weimar/abs/513989765_abs.pdf
	Weimar: Universitätsverl, 2006
	TUB_HH_Katalog
	Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall
	DWA-Regelwerk
	Hennef: DWA, 2004
	TUB_HH_Katalog
	Wiesmann, Udo (Choi, In Su; Dombrowski, Eva-Maria;)
	Fundamentals of biological wastewater treatment
	ISBN: 3527312196 (Gb.) URL: http://deposit.ddb.de/cgi-bin/dokserv?id=2774611&prov=M&dok_var=1&dok_ext=htm
	Weinheim: WILEY-VCH, 2007
	TUB_HH_Katalog

Course 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

Module M1403: Const	truction and Simulation of Sewera	ge Systems		
Courses				
Title		Тур	Hrs/wk	СР
Construction and renovation of urb	-	Seminar	3	3
Simulation of sewerage systems (L		Seminar	3	3
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
Recommended Previous Knowledge	Hydraulics in pipes and gravity-sewers Mechanics Soil mechanics and foundation engineering Knowledge about urban sewerage systems	and water management		
Educational Objectives	After taking part successfully, students have reacl	ned the following learning results		
Professional Competence				
Knowledge	Students can describe urban wastewater systems by means of software-based modeling. In case studies they can perform system and weak point analyzes. In addition, they can analyze the hydraulic effects quantitatively. Furthermore, they have the knowledge 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 the knowledge regarding different renovation technologies for sewer systems is acquired.			
Skills	The students can simulate different run-off events in sewer systems and are able to dimension the sewer systems accordingly. Moreover, they can determine suitable construction materials and static requirements for different cases of application.			
Personal 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 w simulation of sewer systems. Furthermore, they a			r dimensioning and
Workload in Hours	Independent Study Time 96, Study Time in Lectur	e 84		
Credit points	6			
Course achievement	CompulsoryBonusFormNo20 %Presentation	Description		
Examination	Written elaboration			
Examination duration and	nach Absprache			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic	: Compulsory		
Following Curricula	Water and Environmental Engineering: Specialisat	ion Water: Compulsory		
	Water and Environmental Engineering: Specialisat	ion Environment: Elective Compulsory		

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	EN	
Cycle	WiSe	
Content	The lecture focusses on construction and renovation of urban se	ewer pipelines.
	Construction:	
	Pipe materials, types and joint technology	
	Open trenches	
	Trenchless technologies	
	Pipe Statics:	
	 Design of sewers according to ATV A 127 	
	Earth pressure on pipes, pipe deformation, cutting forces	5
	 Comparison with other international calculation approach 	hes
	Renovation:	
	Failure case study	
	Overview on the different renovation technologies	
	Liner design according to DWA-A 143	
Literature		Titel
		ATV A 127, Abwassertechnische Vereinigung e.V., Arbeitsblatt A 127, Regelwerk Abwasser-Abfall, Vertrieb: GFA, DK 628.22
		(083),A 127, 2000
	2	DIN EN 1610, Verlegung und Prüfung von Abwasserleitungen und
		-kanälen, Beuth Verlag, Berlin, 1997
	3	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.
	6	Zeitschrift 3R, Fachzeitschrift für sichere und effiziente
	7	Rohrleitungssysteme Handbuch für den Rohrleitungsbau Band 1 und 2, 4. Auflage,
		Günter Wossog, 2015
	8	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 & Partner
	10	GmbH, 2014
	10	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	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	Modeling of sewer systems:	
	 Modeling approaches in wastewater management, especially approaches to integrated modeling Planning processes, calculations and design approaches for elements of gravity-sewers Model setup St. Venant equation and simplifications of models (kinematic wave etc.) Calculation & modeling of solids transport (advection, diffusion, dispersion and sales processes) Examples for modeling with SWMM (EPA, USA) 	
Literature		

Engineering"				
Module M0581: Wate	r Protection			
•				
Courses				
Title		Тур	Hrs/wk	CP
Water Protection and Wastewater I		Lecture Project Communication	3	3
Water Protection and Wastewater I		Project Seminar	3	3
Module Responsible	·			
Admission Requirements	None			
Recommended Previous	 Basic knowledge in water management; 			
Knowledge	 Good knowledge in urban drainage; 			
	 Good knowledge of wastewater treatment ted 	chniques;		
	 Good knowledge of pollutants (e.g. COD, BOD 	, TS, N, P) and their properties;		
Educational Objectives	After taking part successfully, students have reache	d the following learning results		
Professional Competence	Σ μ	<u> </u>		
Knowledge	The students can describe the basic principles of th	e regulatory framework related to the	e international and Eu	ropean water sector
	They can explain limnological processes, substance			
	problems related to water protection, such as eco			
	solutions, remediation measures as well as concept			
···			111 1	
Skills	Students can accurately assess current problems a			
	actions to contribute to the planning of tomorrow		they can suggest ap	propriate technical,
	administrative and legislative solutions to solve the	se problems.		
Personal Competence				
	The students can work together in international gro	ins		
social competence	The state in section with together in international gro			
Autonomy	·	epare presentations and discussions.	They can acquire ap	propriate knowledge
	by making enquiries independently.			
Workload in Hours	Independent Study Time 96, Study Time in Lecture	84		
Credit points		-		
Course achievement	None			
Examination	Presentation			
Examination duration and	Term paper plus presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineer	ing: Flective Compulsors		
Following Curricula	Civil Engineering: Specialisation Structural Engineer Civil Engineering: Specialisation Geotechnical Engin			
. Onowing Curricula	Civil Engineering: Specialisation Coastal Engineering			
	Civil Engineering: Specialisation Water and Traffic: E	' '		
	Environmental Engineering: Specialisation Water En			
	International Management and Engineering: Special		Compulsorv	
	Joint European Master in Environmental Studies - Cit	• •		oulsorv
	Water and Environmental Engineering: Specialisatio		Zicciive comp	,
	Water and Environmental Engineering: Specialisatio			
	Water and Environmental Engineering: Specialisatio			

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

Course L2008: Water Protect	ourse 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			

Linginicering				
Module M0511: Electi	rical Energy from Solar Radiation an	d 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		Lecture	1	1
Module Responsible				
Admission Requirements	None			
Recommended Previous	Module: Technical Thermodynamics I,			
Knowledge	Module: Technical Thermodynamics II,			
	Module: Fundamentals of Fluid Mechanics			
Educational Objectives	After taking part successfully, students have reache	d the following learning results		
Professional Competence				
Knowledge	By ending this module students can explain in det	ail knowledge of wind turbines w	ith a particular focus of	wind energy use in
	offshore conditions and can critical comment these			
	to describe fundamentally the use of water power to	·	s reproduce and explain	the basic procedure
	in the implementation of renewable energy projects	in countries outside Europe.		
	Through active discussions of various topics within	n the seminar of the module, stu	dents improve their un-	derstanding and the
	application of the theoretical background and are th	us able to transfer what they have	learned in practice.	
CI:II-	Charles and the control of the contr	-1 6		
Skills	Students are able to apply the acquired theoretic assess technically the resulting relationships in the			
	compare critically the special procedure for the imp			
	in principle applied approach in Europe and can app			side Ediope with the
		,, p		
Personal Competence				
Social Competence	Students can discuss scientific tasks subjet-specific	ly and multidisciplinary within a se	minar.	
Autonomy	Students can independently exploit sources in the	context of the emphasis of the le	ecture material to clear	the contents of the
	lecture and to acquire the particular knowledge about	ut the subject area.		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 8	84		
Credit points		J-T		
Course achievement				
Examination	Written exam			
	2.5 hours written exam + written elaboration (incl. p	presentation) in sustainability man	agement	
scale	215 Hours Witten exam 1 Witten diaboration (man)	nesentation, in sustainasint, main	agement	
Assignment for the	Civil Engineering: Specialisation Structural Engineeri	ing: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engine			
-	Civil Engineering: Specialisation Coastal Engineering	: Elective Compulsory		
	International Management and Engineering: Special	isation II. Energy and Environment	al Engineering: Elective	Compulsory
	International Management and Engineering: Special	sation II. Renewable Energy: Elect	ive Compulsory	
	Product Development, Materials and Production: Spe	ecialisation Product Development:	Elective Compulsory	
	Product Development, Materials and Production: Spe	ecialisation Production: Elective Co	mpulsory	
	Product Development, Materials and Production: Spe	ecialisation Materials: Elective Com	npulsory	
	Renewable Energies: Core Qualification: Compulsory			
	Theoretical Mechanical Engineering: Specialisation E		•	
	Process Engineering: Specialisation Environmental P		oulsory	
	Water and Environmental Engineering: Specialisation			
	Water and Environmental Engineering: Specialisation	n 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:
	 What is "sustainability"? Why is this concept an important topic for companies? What opportunities and business risks are addressed or are associated with it? 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? What concepts or frameworks exist for the implementation of sustainability management in companies? Which sustainability labels exist for products or companies? What do they have in common, and where do they differ?
	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. 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 in sustainability aspects are taken into account in management decisions.
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	 Introduction, importance of water power in the national and global context Physical basics: Bernoulli's equation, usable height of fall, hydrological measures, loss mechanisms, efficiencies Classification of Hydropower: Flow and Storage hydropower, low and high pressure systems Construction of hydroelectric power plants: description of the individual components and their technical system interaction Structural engineering components; representation of dams, weirs, dams, power houses, computer systems, etc. Energy Technical Components: Illustration of the different types of hydraulic machinery, generators and grid connection Hydropower and the Environment Examples from practice
Literature	 Schröder, W.; Euler, G.; Schneider, K.: Grundlagen des Wasserbaus; Werner, Düsseldorf, 1999, 4. Auflage Quaschning, V.: Regenerative Energiesysteme: Technologie - Berechnung - Simulation; Carl Hanser, München, 2011, 7. Auflage Giesecke, J.; Heimerl, S.; Mosony, E.: Wasserkraftanlagen - Planung, Bau und Betrieb; Springer, Berlin, Heidelberg, 2009, 5. Auflage von König, F.; Jehle, C.: Bau von Wasserkraftanlagen - Praxisbezogene Planungsunterlagen; C. F. Müller, Heidelberg, 2005, 4. Auflage Strobl, T.; Zunic, F.: Wasserbau: Aktuelle Grundlagen - Neue Entwicklungen; Springer, Berlin, Heidelberg, 2006

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

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

Engineering"				
Module M0827: Modeling in Water Management				
Courses				
Title		Тур	Hrs/wk	СР
Groundwater Modeling using Modflow (L0543)		Lecture	1	1
Groundwater Modeling using Modflow (L0544)		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			
Recommended Previous	Groundwater			
Knowledge	 groundwater hydraulics and transport of substance 	ras.		
	• groundwater flydraulics and transport of substant	es		
	Pipe Systems			
	 Knowledge on urban water infrastructures, in page 1 	particular drinking water systemsand i	ırhan drainad	a systems including
	special structures	difficular difficing water systemsand t	irbair drainag	e systems including
	Hydraulics of drinking water supply systems and s	sewer systems		
	Basic knowledge on water management			
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
Knowledge	The students are able to describe the modelling of groun			_
	carry out systems analyses and can detect technical and conceptual weak points within the systems in case studies. Besides they			
	are able to analyse interdependencies of hydraulic and t	oxic phenomena in soil and water.		
CL'III.	The state of the s			P.CC.
SKIIIS	The students are able to construct and apply scientific			
	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, EP	A-SWIMM).		
Personal Competence				
Social Competence	Wird nicht vermittelt.			
Autonomy	Wird nicht vermittelt.			
Autonomy	with them verificete.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	20 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering:	Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering	ng: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Ele			
	Civil Engineering: Specialisation Water and Traffic: Elect			
	Water and Environmental Engineering: Specialisation Wa			
	Water and Environmental Engineering: Specialisation En			
	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: PMWIN

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

ourse 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.	

Engineering						
Module M1717: Adva	nced Vadose Zone Hydrology					
Courses						
Title		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)		Recitation Section (large)	2	2		
Module Responsible	Prof. Nima Shokri					
Admission Requirements	None					
Recommended Previous						
Knowledge						
Educational Objectives	After taking part successfully, students hav	e reached 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 Water and	Traffic: Elective Compulsory				
	Environmental Engineering: Specialisation \	Water: Elective Compulsory				
	Environmental Engineering: Specialisation \	Water: Elective Compulsory				
	Water and Environmental Engineering: Specialisation Water: Elective Compulsory					
	Water and Environmental Engineering: Spe-	cialisation Environment: Elective Compulsory				
	Water and Environmental Engineering: Spe-	cialisation Cities: Elective Compulsory				
	Water and Environmental Engineering: Spe-	cialisation Cities: Elective Compulsory				
	Water and Environmental Engineering: Spe-	cialisation Environment: Elective Compulsory				
	Water and Environmental Engineering: Spe-	cialisation Water: Elective Compulsory				

Course L2734: Modeling Prod	ourse 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 Prod	ourse 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	
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	

Madula M1710, Madula	share Flow in Dayous Medi-					
Module MT/18: Multi	phase Flow in Porous Media					
Courses						
		_		CD.		
Title Advanced Medeling Techniques for	Multiphaca Flow in Paraus Madia (12729)	Typ Recitation Section (small)	Hrs/wk 2	CP 2		
Fundamentals of Multiphase Flow i	Multiphase Flow in Porous Media (L2738) Decrous Media (L2736)	Lecture	2	2		
Fundamentals of Multiphase Flow in		Recitation Section (large)	2	2		
Module Responsible						
Admission Requirements						
Recommended Previous						
Knowledge						
	After taking part successfully, students have reach	ned 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						
Course achievement						
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 Engi	ineering: Elective Compulsory				
_	Civil Engineering: Specialisation Geotechnical Engi	ineering: 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: Specialisat	ion Cities: Elective Compulsory				
	Water and Environmental Engineering: Specialisat	ion Cities: Elective Compulsory				
	Water and Environmental Engineering: Specialisat	ion Environment: Elective Compulsory				
	Water and Environmental Engineering: Specialisat	, ,				
	Water and Environmental Engineering: Specialisat					
	Water and Environmental Engineering: Specialisat	ion Water: Elective Compulsory				

ourse 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: Water	and Environment: Theory and Applica	ation		
Courses				
Title		Тур	Hrs/wk	СР
Water and Environment: Application	n and Field Work (L2754)	Project-/problem-based Learning	3	4
Water and Environment: Theory (L2	7753)	Lecture	1	2
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	e 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 (about 15 m	nin)		
scale				
Assignment for the	Civil Engineering: Specialisation Coastal Engineering: Ele	ective Compulsory		
Following Curricula	Civil Engineering: Specialisation Water and Traffic: Election	ive Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Ele	ective Compulsory		
	Civil Engineering: Specialisation Water and Traffic: Election	ive Compulsory		
	Environmental Engineering: Specialisation Water: Electiv	ve Compulsory		
	Environmental Engineering: Specialisation Water: Electiv	ve Compulsory		
	Water and Environmental Engineering: Specialisation Cit	ties: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Cit	ties: Elective Compulsory		
	Water and Environmental Engineering: Specialisation En	vironment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation En			
	Water and Environmental Engineering: Specialisation Wa	• •		
	Water and Environmental Engineering: Specialisation Wa	ater: 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: Syste	m Aspects of Renewable Energies			
Courses				
Title		Тур	Hrs/wk	CP
	ge: New Materials for Energy Production and Storage (L0021)	Lecture	2	2
Energy Trading (L0019)		Lecture	1	1
Energy Trading (L0020) Deep Geothermal Energy (L0025)		Recitation Section (small) Lecture	1 2	1 2
Module Responsible	Prof. Martin Kaltschmitt	Eccture		2
Admission Requirements	None			
Recommended Previous				
Knowledge	module. reclinical memodynamics i			
Kilowieuge	Module: Technical Thermodynamics II			
Educational Objectives	After taking part successfully, students have reached the fol	lowing learning results		
Professional Competence				
Knowledge	Students are able to describe the processes in energy trading and the design of energy markets and can critically evaluate them in 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.			
Skills	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 procedure other modules on renewable energy projects. In this context markets and energy trades.			
Personal Competence				
Social Competence	Students are able to discuss issues in the thematic fields in t	the renewable energy sector addr	essed within the	module.
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	3 hours written exam			
scale				
Assignment for the	Bioprocess Engineering: Specialisation A - General Bioproces	ss Engineering: Elective Compulso	ory	
Following Curricula	International Management and Engineering: Specialisation II	. Renewable Energy: Elective Con	npulsory	
	International Management and Engineering: Specialisation II	. Energy and Environmental Engir	neering: Elective	Compulsory
	International Management and Engineering: Specialisation II	. 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		
Тур	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	1. Introduction to electrochemical energy conversion 2. Function and structure of electrolyte 3. Low-temperature fuel cell	
Literature	Hamann, C.; Vielstich, W.: Elektrochemie 3. Aufl.; Weinheim: Wiley - VCH, 2003	

Course L0019: Energy Tradin	ıg
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	 Basic concepts and tradable products in energy markets Primary energy markets Electricity Markets European Emissions Trading Scheme Influence of renewable energy Real options Risk management Within the exercise the various tasks are actively discussed and applied to various cases of application.
Literature	

Course L0020: Energy Tradin	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	 Introduction to the deep geothermal use Geological Basics I Geology and thermal aspects Rock Physical Aspects Geochemical aspects Exploration of deep geothermal reservoirs Drilling technologies, piping and expansion Borehole Geophysics Underground system characterization and reservoir engineering Microbiology and Upper-day system components Adapted investment concepts, cost and environmental aspect
Literature	 Dipippo, R.: Geothermal Power Plants: Principles, Applications, Case Studies and Environmental Impact. Butterworth Heinemann; 3rd revised edition. (29. Mai 2012) www.geo-energy.org Edenhofer et al. (eds): Renewable Energy Sources and Climate Change Mitigation; Special Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, 2012. Kaltschmitt et al. (eds): Erneuerbare Energien: Systemtechnik, Wirtschaftlichkeit, Umweltaspekte. Springer, 5. Aufl. 2013. Kaltschmitt et al. (eds): Energie aus Erdwärme. Spektrum Akademischer Verlag; Auflage: 1999 (3. September 2001) Huenges, E. (ed.): Geothermal Energy Systems: Exploration, Development, and Utilization. Wiley-VCH Verlag GmbH & Co. KGaA; Auflage: 1. Auflage (19. April 2010)

Linginicering			
Module M0828: Urbai	n Environmental Management		
Courses			
Title	Тур	Hrs/wk	CP
Noise Protection (L1109)	Lecture	2	2
Urban Infrastructures (L0874)	Project-/problem-based Learnin	2	4
Module Responsible	Dr. Dorothea Rechtenbach		
Admission Requirements	None		
Recommended Previous	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 learning results		
Professional Competence			
Knowledge	Students can describe urban development corridors as well as current and future urban enviro	nmental proble	ms. They are able to
	explain the causes of environmental problems (like noise).		
	Students can specify applications for various technical innovations and explain why these con	ribute to the in	nprovement of urba
	life. They can, for example, derive and discuss measures for effective noise abatement.		
Skills	Skills Students are able to develop specific solutions for correcting existing or future environment-related pr		problems of urba
Skills	development. They can define a range of conceptual and technical solutions for environmenta		•
	paths. To solve specific urban environmental problems they can select technical innovations	•	
	context.	and integrate	them into the dibai
Personal Competence			
	The students can work together in international groups.		
Social competence	The statement can work together in international groups.		
Autonomy	Students are able to organize their work flow to prepare themselves for presentations and co	ntributions to t	he discussions. The
	can acquire appropriate knowledge by making enquiries independently.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points			
Course achievement			
Examination	Written elaboration		
Examination duration and			
scale	Whitein report plus draff resentation		
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory		
Following Curricula			
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory		
	Environmental Engineering: Core Qualification: Elective Compulsory		
	Joint European Master in Environmental Studies - Cities and Sustainability: Core Qualification: 0	Compulsory	
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure and Mobility: Elective Comp		
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Cities: Compulsory		

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

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

Module M1702: Proce	ess Imaging			
S				
Courses				
itle		Тур	Hrs/wk	СР
rocess Imaging (L2723)		Lecture	2	3
Process Imaging (L2724)		Project-/problem-based Learning	2	3
Module Responsible				
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following	ng 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 En	gaineering: Flective Compulsory		
Following Curricula				
ronowing curricula		, ,	,	
	Bioprocess Engineering: Specialisation B - Industrial Bioprocess Engineering: Elective Compulsory Bioprocess Engineering: Specialisation B - Industrial Bioprocess Engineering: Elective Compulsory			
	Bioprocess Engineering: Specialisation C - Bioeconomic Process Engineering, Focus Energy and Bioprocess Technology: Elective			
	Compulsory			
	Bioprocess Engineering: Specialisation C - Bioeconomic Process Engineering, Focus Energy and Bioprocess Technology: Elective			
	Compulsory			
	Chemical and Bioprocess Engineering: Specialisation General Pro	ocess Engineering: Elective Comp	oulsory	
	Chemical and Bioprocess Engineering: Specialisation General Pro			
	Chemical and Bioprocess Engineering: Specialisation Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Bioprocess Engineering: Elective Compulsory			
	Chemical and Bioprocess Engineering: Specialisation Bioprocess			
	Chemical and Bioprocess Engineering: Specialisation Chemical P			
	Chemical and Bioprocess Engineering: Specialisation Chemical P	rocess Engineering: Elective Com	npulsory	
	Computer Science: Specialisation II: Intelligence Engineering: Ele			
	Information and Communication Systems: Specialisation Commu		rocessing: Ele	ctive Compulsory
	International Management and Engineering: Specialisation II. Pro	cess Engineering and Biotechnol	logy: Elective (Compulsory
	Theoretical Mechanical Engineering: Specialisation Robotics and	Computer Science: Elective Com	pulsory	
	Theoretical Mechanical Engineering: Specialisation Robotics and	Computer Science: Elective Com	ipulsory	
	Process Engineering: Specialisation Process Engineering: Elective	e Compulsory		
	Process Engineering: Specialisation Process Engineering: Elective	e Compulsory		
	Process Engineering: Specialisation Chemical Process Engineerin	g: Elective Compulsory		
	Process Engineering: Specialisation Chemical Process Engineerin	g: Elective Compulsory		
	Process Engineering: Specialisation Environmental Process Engin	eering: Elective Compulsory		
	Process Engineering: Specialisation Environmental Process Engin			
	Water and Environmental Engineering: Specialisation Environme	nt: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Environme			
	Water and Environmental Engineering: Specialisation Water: Elec	ctive Compulsory		
	Water and Environmental Engineering: Specialisation Water: Elec	ctive Compulsory		

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		

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

ourse 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		

Engineering"				
Module M0749: Waste	e Treatment and Solid Matter Pi	ocess Technology		
Courses				
Title		Тур	Hrs/wk	СР
Solid Matter Process Technology fo	r Biomass (L0052)	Lecture Lecture	2	2
Thermal Waste Treatment (L0320) Thermal Waste Treatment (L1177)		Recitation Section (large)	1	2
Module Responsible	Prof Kerstin Kuchta	iteelitation Section (ia.ge)	_	_
Admission Requirements				
Recommended Previous				
Knowledge				
	thermo dynamics			
	fluid dynamics			
	chemistry			
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
Professional Competence				
Knowledge	The students can name, describe current is	sue and problems in the field of therma	l waste treatment a	and particle process
	engineering and contemplate them in the cont	ext of their field.		
	The industrial application of unit operations as	s nart of process engineering is explained l	ny actual evamples	of waste incineration
	technologies and solid biomass processes. Co			
	renewable resources and wastes are described			
	and refining edible oils, electricity , heat and m			, p
Skills	The students are able to select suitable proces			
	and the process aims. They can evaluate the e	fforts and costs for processes and select ec	onomically feasible t	reatment concepts.
Personal Competence				
Social Competence	Students can			
		didition of the desired to the		
	respectfully work together as a team and discuss technical tasks a participate in subject pageiffs and interdisciplinant discussions.			
	participate in subject-specific and interdisciplinary discussions, develop cooperated solutions			
	 develop cooperated solutions promote the scientific development and accept professional constructive criticism. 			
	promote the scientific development and	a decept professional constructive enticism.		
Autonomy	Students can independently tap knowledge	of the subject area and transform it to	new questions. T	hey are capable, in
	consultation with supervisors, to assess their learning level and define further steps on this basis. Furthermore, they can define			
	targets for new application-or research-oriente	d duties in accordance with the potential so	cial, economic and o	cultural impact.
Workload in Hours	Independent Study Time 110, Study Time in Le	ecture 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the		• •		
Following Curricula	Bioprocess Engineering: Specialisation A - Gen			Carrier Inc.
	International Management and Engineering: Sp	• •		Compulsory
	International Management and Engineering: Spanish Propagation Prop	• •	compulsory	
	Renewable Energies: Specialisation Bioenergy Process Engineering: Specialisation Chemical F			
	Process Engineering: Specialisation Chemical Process Engineering: Specialisation Process En			
	Process Engineering: Specialisation Environme		orv	
	Water and Environmental Engineering: Special			
	Water and Environmental Engineering: Special			

Course L0052: Solid Matter 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	te 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	 Introduction, actual state-of-the-art of waste incineration, aims. legal background, reaction principals basics of incineration processes: waste composition, calorific value, calculation of air demand and flue gas composition Incineration techniques: grate firing, ash transfer, boiler Flue gas cleaning: Volume, composition, legal frame work and emission limits, dry treatment, scrubber, de-nox techniques, dioxin elimination, Mercury elimination Ash treatment: Mass, quality, treatment concepts, recycling, disposal
Literature	Thomé-Kozmiensky, K. J. (Hrsg.): Thermische Abfallbehandlung Bande 1-7. EF-Verlag für Energie- und Umwelttechnik, Berlin, 196 - 2013.

Course 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 M0857: Geoch	hemical Engineering				
Courses					
Title		Тур	Hrs/wk	СР	
Contaminated Sites and Landfilling		Lecture	2	2	
Contaminated Sites and Landfilling Geochemical Engineering (L0904)	(L0907)	Recitation Section (large) Lecture	1 2	2	
	D. M. C. Pit I. at i	Lecture	2	2	
Module Responsible					
Admission Requirements					
	Module: General and Inorganic Chemistry,				
Knowledge	Module:Organic Chemistry,				
	Biology (Basic Knowledge)				
Educational Objectives	After taking part successfully, students have reached t	he following learning results			
Professional Competence					
Knowledge	With the completion of this module students acquire	profound knowledge of biogeochemica	I processes, the	fate of pollutants in	
	soil and groundwater, and techniques to deposit contain	minated waste material. They are able	to describe in pri	nciple the behaviour	
	of chemicals in the environment. Students can explain	of chemicals in the environment. Students can explain and report the approach to remediate contaminated sites.			
Skille	With the completion of this module students can app	ly the acquired theoretical knowledge	to model cases	of site pollution and	
SKIIIS	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 tre		3 On uniterent re	nediation strategies	
	and techniques. Moder projects can be devised and the	ateu.			
Personal Competence					
Social Competence	Students can discuss technical and scientific tasks wit	hin a seminar subject specific and inter	disciplinary .		
Autonomy	Students can independently exploit sources , acquire the	ne particular knowledge of the subject a	and apply it to ne	w 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 Traffic: Elec	ctive Compulsory			
Following Curricula	Environmental Engineering: Core Qualification: Elective	e Compulsory			
	Water and Environmental Engineering: Specialisation V	Vater: Elective Compulsory			
	Water and Environmental Engineering: Specialisation E	nvironment: Elective Compulsory			
	Water and Environmental Engineering: Specialisation C	Cities: Elective Compulsory			

Course L0906: Contaminated	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	1) Waste Management. Bernd Bilitewski; Georg Härdtle; Klaus Marek (Eds.), ISBN: 9783540592105, Springer Verlag Lehrbuchsammlung der TUB, Signatur USH-305 2) Solid Waste Technology and Management. Thomas Christensen (Ed.), ISBN: 978-1-4051-7517-3, Wiley Verlag Lesesaal 2: US - Umweltschutz, Signatur USH-332 3) Natural attenuation of fuels and chlorinated solvents in the subsurface. Todd H. Wiedemeier(Ed.), ISBN: 0471197491 Lesesaal 2: US - Umweltschutz, Signatur USH-844

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		

S	
Course L0904: Geochemical	
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	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 Learning	2	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous	Fundamentals of Hydromechanics, Hydraulics, Hydrology and	d Hydraulic Engineering; Hydra	ulic Engineerir	ng I and Hydraulic
Knowledge	Engineering II			
Educational Objectives	After taking part successfully, students have reached the follow	ing learning results		
Professional Competence				
Knowledge	Students are able to define in detail the basic processes tha	t are related to the modelling of	of flows in hyd	draulic engineering.
	Besides, they can describe the basic aspects of numerical mod	lelling and actual numerical mode	els for the sim	ulation of flows and
	waves. They can also depict the concepts of nature oriented hydraulic engineering.			
Clatte	Children and a half har and the standard are as in a constant and a half har a		alaa Essable assasa	
SKIIIS	Students are able to apply hydrodynamic-numerical models to pable to set up flood-risk management concepts and are able to			
	able to set up 11000-115k management concepts and are able to	apply basic concepts of renaturat	ion to practica	i problems.
Personal Competence				
Social Competence	The students are able to deploy their gained knowledge in applied problems of the practical nature-based hydraulic engineering			draulic engineering.
	Additionaly, they will be able to work in team with engineers of	other disciplines.		
Autonomy	The students will be able to independently extend their knowledge and apply it to new problems.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70	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 ur	nderstanding of the
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Compulsory			
Following Curricula	Environmental Engineering: Core Qualification: Elective Compul	sory		
	Joint European Master in Environmental Studies - Cities and Sus	tainability: Core Qualification: Cor	mpulsory	
	Water and Environmental Engineering: Specialisation Water: Co	mpulsory		
	Water and Environmental Engineering: Specialisation Environme	ent: Compulsory		
	Water and Environmental Engineering: Specialisation Cities: Ele	ctive Compulsory		

Linginieering	
Course L0810: Modelling of I	
	Lecture
Hrs/wk	
CP	
	Independent Study Time 78, Study Time in Lecture 42
	Dr. Edgar Nehlsen, Prof. Peter Fröhle
Language	
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	 Regime-Theory and application for the development of environmental guiding priciples of rivers Engineering - biological measures for the stabilization of rivers Risk management in flood protection Design techniques in technical flood protection Methods for the assessment of flood caused damages 	
Literature	Vorlesungsumdruck	

<u> </u>				
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	Fluvial Areas (L0295)	Project-/problem-based Learning	1	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous	Fundamentals of Hydromechanics and Hydraulic En	gineering: Hydraulic Engineering I and Hydrau	ulic Engineerii	ng II
Knowledge				
Educational Objectives	After taking part successfully, students have reache	ed the following learning results		
Professional Competence				
Knowledge	The students are able to define the basic concepts	of hydrology and water management. They	are able to d	escribe and quantify
	the relevant processes of the hydrological water cy	cle. Besides, the students know the main asp	ects of rainfa	ll-run-off-models and
	are able to theoretically derive established reservoi	r / storage models and a unit-hydrograph.		
Skills	The students are able to use the basic hydrologic			*
	reservoir / storage models or a unit-hydrograph as			
	concepts of measurements of hydrological and hydrological	•		-
	assess these measurements. Furthermore, they are	able to apply a hydrological model to basic h	iyarological pi	obiems.
Personal Competence				
Social Competence	The students are able to deploy their gained knowle	edge in applied problems of the hydrology and	d water mana	gement. Additionaly,
	they will be able to work in team with engineers of	other disciplines.		
Autonomy	The students will be able to independently extend to	heir knowledge and apply it to new problems		
	Independent Study Time 124, Study Time in Lecture	2 56		
Credit points				
Course achievement				
Examination				
	The duration of the examination is 90 min. The examination	mination includes tasks with respect to the ge	eneral underst	anding of the lecture
scale	contents and calculations tasks.			
	Civil Engineering: Specialisation Water and Traffic: I			
Following Curricula	Environmental Engineering: Core Qualification: Elective Compulsory			
	Joint European Master in Environmental Studies - Ci	· ·	mpulsory	
	Water and Environmental Engineering: Specialisation	· · ·		
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory			
	Water and Environmental Engineering: Specialisation	n Cities: Elective Compulsory		

Course L0289: Applied Surfa	ce 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:
	 Hydrological cycle Data acquisition Data analyses and statistical assessment Statistics of extremes Regionalization methods for hydrological values Rainfall-run-off modelling on the basis of a unit hydrograph conceps Application of rainfall-run-off models on the basis of Kalypso-Hydrology which is an OpenSource Software Tool.
Literature	http://de.wikipedia.org/wiki/Kalypso_(Software)
	http://kalypso.bjoernsen.de/
	http://sourceforge.net/projects/kalypso/

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

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

Engineering				
Module M0874: Wasto	ewater Systems			
Courses				
Title		Тур	Hrs/wk	СР
Wastewater Systems - Collection, T	reatment and Reuse (L0934)	Lecture	2	2
Wastewater Systems - Collection, T	reatment and Reuse (L0943)	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			
Recommended Previous	Knowledge of wastewater management and the key	processes involved in wastewater treatme	ent.	
Knowledge				
Educational Objectives	After taking part successfully, students have reache	d the following learning results		
Professional Competence				
Knowledge	Students are able to outline key areas of the full rar	nge of treatment systems in waste water	management, as	well as their mutual
	dependence for sustainable water protection. They	can describe relevant economic, environm	ental and social	factors.
Civilla	Charles and all to any desire and associate the		+	f their englishing in
SKIIIS	Students are able to pre-design and explain the av	valiable wastewater treatment processes	and the scope of	r their application in
	municipal and for some industrial treatment plants.			
Personal Competence				
Social Competence	Social skills are not targeted in this module.			
Autonomy	Students are in a position to work on a subject a	nd to organize their work flow independe	ently. They can	also present on this
	subject.			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 8	34		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineer	ing: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engine	eering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering	g: Elective Compulsory		
	Civil Engineering: Specialisation Water and Traffic: C			
	Bioprocess Engineering: Specialisation A - General B	lioprocess Engineering: Elective Compulso	ry	
	Environmental Engineering: Specialisation Water: El			
	International Management and Engineering: Special	isation II. Process Engineering and Biotech	nology: Elective	Compulsory
	International Management and Engineering: Special			
	Process Engineering: Specialisation Environmental P	rocess Engineering: Elective Compulsory	-	-
	Process Engineering: Specialisation Process Enginee			
	Water and Environmental Engineering: Specialisatio			
	Water and Environmental Engineering: Specialisatio			
	Water and Environmental Engineering: Specialisatio			
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	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	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 Wa	stewater Treatment			
Тур	Lecture			
Hrs/wk	2			
СР				
Workload in Hours	ndependent Study Time 32, Study Time in Lecture 28			
Lecturer	Dr. Joachim Behrendt			
Language				
Cycle				
Content	Survey on advanced wastewater treatment			
	reuse of reclaimed municipal wastewater			
	Precipitation			
	Flocculation			
	Depth filtration Membrane Processes			
	Activated carbon adsorption			
	Ozonation			
	"Advanced Oxidation Processes"			
	Disinfection			
Literature	Metcalf & Eddy, Wastewater Engineering: Treatment and Reuse, McGraw-Hill, Boston 2003			
	Wassertechnologie, H.H. Hahn, Springer-Verlag, Berlin 1987			
	Membranverfahren: Grundlagen der Modul- und Anlagenauslegung, T. Melin und R. Rautenbach, Springer-Verlag, Berlin 2007			
	Trinkwasserdesinfektion: Grundlagen, Verfahren, Anlagen, Geräte, Mikrobiologie, Chlorung, Ozonung, UV-Bestrahlung, Membranfiltration, Qualitätssicherung, W. Roeske, Oldenbourg-Verlag, München 2006			
	Organische Problemstoffe in Abwässern, H. Gulyas, GFEU, Hamburg 2003			

Course L0358: Advanced Wa	stewater Treatment				
Тур	Recitation Section (large)				
Hrs/wk					
СР					
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: Nexus	Engineering - Water, Soil, Food and	Energy		
Courses				
Title		Тур	Hrs/wk	СР
Ecological Town Design - Water, En		Seminar	2	2
Water & Wastewater Systems in a 0	Global Context (L0939)	Lecture	2	4
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
Recommended Previous	Basic knowledge of the global situation with rising ${\bf p}$	overty, soil degradation, migrat	tion to cities, lack of w	ater resources and
Knowledge	sanitation			
Educational Objectives	After taking part successfully, students have reached tl	ne following learning results		
Professional Competence				
Knowledge	Students can describe the facets of the global water sit	uation. Students can judge the e	normous potential of th	e implementation of
	synergistic systems in Water, Soil, Food and Energy su	oply.		
Skills	Students are able to design ecological settlements for	different geographic and socio-	economic conditions to	r the main climates
	around the world.			
Personal Competence				
Social Competence	The students are able to develop a specific topic in a te	eam and to work out milestones a	according to a given pla	n.
4.4		to a construction of the stant		
Autonomy	Students are in a position to work on a subject and	to organize their work flow inde	ependently. They can a	ilso present on this
	subject.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	j		
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 in	ncludes presentations a	ind papers. Detailed
scale	information can be found at the beginning of the smest	er in the StudIP course module h	andbook.	
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elec	tive Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation A - General Biop	rocess Engineering: Elective Con	npulsory	
	Chemical and Bioprocess Engineering: Specialisation G	eneral Process Engineering: Elect	tive Compulsory	
	Environmental Engineering: Core Qualification: Elective	Compulsory		
	Joint European Master in Environmental Studies - Cities	and Sustainability: Core Qualific	ation: Compulsory	
	Process Engineering: Specialisation Environmental Proc		ilsory	
	Process Engineering: Specialisation Process Engineering	. ,		
	Water and Environmental Engineering: Specialisation V			
	Water and Environmental Engineering: Specialisation E		/	
	Water and Environmental Engineering: Specialisation C	ities: Elective Compulsory		

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

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

Module M0922: City P	lanning
Courses	
Title	Typ Hrs/wk CP
City Planning (L1066)	Project-/problem-based Learning 4 6
Module Responsible	Prof. Carsten Gertz
	None
Recommended Previous Knowledge	for "Principles of Urban Planning": none
	for "Designing Urban Streetscapes": some knowledge of transport planning, e.g. through taking the undergraduate class "Transport planning and Traffic Engineering"
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to:
	use technical terms of urban planning.
	describe the main determinants of urban development.
	explain and compare different possibilities of how urban development can be influenced.
	 discuss requirements for public streetscapes. explain the importance of street design.
	• explain the importance of surest design.
Skills	Students are able to:
	read and analyze urban development concepts and designs for streetscapes
	appraise such concepts in the context of competing requirements.
	design, justify and reflect their own solutions for concrete examples.
Personal Competence	
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:
	 independently complete a written report including drawings following a broadly pre-defined process.
	assess the consequences of their proposed solutions.
	independently acquire knowledge and apply this to new issues or problem areas.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written elaboration
	written assignment, designwork during the semester
scale Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory
-	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory 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
	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

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:
	 legal framework, instruments and methods of planning, functional requirements, stakeholders and actors basic design requirements different planning levels and historical contexts. The objective of the course is for students to acquire a basic understanding of urban development problems and approaches for solving them. They will also be able to comprehend the process of urban planning. The course also covers the various functional and aesthetic requirements for designing streetscape as the most important elements of public space. The project work deals with a real life scenario and includes drawing up a development plan, an urban design concept, a building masterplan and a street redesign.
Literature	Albers, Gerd; Wekel, Julian (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.

<u> </u>					
Module M0663: Marin	ne Geotechnics				
Courses					
itle		Тур	Hrs/wk	СР	
Marine Geotechnics (L0548)		Lecture	1	2	
larine Geotechnics (L0549)		Recitation Section (large)	2	2	
teel Structures in Foundation and	Hydraulic Engineering (L1146)	Lecture	2	2	
Module Responsible	Prof. Jürgen Grabe				
Admission Requirements	None	None			
Recommended Previous	complete modules: Geotechnics I-III, Mather	complete modules: Geotechnics I-III, Mathematics I-III			
Knowledge	G. The boundary of the second				
	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 ir	n Lecture 70			
Credit points					
Course achievement	None				
Examination	Written exam				
Examination duration and	90 min				
scale					
Assignment for the	Civil Engineering: Specialisation Geotechnic	cal Engineering: Compulsory			
Following Curricula	Civil Engineering: Specialisation Structural E	Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Coastal Engineering: Compulsory				
	Theoretical Mechanical Engineering: Special	lisation Maritime Technology: Elective Compuls	ory		
	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 L0548: Marine Geotechnics				
Тур	Lecture			
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	 Geotechnical investigation an description of the seabed Foundations of Offshore-Constructions cCliff erosion Sea dikes Port structures Flood protection structures 			
Literature	 EAK (2002): Empfehlungen für Küstenschutzbauwerke EAU (2004): Empfehlungen des Arbeitsausschusses Uferbauwerke Poulos H.G. (1988): Marine Geotechnics. Unwin Hyman, London Wagner P. (1990): Meerestechnik: Eine Einführung für Bauingenieure. Ernst & Sohn, Berlin 			

Course L0549: Marine Geotechnics		
Тур	Recitation Section (large)	
Hrs/wk	2	
СР	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	

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

Course 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		

Module M1724: Smar	t Monitoring			
Courses				
Title	Typ Hrs/wk CP			
Smart Monitoring (L2762)	Integrated Lecture 2 2			
Smart Monitoring (L2763)	Recitation Section (small) 2 4			
Module Responsible	Prof. Kay Smarsly			
Admission Requirements	None			
Recommended Previous	Basic knowledge or interest in object-oriented modeling, programming, and sensor technologies are helpful. Interest in mo			
Knowledge	research and teaching areas, such as Internet of Things, Industry 4.0 and cyber-physical systems, as well as the will to deepe skills of scientific working, are required. Basic knowledge in scientific writing and good English skills.			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowleage	The students will become familiar with the principles and practices of smart monitoring. The students will be able to design decentralized smart systems to be applied for continuous (remote) monitoring of systems in the built and in the natural environment. In addition, the students will learn to design and to implement intelligent sensor systems using state-of-the-art data analysis techniques, modern software design concepts, and embedded computing methodologies. Besides lectures, project work is also part of this module. In small groups, the students will design smart monitoring systems that integrate a number of "intelligent" sensors to be implemented by the students. Specific focus will be put on the application of machine learning techniques. The smart monitoring systems will be mounted on real-world (built or natural) systems, such as bridges or slopes, on scaled lab structures for validation purposes. The outcome of every group will be documented in a paper. All students of this module will "automatically" participate with their smart monitoring system in the annual "Smart Monitoring" competition. The written papers and oral examinations form the final grades. The module will be taught in English. Limited enrollment.			
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours				
Credit points				
Course achievement				
Examination				
Examination duration and				
scale				
Assignment for the				
Following Curricula				
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory			
	Environmental Engineering: Specialisation Waste and Energy: Elective Compulsory			
	Environmental Engineering: Specialisation Biotechnology: Elective Compulsory			
	Environmental Engineering: Specialisation Water: Elective Compulsory			
	Environmental Engineering: Specialisation Waste and Energy: Elective Compulsory			
	Environmental Engineering: Specialisation Biotechnology: Elective Compulsory			
	Environmental Engineering: Specialisation Water: 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 Environment: Elective Compulsory			
	Water and Environmental Engineering: Specialisation Water: Elective Compulsory			
	Water and Environmental Engineering: Specialisation Water: Elective Compulsory			

Course L2762: Smart Monito	ring
Тур	Integrated Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Kay Smarsly
Language	EN
Cycle	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			
Recommended Previous				
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: I	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	Aquatic Chemistry		
Тур	cture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form	Klausur		
Examination duration and	60 min		
scale			
Lecturer	Dr. Klaus Johannsen		
Language	EN		
Cycle	SoSe		
Content	 Concentration and activity Gas-water partitioning Acid/base equilibria Alkalinity and acidity Precipitation/dissolution equilibria Redox equilibria Complex formation Sorption 		
Literature	Worch, E.: Hydrochemistry. Basic Concepts and Exercises. De Gruyter, Berlin, 2015		

Course 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	nent			
Тур	Lecture			
Hrs/wk				
СР				
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			

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

Course L2386: Thermal Biomass Utilization				
Тур	Practical Course			
Hrs/wk				
СР				
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			

Module M0620: Special Aspects of Waste Resource Management						
Courses						
Title				Тур	Hrs/wk	СР
			Project-/problem-based Learning	3	3	
International Waste Management (1			Project-/problem-based Learning	2	3
Module Responsible	Prof. Kerstin Kuchta					
Admission Requirements	None					
Recommended Previous	basics in waste treatr	nent technologies				
Knowledge						
Educational Objectives	After taking part succ	essfully, students have rea	ached the following	ng learning results		
Professional Competence						
Knowledge				as advanced technologies for re	, ,	,
	from waste in detail.	This covers collection, tran	sport, treatment	and disposal in national and inte	ernational con	texts.
Skills	Students are able to	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 work results in front of others and promote the scientific development of colleagues. Furthermore, they can give and accept professional constructive criticisms.				
	r ditileilliole, tiley ca	r give and accept profession	onar constructive	CHUCISHIS.		
Autonomy	Students can indepe	ndently gain additional kr	nowledge of the	subject area and apply it in so	olving the give	en course tasks and
	projects.					
Workload in Hours	Independent Study Ti	me 110, Study Time in Led	ture 70			
Credit points						
Course achievement	Compulsory Bonus	Form	Description			
	Yes 20 %	Written elaboration				
Examination	Presentation					
Examination duration and	PowerPoint presentat	ion (10-15 minutes)				
scale						
Assignment for the	Civil Engineering: Spe	cialisation Water and Traf	fic: Elective Comp	oulsory		
Following Curricula	Environmental Engine	ering: Specialisation Wast	e and Energy: Ele	ective Compulsory		
				ainability: Specialisation Energy:	Elective Com	pulsory
		ntal Engineering: Specialis				
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory					
	Water and Environme	ntal Engineering: Specialis	ation Cities: Elec	tive Compulsory		

Course L1055: Advanced Top	oics 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	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).
	The course is split into two parts:
	1. part: "Conventional" lecture (development of waste management, legislation, collection, transportation and organisation of
	waste management, costs, fees and revenues).
	2. 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.
	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.
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 M0801: Wate	r Resources and -Supply			
Courses				
Title		Тур	Hrs/wk	СР
Chemistry of Drinking Water Treatr	ment (L0311)	Lecture	2	1
Chemistry of Drinking Water Treatr	ment (L0312)	Recitation Section (large)	1	2
Water Resource Management (L04	02)	Lecture	2	2
Water Resource Management (L04)	T	Recitation Section (small)	1	1
Module Responsible	Prof. Mathias Ernst			
Admission Requirements				
Recommended Previous	Knowledge of water management and the key proces	ses 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 of conflict	in water management, as well as thei	ir mutual depend	ence for sustainable
	water supply. They will understand relevant econon	nic, environmental and social factors.	Students will be	able to explain and
	outline the organisational structures of water compar	nies. They will be able to explain the ava	ailable water treat	tment processes and
	the scope of their application.			
Skills	Students will be able to assess complex probler	ns in drinking water production and	establish solutio	ons involving water
Simil	management and technical measures. They will be a	•		-
	be able to carry out chemical calculations for selec			
	standards to these processes.	p a app., g.	,	
Personal Competence				
Social Competence	Working in a diverse group of specialists, students w			_
	and treatment of drinking water. They will be able			-
	interests. They will be able to develop joint solutions	in teams of diverse experts and present	these solutions to	o others.
Autonomy	Students will be in a position to work on a subject ind	ependently and present on this subject.		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 min (chemistry) + presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineerin	g: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineer	ering: Elective Compulsory		
	Civil Engineering: Specialisation Water and Traffic: Co	mpulsory		
	Civil Engineering: Specialisation Coastal Engineering:	Elective Compulsory		
	International Management and Engineering: Specialis	ation II. Energy and Environmental Engi	neering: Elective	Compulsory
	Process Engineering: Specialisation Environmental Process	ocess Engineering: Elective Compulsory		
	Process Engineering: Specialisation Process Engineering	ng: Elective Compulsory		
	Water and Environmental Engineering: Specialisation	Water: Compulsory		
	Water and Environmental Engineering: Specialisation	Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation	Cities: Elective Compulsory		

Course L0311: Chemistry of	Drinking Water Treatment
Тур	Lecture
Hrs/wk	2
СР	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dr. Klaus Johannsen
Language	DE
Cycle	WiSe
Content	The topic of this course is water chemistry with respect to drinking water treatment and water distribution
	Major topics are solubility of gases, carbonic acid system and calcium carbonate, blending, softening, redox processes, materials and legal requirements on drinking water treatment. Focus is put on generally accepted rules of technology (DVGW- and DINstandards).
	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.

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

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

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

Module M0802: Memb	orane Technology			
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			1
Module Responsible	Prof. Mathias Ernst			
Admission Requirements	None			
Recommended Previous	Basic knowledge of water chemistry. Knowledge of the co	re processes involved in water, gas	and steam treatn	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 applications of	industrially important membrane p	rocesses. They w	vill be able to explain
	the different driving forces behind existing membrane	separation processes. Students wil	l be able to nam	ne materials used in
	membrane filtration and their advantages and disadvant	ages. Students will be able to exp	lain the key diffe	rences in the use of
	membranes in water, other liquid media, gases and in liqu	ıid/gas mixtures.		
Skills	Students will be able to prepare mathematical equations	s for material transport in porous a	nd solution-diffus	sion membranes and
Simil	calculate key parameters in the membrane separation p			
	available boundary data and provide recommendations	•		
	experiments, students will be able to classify the sep	·		-
	membrane materials. Students will be able to characterise			
	measures to control this.	3 ,		
Personal Competence				
Social Competence	Students will be able to work in diverse teams on tasks in			le to make decisions
	within their group on laboratory experiments to be undert	aken 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	v will be capable of
	finding creative solutions to technical questions.			, 20 22/2222 21
Workload in Hours	Independent Study Time 124, Study Time 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 Traffic: Electiv	e Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation A - General Biopro	cess Engineering: Elective Compulso	ory	
	Bioprocess Engineering: Specialisation B - Industrial Biopr	ocess Engineering: Elective Compul	sory	
	Chemical and Bioprocess Engineering: Specialisation Chemical	mical Process Engineering: Elective	Compulsory	
	Chemical and Bioprocess Engineering: Specialisation Gen	•	ompulsory	
		Environmental Engineering: Specialisation Water: Elective Compulsory		
	Joint European Master in Environmental Studies - Cities ar	• •	er: Elective Comp	oulsory
	Process Engineering: Specialisation Process Engineering:			
	Process Engineering: Specialisation Environmental Proces	3 3 ,		
	Water and Environmental Engineering: Specialisation Wat			
	Water and Environmental Engineering: Specialisation Env			
	Water and Environmental Engineering: Specialisation Citie	es: 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
	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	 T. Melin, R. Rautenbach: Membranverfahren: Grundlagen der Modul- und Anlagenauslegung (2., erweiterte Auflage), Springer-Verlag, Berlin 2004. Marcel Mulder, Basic Principles of Membrane Technology, Kluwer Academic Publishers, Dordrecht, The Netherlands Richard W. Baker, Membrane Technology and Applications, Second Edition, John Wiley & Sons, Ltd., 2004

ourse 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 Technology			
Courses				
Title		Тур	Hrs/wk	СР
Process Modelling of Wastewater T	reatment (L0522)	Project-/problem-based Learning	2	3
Process Modeling in Drinking Water	Treatment (L0314)	Project-/problem-based Learning	2	3
Module Responsible	Dr. Klaus Johannsen			
Admission Requirements	None			
Recommended Previous	Knowledge of the most important processes in drinkin	g water and waste water treatment.		
Knowledge				
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	Students are able to explain selected processes of d	rinking water and waste water treatment i	n detail. The	y are able to explain
	basics as well as possibilities and limitations of dynam	nic modeling.		
<i>Sville</i>	Students are able to use the most important feature:	s Modelica offers. They are able to transpo	ise selected i	nrocesses in drinking
SKIIIS	water and waste water treatment into a mathematica	·		-
	They are able to set up and apply models and assess	·	mann, kineties	dia mass balances.
	mey are usic to set up and apply models and assess	and mines and		
Personal Competence				
-	Students are able to solve problems and document so	plutions in a group with members of differe	nt technical h	ackground They are
	able to give appropriate feedback and can work const			,,
	3			
Autonomy	Students are able to define a problem, gain the requir	ed knowledge and set up a model.		
riaconomy	stadents are able to define a problem, gain the requir	ea knowleage and set up a model.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	66		
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Ele	ective Compulsory		
Following Curricula	Environmental Engineering: Specialisation Water: Elec	tive Compulsory		
	Joint European Master in Environmental Studies - Citie	s and Sustainability: Specialisation Water: I	Elective Comp	oulsory
	Process Engineering: Specialisation Environmental Pro	cess Engineering: Elective Compulsory		
	Process Engineering: Specialisation Process Engineeri	ng: 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 L0522: Process Mode	elling 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	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 explainedd 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.

ourses	
itle	Typ Hrs/wk CP
tegrated Transportation Planning	
Module Responsible	
Admission Requirements	
	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. relate current issues in the area of integrated transport planning and formulate an opinion on them.
	relate current issues in the area of integrated transport planning and formulate an opinion on them.
Skills	Students are able to:
	quantify important parameters, which influence travel demand or are influenced by it.
	comprehensively examine a pre-defined or self-selected topic from a transportation studies perspective and document to the comprehensively examine a pre-defined or self-selected topic from a transportation studies perspective and document to the comprehensively examine a pre-defined or self-selected topic from a transportation studies perspective and document to the comprehensively examine a pre-defined or self-selected topic from a transportation studies perspective and document to the comprehensively examine a pre-defined or self-selected topic from a transportation studies perspective and document to the comprehensive and
	results in accordance with scientific conventions.
Damanal Commetence	
Personal Competence	Students are able to
Social Competence	Students are able to:
	provide feedback on topical contents and their teaching.
	constructively handle feedback on their own work.
	produce results in group work and document these.
Autonomy	Students are able to:
	assess potential consequences of their future professional activities
	• independently plan working on a pre-defined project topic, acquire the necessary knowledge and use appropriate means
	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	
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 Water: Elective Compulsory Water and Environmental Engineering: Specialisation Environment: Elective Compulsory
	, reacon and Environmental Engineering, openianouton Environment, Elective Compulsory

Course L1068: Integrated Tr	ansportation Planning		
Тур	Project-/problem-based Learning		
Hrs/wk			
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		
	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	Sanitation for diffe	erent Climate Zon	es
Courses				
Title		Тур	Hrs/wk	СР
	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			
Recommended Previous	Basic knowledge of the global situation with rising pove	rty, soil degradation, lack of v	water resources and sanita	ntion
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
Knowledge	Students can describe resources oriented wastewater	systems mainly based on so	ource 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	oroaches in Rural Develonmer	nt from and for many region	ons of the world
	Students are usic to discuss a wide range of proven ap	orodenes in Narai Developinei	it 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	soil building throug
	"Holisitc Planned Grazing" as developed by Allan Savor	ý.		
Personal Competence				
•	The students are able to develop a specific topic in a te	am and to work out milestone	es according to a given pla	n.
,				
Autonomy	Students are in a position to work on a subject and	to organize their work flow i	ndependently. They can a	also present on thi
	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 wor	k includes presentations	and papers. Detaile
scale	information will be provided at the beginning of the smo	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	Compulsory	
	Chemical and Bioprocess Engineering: Specialisation Ge	eneral Process Engineering: El	lective Compulsory	
	Environmental Engineering: Specialisation Water: Electi	ve Compulsory		
	International Management and Engineering: Specialisat	ion II. Energy and Environmer	ntal Engineering: Elective	Compulsory
	Joint European Master in Environmental Studies - Cities		·	ulsory
	Process Engineering: Specialisation Environmental Proc		npulsory	
	Process Engineering: Specialisation Process Engineering			
	Water and Environmental Engineering: Specialisation W			
	Water and Environmental Engineering: Specialisation E	•	sory	
	Water and Environmental Engineering: Specialisation C	ties: Elective Compulsory		

Course L0942: Rural Develop	oment 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	
	 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. 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.
Literature	 J. Lange, R. Otterpohl 2000: Abwasser - Handbuch zu einer zukunftsfähigen Abwasserwirtschaft. Mallbeton Verlag (TUHH Bibliothek) Winblad, Uno and Simpson-Hébert, Mayling 2004: Ecological Sanitation, EcoSanRes, Sweden (free download) Schober, Sabine: WTO/TUHH Award winning Terra Preta Toilet Design: http://youtu.be/w_R09cYq6ys

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

Module M0950: Study	/ Work Environment
Courses	
Title	Typ Hrs/wk CP
Module Responsible	
Admission Requirements	None
Recommended Previous	
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students are able to demonstrate their detailed knowledge in the field of Water and Environmental Engineering. They can exemplify the state of technology and application and discuss critically in the context of actual problems and general conditions of 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, and 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 has to be adjusted. General findings and further developments may essentially be outlined.
Personal Competence	
Social Competence	The students are able to condense the relevance and the structure of the project work, the work steps and the sub-problems for the presentation and discussion in front of a bigger group. They can lead the discussion and give a feedback on the project to their colleagues.
Autonomy	The students are capable of independently planning and documenting the work steps and procedures while considering the giver deadlines. This includes the ability to accurately procure the newest scientific information. Furthermore, they can obtain feedback 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 Environment: Compulsory
Following Curricula	

Module M1716: Subsurface 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	Solute Transport (L2728)	Lecture	2	2
Modern Techniques for Subsurface	Solute Transport (L2729)	Recitation Section (large)	1	1
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
Recommended Previous	Basic Mathematics, Hydrology			
Knowledge				
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge	Upon completion of this module, the students w	ill understand the mechanisms controlling	solute transpor	t in soil and natural
	porous media and will be able to work with the equ	uations that govern the fate and transport o	of solutes in poro	us media. Analytical,
	numerical and experimental tools and techniques v	vill be used in this module.		
Skills	In addition to the physical insights, the students w			·
	this module. This provides them with an excellent	opportunity to improve their skills on multi	ple fronts which	will be useful in their
	future career.			
Personal Competence				
Social Competence	Teamwork & problem solving			
Autonomy	The students will be involved in writing individu	al reports and presentation. This will con	ntribute to the s	students' ability and
	willingness to work independently and responsibly.			
Workload in Hours	Independent Study Time 96, Study Time in Lecture	84		
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	Report and Presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Enginee	ring: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engin	neering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineerin	ng: Elective Compulsory		
	Civil Engineering: Specialisation Water and Traffic:	Elective Compulsory		
	Process Engineering: Specialisation Environmental	Process Engineering: Elective Compulsory		
	Process Engineering: Specialisation Process Engine	ering: Elective Compulsory		
	Water and Environmental Engineering: Specialisati	on Water: Compulsory		
	Water and Environmental Engineering: Specialisati	on Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialisati	on Cities: Elective Compulsory		
	J 11 J 1, 1000	E		

Course L2730: Modeling of S	ourse 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	ourse 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 M0619: Wasto	e Treatment Technologies				
Courses					
Fitle Waste and Environmental Chemistr			Typ Practical Course Project-/problem-based Learning	Hrs/wk 2 3	CP 2 4
Module Responsible			Troject /problem based Leanning		
Admission Requirements	None				
	chemical and biological basics				
Knowledge	enemeal and stological subject				
Educational Objectives	After taking part successfully, students hav	e reached the followi	ng learning results		
Professional Competence	31				
Knowledge	The module aims possess knowledge conce design and layout of anaerobic and aerobic plants for biological waste treatment plants	waste treatment pla	nts in detail, describe different to		
Skills	The students are able to discuss the compilation of design and layout of plants. They can critically evaluate techniques and quality control measurements. The students can recherché and evaluate literature and date connected to the tasks given in der module and plan additional tests. They are capable of reflecting and evaluating findings in the group.				
Personal Competence Social Competence	Students can participate in subject-specific work results in front of others and promo accept professional constructive criticism.				
Autonomy	Students can independently tap knowledge are capable, in consultation with supervisor steps on this basis. Furthermore, they can potential social, economic and cultural imp	rs as well as in the int define targets for ne	terim presentation, to assess the	ir learning leve	l and define furtl
Workload in Hours	Independent Study Time 110, Study Time in	a Lecture 70			
		. 2000010 70			
Course achievement	Compulsory Bonus Form Yes None Subject theoretics practical work	Description al and			
Examination	Presentation				
Examination duration and	Elaboration and Presentation (15-25 minute	es in groups)			
scale					
Assignment for the	Civil Engineering: Specialisation Structural	Engineering: Elective	Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnic	3	, ,		
	Civil Engineering: Specialisation Coastal Engineering				
	Civil Engineering: Specialisation Water and		pulsory		
	Environmental Engineering: Core Qualificat		eray and Environmental Engineer	ring: Elective C	ompulsor.
	International Management and Engineering Joint European Master in Environmental Stu				
	Water and Environmental Engineering: Spe			Ficcuse Comp	41301 y
	Water and Environmental Engineering: Spe				
			10.000		

Course 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 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	 Introduction biological basics determination process specific material characterization aerobic degradation (Composting, stabilization) anaerobic degradation (Biogas production, fermentation) Technical layout and process design Flue gas treatment Plant design practical phase
Literature	

Module M1720: Emerging Trends in Environmental Engineering				
Courses				
Title		Тур	Hrs/wk	СР
Environmental Research Trends (L2	2752)	Seminar	2	2
Microplastics in Environment (L275	0)	Lecture	2	2
Scientific Communication and Meth	nods (L2751)	Lecture	1	2
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
Recommended Previous	Basic knowledge on water, soil and environmen	tal research.		
Knowledge				
Educational Objectives	After taking part successfully, students have re-	ached the following learning results		
Professional Competence				
Knowledge	The students will be exposed to up-to-date reso	earch topics focused on soil, water and	climate related challeng	ges with a particular
	focus on the effects of microplastics in environ	nment. Data analysis, data measureme	ent, curation and preser	ntation will be other
	skills that the students will develop in this modu	ule.		
Skills	Students' research skills will be improved in th	nis module. How to prepare and deliver	r an effective presentati	on, how to write an
	abstract, research paper and proposal will be o	discussed in this module. Moreover, thr	ough Research-Based Le	earning approaches,
	the students will be exposed to current research	h trends in environmental engineering.		
Personal Competence				
Social Competence	Developing teamwork and problem solving skills	s through Research-Based Teaching app	proaches will be at the co	ore of this module.
Autonomy		·	will contribute to the s	tudents' ability and
	willingness to work independently and responsi	bly.		
Workload in Hours	Independent Study Time 110, Study Time in Led	cture 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 Traf	fic: Elective Compulsory		
Following Curricula	Environmental Engineering: Specialisation Water	er: Elective Compulsory		
	Environmental Engineering: Specialisation Wast	te and Energy: Elective Compulsory		
	Environmental Engineering: Specialisation Biote	echnology: Elective Compulsory		
	Water and Environmental Engineering: Specialis	sation Cities: Elective Compulsory		
	Water and Environmental Engineering: Specialis	sation Environment: Elective Compulsor	у	
	Water and Environmental Engineering: Specialis	sation Water: Elective Compulsory		

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	The Craft of Scientific Writing Fourth edition Author: Michael Alley Springer-Verlag New York, Copyright 2018, DOI 10.1007/978-1-4419-8288-9
	Supplemental materials and web links which will be available to registered students.

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

Typ L	
	Lecture
Hrs/wk	1
CP 2	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer F	Prof. Nima Shokri
Language E	EN
Cycle \	WiSe
Content	Introduction - course objectives, expectations and format
<i>I</i>	Analyzing the Audience, purpose and occasion
	Constructing and delivering effective technical presentations
ŀ	How to write an abstract
ŀ	How to create a scientific poster
ŀ	How to write a scientific paper
[Developing competitive and persuasive research proposals
I	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	
itle	Typ Hrs/wk CP
daptation to climate change in hy	ydraulic engineering (L2291) Project-/problem-based Learning 4 6
Module Responsible	Prof. Peter Fröhle
Admission Requirements	None
Recommended Previous Knowledge	Hydrology Hydraulic Engineering
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence Knowledge	Climate protection and climate adaptation Insights into climate change and its regional characteristics - fundamentals, climate modelling / climate models Impacts of climate change on the components of the regional hydrological cycle Fundamentals of analysis of climate data Consequences of the impact of the climate change Measures for climate adaptation Assessment, prioritization and communication of adaptation measures Fundamentals of the analysis of hydrometeorological and hydrological data
Personal Competence Social Competence Autonomy	Working in heterogenous groups Working with different scientific / non-scientific disciplines Self reflection
	Autonomous work on complex tasks
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	
Course achievement	
	Written elaboration
Examination duration and scale	Preparation of a written report and a presentation of a complex task.
Assignment for the	
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	 Climate protection and climate adaptation Findings on climate change and its regional characteristics: fundamentals of climate change, climate modelling / climate models Impacts of climate change on the components of the regional hydrological cycle(climate science view) Fundamentals of the analysis of climate data Concequences of the impacts of climate change (ingenieering science view) Measures for climate change adaptation Assessment, prioritization and communication of measures Fundamentals of analysis of hydrometeorological and hydrological data
Literature	Bereitgestellte eLearning Plattform

Courses		
Title Sustainable Nature based Coastal D	Protection in a Changing Climate (SeaPiaC) (L2926)	Typ Hrs/wk CP Project-/problem-based Learning 4 6
		Project/problem-based Leanning 4 0
Module Responsible		
Admission Requirements	Notice	
Recommended Previous Knowledge	Hydraulic Engineering	
Kilowieuge	 Hydromechanics, Hydraulics 	
	 Fundamentals of Coastal Engineering, Co 	pastal- and Flood Protection
Educational Objectives	After taking part successfully, students have re-	ached the following learning results
Professional Competence	,,	
Knowledge		
	Climate and Climate Change	
	General Impacts of Climate Change on W	
	Consequences of Climate Change for Coastal Protection in Taiwan and Cormon	
	 Coastal Protection in Taiwan and Germar Fundamentals of Climate Adaptation 	ıy
	Nature-based Solutions (NBS) for Coastal	Protection
Skills	Critical thinking: analysis of processes ar	nd relations, assessment of needs for action
	Creative thinking: development of adapta	
		ons, application of calculation approaches, methods, numerical models, planni
	methods	
	 Consideration of complex tasks 	
Personal Competence		
Social Competence		
Social competence	 Working in heterogenous groups 	
	 Working in international groups 	
	Working with different scientific / non-sci	entific disciplines
	Self reflection	
Autonomy		
	Application oriented use of knowledge ar	nd skills
	 Autonomous work on complex tasks 	
Workload in Hours	Independent Study Time 124, Study Time in Le	cture 56
Credit points	6	
Course achievement	None	
Examination	Written elaboration	
Examination duration and	Preparation of a written report on a complex to	ask with a presentation and subsequent discussion. The work on the complex ta
	happens in the course of the lecture.	
•	Civil Engineering: Specialisation Coastal Engine	
Following Curricula	Civil Engineering: Specialisation Geotechnical E	
	Civil Engineering: Specialisation Structural Engi	neering: Elective Compulsory
	Civil Engineering: Specialisation Water and Traf	fic: Elective Compulsory
		fic: Elective Compulsory sation Cities: Elective Compulsory

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

Specialization Water

Module M0801: Water Resources and -Supply				
Courses				
Title		Тур	Hrs/wk	СР
Chemistry of Drinking Water Treatn	nent (L0311)	Lecture	2	1
Chemistry of Drinking Water Treatn	nent (L0312)	Recitation Section (larg	je) 1	2
Water Resource Management (L040	02)	Lecture	2	2
Water Resource Management (L040	03)	Recitation Section (sma	all) 1	1
Module Responsible	Prof. Mathias Ernst			
	None			
Recommended Previous	Knowledge of water management and the k	ey processes involved in water treatment.		
Knowledge				
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
	Students will be able to outline key areas of conflict in water management, as well as their mutual dependence for sustainable water supply. They will understand relevant economic, environmental and social factors. Students will be able to explain and outline the organisational structures of water companies. They will be able to explain the available water treatment processes and the scope of their application.			
Skills	Students will be able to assess complex problems in drinking water production and establish solutions involving water 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 and 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 management and treatment of drinking water. They will be able to take an appropriate professional position, for example representing user 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 subject independently and present on this subject.			
Workload in Hours	Independent Study Time 96, Study Time in I	Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 min (chemistry) + presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structural E	Engineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnic	al Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Water and	Traffic: Compulsory		
	Civil Engineering: Specialisation Coastal Eng	gineering: Elective Compulsory		
	International Management and Engineering:	Specialisation II. Energy and Environment	al Engineering: Elective	e Compulsory
	Water and Environmental Engineering: Spec	cialisation Water: Compulsory		
	Water and Environmental Engineering: Spec	cialisation Environment: Elective Compulsor	ry	
	Water and Environmental Engineering: Spec	cialisation Cities: Elective Compulsory		

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

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

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

Course L0403: Water Resour	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 M1716: Subsu	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
Modern Techniques for Subsurface	Solute Transport (L2728)	Lecture	2	2
Modern Techniques for Subsurface	Solute Transport (L2729)	Recitation Section (large)	1	1
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have reache	ed 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				
scale	30 111111			
Assignment for the	Civil Engineering: Specialisation Structural Engineer	ring: Flective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineer			
r onouning curriculu	Civil Engineering: Specialisation Coastal Engineering			
	Civil Engineering: Specialisation Water and Traffic:			
	Process Engineering: Specialisation Environmental	• •		
	Process Engineering: Specialisation Process Engineering			
	Water and Environmental Engineering: Specialisation			
	Water and Environmental Engineering: Specialisation	• •		
	Water and Environmental Engineering: Specialisation	•		
	water and Environmental Engineering. Specialisation	in cities. Elective compulsory		

Course L2730: Modeling of S	urse 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	

Module M1403: Const	truction and Simulation of Sewera	ge Systems		
Courses				
Title		Тур	Hrs/wk	СР
Construction and renovation of urb	-	Seminar	3	3
Simulation of sewerage systems (L	2006)	Seminar	3	3
Module Responsible	Prof. Ralf Otterpohl	Prof. Ralf Otterpohl		
Admission Requirements	None			
Recommended Previous Knowledge	Hydraulics in pines and gravity-sewers			
Educational Objectives	After taking part successfully, students have reach	ned the following learning results		
Professional Competence				
Knowledge	Students can describe urban wastewater systems by means of software-based modeling. In case studies they can perform system and weak point analyzes. In addition, they can analyze the hydraulic effects quantitatively. Furthermore, they have the knowledge 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 the knowledge regarding different renovation technologies for sewer systems is acquired.			
Skills	The students can simulate different run-off events in sewer systems and are able to dimension the sewer systems accordingly. Moreover, they can determine suitable construction materials and static requirements for different cases of application.			
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 and simulation of sewer systems. Furthermore, they are able to present and justify their solutions.			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	CompulsoryBonusFormNo20 %Presentation	Description		
Examination	Written elaboration			
Examination duration and	nach Absprache			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic	Compulsory		
Following Curricula	Water and Environmental Engineering: Specialisat	ion Water: Compulsory		
	Water and Environmental Engineering: Specialisat	ion Environment: Elective Compulsory		

	and renovation of urban sewer systems		
	Seminar		
Hrs/wk			
СР			
Workload in Hours			
Lecturer	Prof. Ingo Weidlich		
Language	EN		
Cycle	WiSe		
Content	The lecture focusses on construction and renovation of urban	sewer pipelines.	
	Construction:		
	Pipe materials, types and joint technology		
	Open trenches		
	Trenchless technologies		
	Pipe Statics:		
	Design of sewers according to ATV A 127		
	Earth pressure on pipes, pipe deformation, cutting force	es	
	Comparison with other international calculation approa	ches	
	Renovation:		
	Failure case study		
	Overview on the different renovation technologies		
	Liner design according to DWA-A 143		
Literature		Titel	
		ATV A 127, Abwassertechnische Vereinigung e.V., Arbeitsblatt A	
		127, Regelwerk Abwasser-Abfall, Vertrieb: GFA, DK 628.22 (083),A 127, 2000	
	2	DIN EN 1610, Verlegung und Prüfung von Abwasserleitungen und	
		-kanälen, Beuth Verlag, Berlin, 1997	
	3	Arbeitsblatt DWA-A 143-1, Sanierung von	
		Entwässerungssystemen außerhalb von Gebäuden, Teil 1:	
		Planung und Überwachung von Sanierungsmaßnahmen Februar	
		2015 Arbeitsblatt DWA-A 143-2, Sanierung von	
	4	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.	
	6	Zeitschrift 3R, Fachzeitschrift für sichere und effiziente	
	7	Rohrleitungssysteme Handbuch für den Rohrleitungsbau Band 1 und 2, 4. Auflage,	
		Günter Wossog, 2015	
	8	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 & Partner	
	10	GmbH, 2014	
	10	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	eminar	
Hrs/wk		
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Prof. Ralf Otterpohl	
Language	EN	
Cycle	WiSe	
Content	Modeling of sewer systems:	
	 Modeling approaches in wastewater management, especially approaches to integrated modeling Planning processes, calculations and design approaches for elements of gravity-sewers Model setup St. Venant equation and simplifications of models (kinematic wave etc.) Calculation & modeling of solids transport (advection, diffusion, dispersion and sales processes) Examples for modeling with SWMM (EPA, USA) 	
Literature		

Module M0513: Syste	m Aspects of Renewable Energies			
Courses				
Title		Тур	Hrs/wk	СР
	ge: New Materials for Energy Production and Storage (L0021)	Lecture	2	2
Energy Trading (L0019)		Lecture	1 1	1 1
Energy Trading (L0020) Deep Geothermal Energy (L0025)		Recitation Section (small) Lecture	2	2
	Prof. Martin Kaltschmitt	Eccture		2
	Module: Technical Thermodynamics I			
	Module. reclinical memodynamics i			
Knowledge	Module: Technical Thermodynamics II			
Educational Objectives	After taking part successfully, students have reached the fo	llowing learning results		
Professional Competence				
Knowledge	Students are able to describe the processes in energy tradir	ng and the design of energy marke	ets and can critic	ally evaluate them in
	relation to current subject specific problems. Furtherm	ore, they are able to explain	the basics of	thermodynamics of
	electrochemical energy conversion in fuel cells and can es	tablish and explain the relationsh	ip to different ty	pes of fuel cells and
	their respective structure. Students can compare this techn	ology with other energy storage of	ptions. In addition	on, students can give
	an overview of the procedure and the energetic involvemen	t of deep geothermal energy.		
Skills	Students can apply the learned knowledge of storage system	ms for excessive energy to explair	n for various ene	rgy systems different
	approaches to ensure a secure energy supply. In particul			
	heating equipment using energy storage systems in an er			
	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				
· ·	Students are able to discuss issues in the thematic fields in	the renewable energy sector addr	assad within the	module
Social competence	Students are use to discuss issues in the thematic fields in	the renewable energy sector addr	cssca within the	module.
Autonomy	Students can independently exploit sources , acquire the	particular knowledge about the s	subject area and	transform it to new
	questions.			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points				
Course achievement				
	Written exam			
Examination duration and				
scale	5 Hours Witten Grain			
	Bioprocess Engineering: Specialisation A - General Bioproce	ss Engineering: Elective Compulso	irv	
_	International Management and Engineering: Specialisation I			
i onowing curricula	International Management and Engineering: Specialisation I	3,	. ,	Compulsory
	International Management and Engineering: Specialisation I	3,	9	. ,
	Renewable Energies: Core Qualification: Compulsory	i. Frocess Engineering and biolect	mology. Elective	Compuisory
	Process Engineering: Specialisation Environmental Process	Engineering: Elective Compulsors		
	Process Engineering: Specialisation Process Engineering: Ele			
	Water and Environmental Engineering: Specialisation Water			
	Water and Environmental Engineering: Specialisation Enviro	nment: Elective Compulsory		

Course L0021: Fuel Cells, Batteries, and Gas Storage: New Materials for Energy Production and Storage		
Тур	Lecture	
Hrs/wk		
СР		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Michael Fröba	
Language	DE	
Cycle	SoSe	
Content	1. Introduction to electrochemical energy conversion 2. Function and structure of electrolyte 3. Low-temperature fuel cell	
Literature	Hamann, C.; Vielstich, W.: Elektrochemie 3. Aufl.; Weinheim: Wiley - VCH, 2003	

Course L0019: Energy Tradin	g			
Тур	Lecture			
Hrs/wk				
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	Basic concepts and tradable products in energy markets Primary energy markets Electricity Markets European Emissions Trading Scheme Influence of renewable energy Real options Risk management Within the exercise the various tasks are actively discussed and applied to various cases of application.			
Literature				

Course L0020: Energy Tradin	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	rmal Energy
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Ben Norden
Language	DE
Cycle	SoSe
Content	 Introduction to the deep geothermal use Geological Basics I Geology and thermal aspects Rock Physical Aspects Geochemical aspects Exploration of deep geothermal reservoirs Drilling technologies, piping and expansion Borehole Geophysics Underground system characterization and reservoir engineering Microbiology and Upper-day system components Adapted investment concepts, cost and environmental aspect
Literature	 Dipippo, R.: Geothermal Power Plants: Principles, Applications, Case Studies and Environmental Impact. Butterworth Heinemann; 3rd revised edition. (29. Mai 2012) www.geo-energy.org Edenhofer et al. (eds): Renewable Energy Sources and Climate Change Mitigation; Special Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, 2012. Kaltschmitt et al. (eds): Erneuerbare Energien: Systemtechnik, Wirtschaftlichkeit, Umweltaspekte. Springer, 5. Aufl. 2013. Kaltschmitt et al. (eds): Energie aus Erdwärme. Spektrum Akademischer Verlag; Auflage: 1999 (3. September 2001) Huenges, E. (ed.): Geothermal Energy Systems: Exploration, Development, and Utilization. Wiley-VCH Verlag GmbH & Co. KGaA; Auflage: 1. Auflage (19. April 2010)

Liigiiieeiiiig					
Module M0827: Modeling in Water Management					
Courses					
Title Groundwater Modeling using Modflow (L0543) Groundwater Modeling using Modflow (L0544)		Typ Lecture Recitation Section (small)	Hrs/wk 1 2	CP 1 2	
Modeling of Water Supply and Sewi	er Network (L0875)	Project-/problem-based Learning	2	3	
Module Responsible	Dr. Klaus Johannsen				
Admission Requirements	None				
Recommended Previous	Groundwater				
Knowledge					
	groundwater hydraulics and transport of substances				
	Pipe Systems				
	Knowledge on urban water infrastructures, in particula	ar drinking water systemsand u	ırban drainage	e systems including	
	special structures				
	 Hydraulics of drinking water supply systems and sewer sy 	ystems			
	Basic knowledge on water management				
Educational Objectives	After taking part successfully, students have reached the followi	ing learning results			
Professional Competence	,	3 3			
	The students are able to describe the modelling of groundwater	flow and transport as well as urb	an water infra	structures. They can	
	carry out systems analyses and can detect technical and conce			-	
	are able to analyse interdependencies of hydraulic and toxic phe	enomena in soil and water.		-	
Skills	The students are able to construct and apply scientific ground	water models indipendently. The	y can work or	n different scenarios	
	and can compare or assess different solutions for existing proble	ems by application of selected so	oftware produc	cts. The students are	
	able to use different software solutions (e.g. EPANET, EPA-SWMM	able to use different software solutions (e.g. EPANET, EPA-SWMM).			
Personal Competence					
	Wird nicht vermittelt.				
Social competence	The many formation				
Autonomy	Wird nicht vermittelt.				
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70				
Credit points	6				
Course achievement	None				
Examination	Oral exam				
Examination duration and	20 min				
scale					
Assignment for the					
Following Curricula					
	Civil Engineering: Specialisation Coastal Engineering: Elective Co				
	Civil Engineering: Specialisation Water and Traffic: Elective Com	. ,			
	Water and Environmental Engineering: Specialisation Water: Col Water and Environmental Engineering: Specialisation Environme				
	Water and Environmental Engineering: Specialisation Cities: Elec	cuve compuisory			

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

Course L0875: Modeling of V	ourse 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 M0857: Geoch	hemical Engineering			
Courses				
Title		Тур	Hrs/wk	СР
Contaminated Sites and Landfilling		Lecture	2	2
Contaminated Sites and Landfilling Geochemical Engineering (L0904)	(L0907)	Recitation Section (large) Lecture	1 2	2
	D. M. C. Pit I. at i	Lecture	2	2
Module Responsible				
Admission Requirements				
	Module: General and Inorganic Chemistry,			
Knowledge	Module:Organic Chemistry,			
	Biology (Basic Knowledge)			
Educational Objectives	After taking part successfully, students have reached t	he following learning results		
Professional Competence				
Knowledge	With the completion of this module students acquire	profound knowledge of biogeochemica	I processes, the	fate of pollutants in
	soil and groundwater, and techniques to deposit contain	minated waste material. They are able	to describe in pri	nciple the behaviour
	of chemicals in the environment. Students can explain	and report the approach to remediate	contaminated sit	es.
Skille	With the completion of this module students can app	ly the acquired theoretical knowledge	to model cases	of site pollution and
SKIIIS	critically assess the situation technically and conceptu			·
	and techniques. Model projects can be devised and tre		3 OII dillerent le	nediation strategies
	and techniques. Moder projects can be devised and the	ateu.		
Personal Competence				
Social Competence	Students can discuss technical and scientific tasks wit	hin a seminar subject specific and inter	disciplinary .	
Autonomy	Students can independently exploit sources , acquire the	ne particular knowledge of the subject a	and apply it to ne	w 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 Traffic: Elec	ctive Compulsory		
Following Curricula	Environmental Engineering: Core Qualification: Elective	e Compulsory		
	Water and Environmental Engineering: Specialisation V	Vater: Elective Compulsory		
	Water and Environmental Engineering: Specialisation E	nvironment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation C	Cities: Elective Compulsory		

Course L0906: Contaminated	
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	1) Waste Management. Bernd Bilitewski; Georg Härdtle; Klaus Marek (Eds.), ISBN: 9783540592105, Springer Verlag Lehrbuchsammlung der TUB, Signatur USH-305 2) Solid Waste Technology and Management. Thomas Christensen (Ed.), ISBN: 978-1-4051-7517-3, Wiley Verlag Lesesaal 2: US - Umweltschutz, Signatur USH-332 3) Natural attenuation of fuels and chlorinated solvents in the subsurface. Todd H. Wiedemeier(Ed.), ISBN: 0471197491 Lesesaal 2: US - Umweltschutz, Signatur USH-844

Course 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	

S	
Course L0904: Geochemical	
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	Geochemistry, groundwater and pollution. C. A. J. Appelo; D. Postma Leiden [u.a.] Balkema 2005 Lehrbuchsammlung der TUB, Signatur GWC-515

Module M1717: Adva	nced Vadose Zone Hydrology			
Courses				
Title		Тур	Hrs/wk	CP
Modeling Processes in Vadose Zone		Lecture	1	1
Modeling Processes in Vadose Zone	e (L2735)	Recitation Section (small)	1	1
Vadose Zone Hydrology (L2732) Vadose Zone Hydrology (L2733)		Lecture Recitation Section (large)	2	2
Module Responsible	Prof. Nima Shokri	Recitation Section (large)	2	2
Admission Requirements				
Recommended Previous	None			
Knowledge				
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence	Arter taking part successfully, stauchts have	reactive the following learning results		
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 96, Study Time in L	ecture 84		
Credit points	, , , , ,			
Course achievement				
Examination				
Examination duration and				
scale	55			
Assignment for the	Civil Engineering: Specialisation Water and T	raffic: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Water and T	· · ·		
_	Environmental Engineering: Specialisation W	ater: Elective Compulsory		
	Environmental Engineering: Specialisation W	ater: Elective Compulsory		
	Water and Environmental Engineering: Speci	alisation Water: Elective Compulsory		
	Water and Environmental Engineering: Speci	alisation Environment: Elective Compulsory		
	Water and Environmental Engineering: Speci	alisation Cities: Elective Compulsory		
	Water and Environmental Engineering: Speci	alisation Cities: Elective Compulsory		
	Water and Environmental Engineering: Speci	alisation Environment: Elective Compulsory		
	Water and Environmental Engineering: Speci	alisation Water: Elective Compulsory		

Course L2734: Modeling Prod	ourse 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	

ourse 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: Multip	phase Flow in Porous Media					
Courses						
Title		Тур	Hrs/wk	СР		
Advanced Modeling Techniques for	Multiphase Flow in Porous Media (L2738)	Recitation Section (small)	2	2		
Fundamentals of Multiphase Flow in	n Porous Media (L2736)	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					
Recommended Previous						
Knowledge						
Educational Objectives	After taking part successfully, students have reach	ed the following learning results				
Professional Competence						
Knowledge						
Skills						
Personal Competence						
Social Competence						
Autonomy						
Workload in Hours	Independent Study Time 96, Study Time in Lecture	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 Engir	neering: Elective Compulsory				
	Civil Engineering: Specialisation Geotechnical Engir	neering: Elective Compulsory				
	Civil Engineering: Specialisation Water and Traffic:	Elective Compulsory				
	Environmental Engineering: Specialisation Water: E	Elective Compulsory				
	Environmental Engineering: Specialisation Water: E	Elective Compulsory				
	Water and Environmental Engineering: Specialisation	on Cities: Elective Compulsory				
	Water and Environmental Engineering: Specialisation	on Cities: Elective Compulsory				
	Water and Environmental Engineering: Specialisation	on Environment: Elective Compulsory				
	Water and Environmental Engineering: Specialisation	on Environment: Elective Compulsory				
	Water and Environmental Engineering: Specialisation	on Water: Elective Compulsory				
	Water and Environmental Engineering: Specialisation	on 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 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	

Modulo M1721, Water	and Environments Theory and	Annlication		
Module M1/21: Water	and Environment: Theory and	Аррисаціон		
Courses				
Title		Typ	Hrs/wk	СР
Vater and Environment: Application	a and Field Work (L2754)	Typ Project-/problem-based Learning	3	4
Vater and Environment: Application Vater and Environment: Theory (L2		Lecture	1	2
Module Responsible				
-	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
Professional Competence	<u> </u>	<u> </u>		
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 Engine	eering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Water and Tra	ffic: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engine	eering: Elective Compulsory		
	Civil Engineering: Specialisation Water and Tra	ffic: Elective Compulsory		
	Environmental Engineering: Specialisation Wat			
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	Water and Environmental Engineering: Special	' '		
	Water and Environmental Engineering: Special	isation water: Elective Compulsory		

ourse 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		

Linginicering					
Module M1702: Proce	ess Imaging				
Courses					
Title		Тур	Hrs/wk	CP	
Process Imaging (L2723)		Lecture	2	3	
Process Imaging (L2724)		Project-/problem-based Learning	2	3	
Module Responsible	Prof. Alexander Penn				
Admission Requirements	None				
Recommended Previous					
Knowledge					
Educational Objectives	After taking part successfully, students have reached the follow	wing 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					
Course achievement	None				
Examination	Written exam				
Examination duration and	120 min				
	120 111111				
scale	Di	Familia de Flantina Camandana			
Assignment for the	Bioprocess Engineering: Specialisation A - General Bioprocess				
Following Curricula					
	Bioprocess Engineering: Specialisation B - Industrial Bioproces				
	Bioprocess Engineering: Specialisation B - Industrial Bioproces			ochnology, Elective	
	Compulsory	Bioprocess Engineering: Specialisation C - Bioeconomic Process Engineering, Focus Energy and Bioprocess Technology: Elective			
	Bioprocess Engineering: Specialisation C - Bioeconomic Proce	ass Engineering Focus Energy and	d Rioprocess T	echnology: Flective	
	Compulsory	233 Engineering, 1 ocus Energy uni	a biopiocess i	cerniology. Elective	
	Chemical and Bioprocess Engineering: Specialisation General I	Process Engineering: Flective Comp	nulsory		
	Chemical and Bioprocess Engineering: Specialisation General I				
	Chemical and Bioprocess Engineering: Specialisation Bioproce				
	Chemical and Bioprocess Engineering: Specialisation Bioproce		•		
	Chemical and Bioprocess Engineering: Specialisation Chemical		-		
	Chemical and Bioprocess Engineering: Specialisation Chemical				
	Computer Science: Specialisation II: Intelligence Engineering: I		,		
	Information and Communication Systems: Specialisation Comr		rocessing: Ele	ctive Compulsory	
	International Management and Engineering: Specialisation II. F				
	Theoretical Mechanical Engineering: Specialisation Robotics ar	nd Computer Science: Elective Com	npulsory		
	Theoretical Mechanical Engineering: Specialisation Robotics ar	nd Computer Science: Elective Com	npulsory		
	Process Engineering: Specialisation Process Engineering: Elect	ive Compulsory			
	Process Engineering: Specialisation Process Engineering: Elect	ive Compulsory			
	Process Engineering: Specialisation Chemical Process Enginee	ring: Elective Compulsory			
	Process Engineering: Specialisation Chemical Process Enginee	ring: Elective Compulsory			
	Process Engineering: Specialisation Environmental Process Eng	gineering: Elective Compulsory			
	Process Engineering: Specialisation Environmental Process Eng	gineering: Elective Compulsory			
	Water and Environmental Engineering: Specialisation Environn	nent: Elective Compulsory			
	Water and Environmental Engineering: Specialisation Environn	nent: Elective Compulsory			
	Water and Environmental Engineering: Specialisation Water: E	lective Compulsory			
	Water and Environmental Engineering: Specialisation Water: E	lective 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	

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Course L2724: Process Imagi	ourse 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 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	arning 2	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous	Fundamentals of Hydromechanics, Hydraulics, H	ydrology and Hydraulic Engineering;	Hydraulic Engineeri	ng I and Hydraulic
Knowledge	Engineering II			
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
	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 numerical modelling and actual numerical models for the simulation of flows and waves. They can also depict the concepts of nature oriented hydraulic engineering.			
	Students are able to apply hydrodynamic-numerical models to practical hydraulic engineering tasks. Furthermore, the students are able to set up flood-risk management concepts and are able to apply basic concepts of renaturation to practical problems.			
Personal Competence				
Social Competence	The students are able to deploy their gained know		icai nature-based ny	draulic engineering.
4	Additionaly, they will be able to work in team with The students will be able to independently extend		hlassa	
Autonomy	The students will be able to independently extend	their knowledge and apply it to new pro	bbiems.	
Workload in Hours	Independent Study Time 110, Study Time in Lectur	re 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 response	ect to the general u	nderstanding of the
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Water and Traffic:	Compulsory		
Following Curricula	Environmental Engineering: Core Qualification: Ele	ctive Compulsory		
	Joint European Master in Environmental Studies - C	ities and Sustainability: Core Qualificati	on: Compulsory	
	Water and Environmental Engineering: Specialisati	on Water: Compulsory		
	Water and Environmental Engineering: Specialisati	on Environment: Compulsory		
	Water and Environmental Engineering: Specialisati	on Cities: Elective Compulsory		

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

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

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	Fluvial Areas (L0295)	Project-/problem-based Learning	1	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous	Fundamentals of Hydromechanics and Hydraulic Engine	ering: Hydraulic Engineering I and Hydra	ulic Engineerir	ng II
Knowledge				
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	The students are able to define the basic concepts of h	ydrology and water management. They	are able to d	escribe and quantify
	the relevant processes of the hydrological water cycle.	Besides, the students know the main asp	ects of rainfa	ll-run-off-models and
	are able to theoretically derive established reservoir / st	orage models and a unit-hydrograph.		
Skills	The students are able to use the basic hydrological c	ancents and approaches and are able t	o theoreticall	v dorivo ostablishod
Skilis	reservoir / storage models or a unit-hydrograph as the			
	concepts of measurements of hydrological and hydrod			*
	assess these measurements. Furthermore, they are able		•	-
	assess these measurements. Furthermore, they are unit	to apply a flyarological filoder to basic fl	iyarological pi	obicitis.
Personal Competence				
Social Competence	The students are able to deploy their gained knowledge in applied problems of the hydrology and water management. Additionaly,		gement. Additionaly,	
	they will be able to work in team with engineers of other	disciplines.		
Autonomy	The students will be able to independently extend their	knowledge and apply it to new problems		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	The duration of the examination is 90 min. The examination includes tasks with respect to the general understanding of the lecture			
scale	contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory			
Following Curricula	Environmental Engineering: Core Qualification: Elective	Compulsory		
	Joint European Master in Environmental Studies - Cities	and Sustainability: Core Qualification: Co	mpulsory	
	Water and Environmental Engineering: Specialisation W	ater: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Er	vironment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Ci	cies: Elective Compulsory		

Course L0289: Applied Surfa	ce 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:
	 Hydrological cycle Data acquisition Data analyses and statistical assessment Statistics of extremes Regionalization methods for hydrological values Rainfall-run-off modelling on the basis of a unit hydrograph conceps Application of rainfall-run-off models on the basis of Kalypso-Hydrology which is an OpenSource Software Tool.
Literature	http://de.wikipedia.org/wiki/Kalypso_(Software)
	http://kalypso.bjoernsen.de/
	http://sourceforge.net/projects/kalypso/

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

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

Module M0874: Wasto	awater Systems			
Module Moo7 4: Wast	ewater Systems			
Courses				
Title		Тур	Hrs/wk	СР
Wastewater Systems - Collection, T	reatment and Reuse (L0934)	Lecture	2	2
Wastewater Systems - Collection, T	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			
Recommended Previous	Knowledge of wastewater management and the key	processes involved in wastewater treatm	ent.	
Knowledge				
Educational Objectives	After taking part successfully, students have reache	d the following learning results		
Professional Competence				
Knowledge	Students are able to outline key areas of the full rar	ige of treatment systems in waste water	management, as	well as their mutual
	dependence for sustainable water protection. They	an describe relevant economic, environm	ental and social	factors.
Skills	Students are able to pre-design and explain the av	ailable wastewater treatment processes	and the scene of	f their application in
Skills	municipal and for some industrial treatment plants.	anable wastewater treatment processes	and the scope c	п спен аррисаціон пі
	municipal and for some industrial deadment plants.			
Personal Competence				
Social Competence	Social skills are not targeted in this module.			
4	Children in a marking to made a continue	-d ti th-iddd		-1
Autonomy	Students are in a position to work on a subject a	nd to organize their work now independ	entiy. They can	also present on this
	subject.			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 8	34		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineer	ng: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engine	eering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering	: Elective Compulsory		
	Civil Engineering: Specialisation Water and Traffic: C	ompulsory		
	Bioprocess Engineering: Specialisation A - General B	ioprocess Engineering: Elective Compulso	ry	
	Environmental Engineering: Specialisation Water: El	ective Compulsory		
	International Management and Engineering: Specialisation II. Process Engineering and Biotechnology: Elective Compulsory			
	International Management and Engineering: Special	•	neering: Elective	Compulsory
	Process Engineering: Specialisation Environmental P			
	Process Engineering: Specialisation Process Enginee			
	Water and Environmental Engineering: Specialisation	· · ·		
	Water and Environmental Engineering: Specialisation			
	Water and Environmental Engineering: Specialisation	n Cities: Compulsory		

Course L0934: Wastewater S	ystems - Collection, Treatment and Reuse
	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	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 Wa	stewater Treatment
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent 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
	Membrane Processes
	Activated carbon adsorption
	Ozonation
	"Advanced Oxidation Processes"
	Disinfection
Literature	Metcalf & Eddy, Wastewater Engineering: Treatment and Reuse, McGraw-Hill, Boston 2003
	Wassertechnologie, H.H. Hahn, Springer-Verlag, Berlin 1987
	Membranverfahren: Grundlagen der Modul- und Anlagenauslegung, T. Melin und R. Rautenbach, Springer-Verlag, Berlin 2007
	Trinkwasserdesinfektion: Grundlagen, Verfahren, Anlagen, Geräte, Mikrobiologie, Chlorung, Ozonung, UV-Bestrahlung, Membranfiltration, Qualitätssicherung, W. Roeske, Oldenbourg-Verlag, München 2006
	Organische Problemstoffe in Abwässern, H. Gulyas, GFEU, Hamburg 2003

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

Module M0875: Nexus	s Engineering - Water, Soil, Food and	d Energy		
Courses				
Title		Тур	Hrs/wk	СР
Ecological Town Design - Water, En		Seminar	2	2
Water & Wastewater Systems in a	Global Context (L0939)	Lecture	2	4
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
Recommended Previous	Basic knowledge of the global situation with rising	poverty, soil degradation, migra	ation to cities, lack of w	vater resources and
Knowledge	sanitation			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	Students can describe the facets of the global water s	situation. Students can judge the	enormous potential of th	e implementation of
	synergistic systems in Water, Soil, Food and Energy s	upply.		
Ckilla	Students are able to design espleaied settlements f	or different apparanhis and socie	a acanomic conditions fo	ur the main climates
SKIIIS	Students are able to design ecological settlements f around the world.	or different geographic and socio	p-economic conditions to	or the main climates
	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 pla	n.
Autonomy	Students are in a position to work on a subject and	d to organize their work flow in	dependently. They can a	also present on this
Autonomy	subject.	a to organize their work now inc	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 wor	k towards mile stones. The work	includes presentations a	and papers. Detailed
scale	information can be found at the beginning of the sme	ster in the StudIP course module	handbook.	
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Ele	ective Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation A - General Bio	oprocess Engineering: Elective Co	mpulsory	
	Chemical and Bioprocess Engineering: Specialisation	General Process Engineering: Ele	ctive Compulsory	
	Environmental Engineering: Core Qualification: Elective	ve Compulsory		
	Joint European Master in Environmental Studies - Citie	es and Sustainability: Core Qualifi	cation: Compulsory	
	Process Engineering: Specialisation Environmental Process		oulsory	
	Process Engineering: Specialisation Process Engineering	ng: Elective Compulsory		
	Water and Environmental Engineering: Specialisation	Water: Elective Compulsory		
	Water and Environmental Engineering: Specialisation		ry	
	Water and Environmental Engineering: Specialisation	Cities: Elective Compulsory		

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

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

Module M0922: City F	Planning
Courses	
Title	Typ Hrs/wk CP
City Planning (L1066)	Project-/problem-based Learning 4 6
Module Responsible	Prof. Carsten Gertz
Admission Requirements	None
Recommended Previous	for "Principles of Urban Planning": none
Knowledge	for "Designing Urban Streetscapes": some knowledge of transport planning, e.g. through taking the undergraduate class "Tran Planning and Traffic Engineering"
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to:
	use technical terms of urban planning.
	describe the main determinants of urban development.
	explain and compare different possibilities of how urban development can be influenced.
	discuss requirements for public streetscapes.
	explain the importance of street design.
Skills	Students are able to:
	read and analyze urban development concepts and designs for streetscapes
	appraise such concepts in the context of competing requirements.
	design, justify and reflect their own solutions for concrete examples.
Personal Competence 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: • independently complete a written report including drawings following a broadly pre-defined process. • assess the consequences of their proposed solutions. • independently acquire knowledge and apply this to new issues or problem areas.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written elaboration
Examination duration and	written assignment, designwork during the semester
scale Assignment for the	Civil Engineering, Specialisation Structural Engineering, Elective Computers
•	
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:
	 legal framework, instruments and methods of planning, functional requirements, stakeholders and actors basic design requirements different planning levels and historical contexts. The objective of the course is for students to acquire a basic understanding of urban development problems and approaches for solving them. They will also be able to comprehend the process of urban planning. The course also covers the various functional and aesthetic requirements for designing streetscape as the most important elements of public space. The project work deals with a real life scenario and includes drawing up a development plan, an urban design concept, a building masterplan and a street redesign.
Literature	Albers, Gerd; Wekel, Julian (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 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	Hydraulic Engineering (L1146)	Lecture	2	2
Module Responsible	Prof. Jürgen Grabe			
Admission Requirements	None			
Recommended Previous	complete modules: Geotechnics I-III, Mathemati	cs I-III		
Knowledge	courses: Soil laboratory course			
Educational Objectives	After taking part successfully, students have rea	ached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 110, Study Time in Led	cture 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Geotechnical En	ngineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Structural Engi	neering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineer	ering: Compulsory		
	Theoretical Mechanical Engineering: Specialisat	ion Maritime Technology: Elective Compulsor	y	
	Water and Environmental Engineering: Specialis	sation Cities: Elective Compulsory		
	Water and Environmental Engineering: Specialis	sation Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialis	sation Water: Elective Compulsory		

Course L0548: Marine Geote	chnics		
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	 Geotechnical investigation an description of the seabed Foundations of Offshore-Constructions cCliff erosion Sea dikes Port structures Flood protection structures 		
Literature	 EAK (2002): Empfehlungen für Küstenschutzbauwerke EAU (2004): Empfehlungen des Arbeitsausschusses Uferbauwerke Poulos H.G. (1988): Marine Geotechnics. Unwin Hyman, London Wagner P. (1990): Meerestechnik: Eine Einführung für Bauingenieure. Ernst & Sohn, Berlin 		

Course L0549: Marine Geote	urse L0549: Marine Geotechnics		
Тур	Recitation Section (large)		
Hrs/wk	2		
СР	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		

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

Course 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	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	

	rt Monitoring			
Courses				
Title	Тур		Hrs/wk	СР
Smart Monitoring (L2762)	Integrated Lecture		2	2
Smart Monitoring (L2763)	Recitation Section (sn	nall)	2	4
Module Responsible	Prof. Kay Smarsly			
Admission Requirements	None			
Recommended Previous	Basic knowledge or interest in object-oriented modeling, programming, and sensor	technolog	jies are helpful	. Interest in mod
Knowledge	research and teaching areas, such as Internet of Things, Industry 4.0 and cyber-ph	ysical syst	ems, as well a	s the will to dee
	skills of scientific working, are required. Basic knowledge in scientific writing and good	d English s	kills.	
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge		nitorina Th	ne students wi	Il he able to des
Knowicage	decentralized smart systems to be applied for continuous (remote) monitoring			
	environment. In addition, the students will learn to design and to implement intellige			
	analysis techniques, modern software design concepts, and embedded computing me			
	also part of this module. In small groups, the students will design smart moni			
	"intelligent" sensors to be implemented by the students. Specific focus will be			
	techniques. The smart monitoring systems will be mounted on real-world (built or na	atural) sys	tems, such as	bridges or slopes
	on scaled lab structures for validation purposes. The outcome of every group will be	e documen	nted in a paper	. All students of
	module will "automatically" participate with their smart monitoring system in the	annual "S	mart Monitorin	g" competition.
	written papers and oral examinations form the final grades. The module will be taugh	t in English	n. Limited enrol	llment.
CI:II-				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours				
Credit points				
Course achievement				
	Written elaboration			
	1 10 pages of work with 15-minute oral presentation			
scale				
Assignment for the				
Following Curricula				
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory			
	Environmental Engineering: Specialisation Waste and Energy: Elective Compulsory			
	Environmental Engineering: Specialisation Biotechnology: Elective Compulsory			
	Environmental Engineering: Specialisation Videe: Elective Compulsory			
	Environmental Engineering: Specialisation Waste and Energy: Elective Compulsory			
	Environmental Engineering: Specialisation Biotechnology: Elective Compulsory			
	Environmental Engineering: Specialisation Water: 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 Compulsi	ory		
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsi	•		
	Water and Environmental Engineering: Specialisation Water: Elective Compulsory	-		
	Water and Environmental Engineering: Specialisation Water: Elective Compulsory			

Course L2762: Smart Monito	ring
Тур	Integrated Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Kay Smarsly
Language	EN
Cycle	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	purse L2763: Smart Monitoring		
Тур	Recitation Section (small)		
Hrs/wk	2		
СР	4		
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28		
Lecturer	Prof. Kay Smarsly		
Language	EN		
Cycle	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			

ted Tenics in Environmental Engir	a coving		
ted Topics in Environmental Engir	leering		
	Typ	Hrs/wk	СР
1444)	••		3
		2	2
	Lecture	2	3
)	Lecture	2	2
)	Practical Course	1	1
Prof. Mathias Ernst			
None			
After taking part successfully, students have reached the following learning results			
Depends on choice of courses			
6			
Environmental Engineering: Core Qualification: El	ective 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 Water: Elective Compulsory		
	Depends on choice of courses Environmental Engineering: Core Qualification: El Water and Environmental Engineering: Specialisa Water and Environmental Engineering: Specialisa Water and Environmental Engineering: Specialisa	Delivery (L2387) Integrated Lecture Lecture Practical Course Prof. Mathias Ernst None After taking part successfully, students have reached the following learning results Depends on choice of courses	Typ Hrs/wk L1444) Lecture 2 Delivery (L2387) Integrated Lecture 2 Lecture 2 Lecture 2 Delivery (L2387) Prof. Mathias Ernst None After taking part successfully, students have reached the following learning results Depends on choice of courses Environmental Engineering: Core Qualification: Elective Compulsory Water and Environmental Engineering: Specialisation Cities: Elective Compulsory Water and Environmental Engineering: Specialisation Environment: Elective Compulsory

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

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

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

Тур	Practical Course
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Schriftliche Ausarbeitung
Examination duration and	Protokolle
scale	
Lecturer	Prof. Martin Kaltschmitt, Dr. Marvin Scherzinger
Language	DE
Cycle	WiSe
Content	The experiments of the practical lab course illustrate the different aspects of heat generation from biogenic solid fuels. Firs 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 pellet combustion system. The gaseous and solid pollutant emissions, especially the particulate matter emissions, are measure 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, 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 an interdisciplinary. They discuss various approaches to solving the problem and advise on the theoretical or practical implementation.
Literature	- Kaltschmitt, Martin; Hartmann, Hans; Hofbauer, Hermann: Energie aus Biomasse: Grundlagen, Techniken und Verfahren. 3 Auflage. Berlin Heidelberg: Springer Science & Business Media, 2016ISBN 978-3-662-47437-2 - Versuchsskript

Module M0620: Speci	al Aspects of W	aste Resource M	anagement			
Courses						
Title				Тур	Hrs/wk	СР
Advanced Topics in Waste Resourc	e Management (L1055)			Project-/problem-based Learning	3	3
International Waste Management (L0317)			Project-/problem-based Learning	2	3
Module Responsible	Prof. Kerstin Kuchta					
Admission Requirements	None					
Recommended Previous	basics in waste treatm	ent technologies				
Knowledge						
Educational Objectives	After taking part succe	essfully, students have re	ached the following	ng learning results		
Professional Competence						
Knowledge				as advanced technologies for re		•
	from waste in detail. T	his covers collection, tra	nsport, treatment	and disposal in national and inte	ernational cont	exts.
Skills	Students are able to s	elect suitable processes	for the treatment	with respect to the national or co	ultural and dev	velopmental context.
	They can evaluate the	ecological impact and th	ne technical effort	of different technologies and ma	anagement sys	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 wo	ork results in front	t of others and promote the scie	entific develop	ment of colleagues.
	Furthermore, they can	give and accept profess	ional constructive	criticisms.		
Autonomy	Students can indeper	dently gain additional k	nowledge of the	subject area and apply it in so	dvina the aive	on course tasks and
Autonomy	projects.	dentity gain additional k	nowicage of the	subject area and apply it in so	iving the give	iii course tusks und
	projects.					
Workload in Hours	Independent Study Tir	ne 110, Study Time in Le	cture 70			
Credit points	6					
Course achievement	Compulsory Bonus	Form	Description			
	Yes 20 %	Written elaboration				
Examination	Presentation					
Examination duration and	PowerPoint presentation	on (10-15 minutes)				
scale						
Assignment for the		cialisation Water and Tra		•		
Following Curricula	_	ering: Specialisation Was		• •		
				ainability: Specialisation Energy:	Elective Comp	oulsory
		ntal Engineering: Special		• •		
		ntal Engineering: Special		• •		
	Water and Environmen	ntal Engineering: Special	sation Cities: Elec	tive Compulsory		

Course L1055: Advanced Top	oics 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	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).
	The course is split into two parts:
	1. part: "Conventional" lecture (development of waste management, legislation, collection, transportation and organisation of
	waste management, costs, fees and revenues).
	2. 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.
	duffing project work takes place via studir.
	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.
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: Meml	brane Technology			
Produce Product Premi	static recimology			
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	Prof. Mathias Ernst			
Admission Requirements	None			
Recommended Previous	Basic knowledge of water chemistry. Knowledge of the	core processes involved in water, gas	and steam treatr	nent
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	ne following learning results		
Professional Competence				
Knowledge	Students will be able to rank the technical applications	of industrially important membrane p	rocesses. They w	ill be able to explain
	the different driving forces behind existing membrane	e separation processes. Students wil	I be able to nan	ne materials used ir
	membrane filtration and their advantages and disadva	antages. Students will be able to exp	lain the key diffe	rences in the use o
	membranes in water, other liquid media, gases and in li	iquid/gas mixtures.		
Skills	Students will be able to prepare mathematical equation	ons for material transport in porous a	nd solution-diffus	sion membranes and
	calculate key parameters in the membrane separation			
	available boundary data and provide recommendation			
	experiments, students will be able to classify the se			
	membrane materials. Students will be able to character	· ·		
	measures to control this.	3.,		
Personal Competence				
Social Competence	Students will be able to work in diverse teams on tasks in the field of membrane technology. They will be able to make decisions			
	within their group on laboratory experiments to be unde	ertaken jointly and present these to ot	hers.	
Autonomy	Students will be in a position to solve homework on t	he topic of membrane technology in	dependently. The	v will be capable o
	finding creative solutions to technical questions.			,
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the				
Following Curricula	Bioprocess Engineering: Specialisation A - General Biop	rocess Engineering: Elective Compulso	ory	
	Bioprocess Engineering: Specialisation B - Industrial Bio			
	Chemical and Bioprocess Engineering: Specialisation Ch			
	Chemical and Bioprocess Engineering: Specialisation Ge		ompulsory	
	Environmental Engineering: Specialisation Water: Electi			
	Joint European Master in Environmental Studies - Cities	• •	er: Elective Comp	oulsory
	Process Engineering: Specialisation Process Engineering	, ,		
	Process Engineering: Specialisation Environmental Proc			
	Water and Environmental Engineering: Specialisation W			
	Water and Environmental Engineering: Specialisation En	• •		
l	Water and Environmental Engineering: Specialisation C	ities: 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
	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	 T. Melin, R. Rautenbach: Membranverfahren: Grundlagen der Modul- und Anlagenauslegung (2., erweiterte Auflage), Springer-Verlag, Berlin 2004. Marcel Mulder, Basic Principles of Membrane Technology, Kluwer Academic Publishers, Dordrecht, The Netherlands Richard W. Baker, Membrane Technology and Applications, Second Edition, John Wiley & Sons, Ltd., 2004

Course L0400: Membrane Te	ourse L0400: Membrane Technology	
Тур	Recitation Section (small)	
Hrs/wk	1	
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 Technology			
Courses				
Title		Тур	Hrs/wk	СР
Process Modelling of Wastewater T	reatment (L0522)	Project-/problem-based Learning	2	3
Process Modeling in Drinking Water	Treatment (L0314)	Project-/problem-based Learning	2	3
Module Responsible	Dr. Klaus Johannsen			
Admission Requirements	None			
	Knowledge of the most important processes in drinking	water and waste water treatment.		
Knowledge				
Educational Objectives	After taking part successfully, students have reached th	ne following learning results		
Professional Competence				
Knowledge	Students are able to explain selected processes of dri	•	n detail. The	y are able to explain
	basics as well as possibilities and limitations of dynamic	c modeling.		
Skills	Students are able to use the most important features	Modelica offers. They are able to transpo	se selected	processes in drinking
	water and waste water treatment into a mathematical	model in Modelica with respect to equilib	rium, kinetics	s and mass balances.
	They are able to set up and apply models and assess th	eir possibilities and limitations.		
Personal Competence				
Social Competence	Students are able to solve problems and document solu	utions in a group with members of differe	nt technical b	ackground. They are
	able to give appropriate feedback and can work constru	ictively with feedback concerning their wo	ork.	
Autonomy	Students are able to define a problem, gain the require	d knowledge and set up a model.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elec	tive Compulsory		
Following Curricula	Environmental Engineering: Specialisation Water: Election	• •		
	Joint European Master in Environmental Studies - Cities	• •	Elective Com	oulsory
	Process Engineering: Specialisation Environmental Proc			
	Process Engineering: Specialisation Process Engineering			
	Water and Environmental Engineering: Specialisation W	• •		
	Water and Environmental Engineering: Specialisation E	• •		
	Water and Environmental Engineering: Specialisation C	ities: 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	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.

Linginieering				
Module M0902: Wast	ewater Treatment and Air Pollut	ion Abatement		
Courses				
litle		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			
Recommended Previous	Basic knowledge of biology and chemistry			
Knowledge				
	Basic knowledge of solids process engineering	and separation technology		
Educational Objections	A fibrar halisia a sanda a sana a fisilis a basala a basala a sana	a bank ba fallassia a la seria a casulta		
Educational Objectives	After taking part successfully, students have re	ached the following learning results		
Professional Competence	After suggested completion of the module stud	onts are able to		
Knowieuge	After successful completion of the module stud	erits are able to		
	 name and explain biological processes for 	or waste water treatment,		
	 characterize waste water and sewage sl 	udge,		
	 discuss legal regulations in the area of e 	missions and air quality		
	 explain the effects of air pollutants on the 	e environment,		
	 name and explan off gas tretament prod 	esses and to define their area of applic	ation	
Skills	Students are able to			
55				
	 choose and design processs steps for th 	e biological waste water treatment		
	 combine processes for cleaning of off-ga 	ses depending on the pollutants contai	ned in the gases	
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 124, Study Time in Le	cture 56		
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Tra	ffic: Elective Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation A - Gen		ompulsory	
	Chemical and Bioprocess Engineering: Speciali	sation General Process Engineering: Ele	ective Compulsory	
	Environmental Engineering: Specialisation Was	te and Energy: Elective Compulsory		
	International Management and Engineering: Sp	ecialisation II. Energy and Environment	al Engineering: Elective	Compulsory
	Joint European Master in Environmental Studie			
	Renewable Energies: Specialisation Bioenergy	Systems: Elective Compulsory		
	Process Engineering: Specialisation Environme	ntal Process Engineering: Elective Comp	oulsory	
	Process Engineering: Specialisation Process En	gineering: Elective Compulsory		
	Water and Environmental Engineering: Special	sation Water: Elective Compulsory		
	Water and Environmental Engineering: Special	sation Environment: Compulsory		
	Water and Environmental Engineering: Special	sation Cities: Compulsory		

Тур	Lecture
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	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;)
	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 Wiscomann IIdo (Chai la Sur Dombrowski, Eva Mariar)
	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
L	

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	
itle	Typ Hrs/wk CP
ntegrated Transportation Planning	
Module Responsible	Prof. Carsten Gertz
Admission Requirements	
	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.
	 relate current issues in the area of integrated transport planning and formulate an opinion on them.
	France current issues in the area of integrated datisport planning and formulate air opinion on area.
Skills	Students are able to:
	quantify important parameters, which influence travel demand or are influenced by it.
	comprehensively examine a pre-defined or self-selected topic from a transportation studies perspective and document to the comprehensively examine a pre-defined or self-selected topic from a transportation studies perspective and document to the comprehensively examine a pre-defined or self-selected topic from a transportation studies perspective and document to the comprehensively examine a pre-defined or self-selected topic from a transportation studies perspective and document to the comprehensively examine a pre-defined or self-selected topic from a transportation studies perspective and document to the comprehensive and
	results in accordance with scientific conventions.
Personal Competence	
	Students are able to:
Social competence	Statetics are able to.
	provide feedback on topical contents and their teaching.
	constructively handle feedback on their own work.
	produce results in group work and document these.
Autonomy	Students are able to:
,	
	assess potential consequences of their future professional activities
	• independently plan working on a pre-defined project topic, acquire the necessary knowledge and use appropriate means
	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 Transportation 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 M0948: Study	/ Work Water/ Waste Water
Courses	
Title	Typ Hrs/wk CP
Module Responsible	Dozenten des SD B
Admission Requirements	None
Recommended Previous	
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students are able to demonstrate their detailed knowledge in the field of Water and Environmental Engineering. They can exemplify the state of technology and application and discuss critically in the context of actual problems and general conditions of 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, and 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 has to be adjusted. General findings and further developments may essentially be outlined.
Personal Competence	
Social Competence	The students are able to condense the relevance and the structure of the project work, the work steps and the sub-problems for the presentation and discussion in front of a bigger group. They can lead the discussion and give a feedback on the project to their colleagues.
Autonomy	The students are capable of independently planning and documenting the work steps and procedures while considering the given deadlines. This includes the ability to accurately procure the newest scientific information. Furthermore, they can obtain feedback 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	d Sanitation for diffe	erent Climate Zon	ies
Courses				
Title		Тур	Hrs/wk	СР
	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			
Recommended Previous	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	ne following learning results		
Professional Competence				
Knowledge	Students can describe resources oriented wastewater	systems mainly based on so	ource control in detail. Th	ey can comment o
	techniques designed for reuse of water, nutrients and s	oil conditioners.		
	Students are able to discuss a wide range of proven app	proaches in Pural Developme	nt from and for many regi	ons of the world
	Students are able to discuss a wide range of proven app	oroaches in Rurai Developinei	inc from and for many regi	ons of the world.
Skills	Students are able to design low-tech/low-cost sanitat	ion, rural water supply, rain	water harvesting system	s, measures for th
	rehabilitation of top soil quality combined with food and	d water security. Students car	n consult on the basics of	soil building throug
	"Holisitc Planned Grazing" as developed by Allan Savor	у.		
Personal Competence				
•	The students are able to develop a specific topic in a te	am and to work out milestone	es according to a given pla	ın.
,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,			, , , , , , , , , , , , , , , , , , ,	
Autonomy	Students are in a position to work on a subject and	to organize their work flow i	independently. They can	also present on thi
	subject.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	During the course of the semester, the students work	towards mile stones. The wor	rk includes presentations	and papers. Detaile
scale	information will be provided at the beginning of the sme	ester.		
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elec	tive Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation A - General Biop	rocess Engineering: Elective (Compulsory	
	Chemical and Bioprocess Engineering: Specialisation Ge	eneral Process Engineering: E	lective Compulsory	
	Environmental Engineering: Specialisation Water: Electi	ve Compulsory		
	International Management and Engineering: Specialisat	ion II. Energy and Environmer	ntal Engineering: Elective	Compulsory
	Joint European Master in Environmental Studies - Cities	and Sustainability: Specialisa	tion Water: Elective Comp	oulsory
	Process Engineering: Specialisation Environmental Proc	ess Engineering: Elective Con	npulsory	
	Process Engineering: Specialisation Process Engineering	g: Elective Compulsory		
	Water and Environmental Engineering: Specialisation W	ater: Elective Compulsory		
	Water and Environmental Engineering: Specialisation En	·	sory	
	Water and Environmental Engineering: Specialisation C	ities: Elective Compulsory		

Course L0942: Rural Develop	oment 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	
	 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. 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.
Literature	 J. Lange, R. Otterpohl 2000: Abwasser - Handbuch zu einer zukunftsfähigen Abwasserwirtschaft. Mallbeton Verlag (TUHH Bibliothek) Winblad, Uno and Simpson-Hébert, Mayling 2004: Ecological Sanitation, EcoSanRes, Sweden (free download) Schober, Sabine: WTO/TUHH Award winning Terra Preta Toilet Design: http://youtu.be/w_R09cYq6ys

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	 Living Soil - THE key element of Rural Development Participatory Approaches Rainwater Harvesting Ecological Sanitation Principles and practical examples Permaculture Principles of Rural Development Performance and Resilience of Organic Small Farms Going Further: The TUHH Toolbox for Rural Development EMAS Technologies, Low cost drinking water supply
Literature	Miracle Water Village, India, Integrated Rainwater Harvesting, Water Efficiency, Reforestation and Sanitation: http://youtu.be/9hmkgn0nBgk Montgomery, David R. 2007: Dirt: The Erosion of Civilizations, University of California Press

Engineering"				
Module M0581: Wate	r Protection			
Courses				
Title		Тур	Hrs/wk	СР
Water Protection and Wastewater Management (L0226)		Lecture	3	3
Water Protection and Wastewater I	Management (L2008)	Project Seminar	3	3
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
Recommended Previous				
Knowledge	Basic knowledge in water management;			
	Good knowledge in urban drainage;	Charles to the		
	Good knowledge of wastewater treatmen Good knowledge of pollutants (e.g. COP)	,		
	Good knowledge of pollutants (e.g. COD,	BOD, 15, N, P) and their properties;		
Educational Objectives	After taking part successfully, students have rea	iched the following learning results		
Professional Competence				
Knowledge	The students can describe the basic principles of	f the regulatory framework related to th	ne international and Eu	ropean water sector.
	They can explain limnological processes, subs	tance cycles and water morphology ir	detail. They are able	to assess complex
	problems related to water protection, such as	ecosystem service and wastewater tre	atment with a special	focus on innovative
	solutions, remediation measures as well as conc	eptual approaches.		
Skille	Students can accurately assess current problen	os and situations in a country specific o	r local context. They c	an suggest concrete
Skills	actions to contribute to the planning of tomo			
	administrative and legislative solutions to solve		, they can suggest ap	propriate teerimear,
	administrative and registative solutions to solve	anese prosiems.		
Personal Competence				
Social Competence	The students can work together in international	groups.		
Autonomy	Students are able to organize their work flow to	prepare presentations and discussions	s. They can acquire ap	propriate knowledge
,	by making enquiries independently.			
Workload in Hours	Independent Study Time 96, Study Time in Lecti	ure 84		
Credit points				
Course achievement				
Examination	Presentation			
	Term paper plus presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engir			
Following Curricula	Civil Engineering: Specialisation Geotechnical Er			
	Civil Engineering: Specialisation Coastal Enginee			
	Civil Engineering: Specialisation Water and Traff			
	Environmental Engineering: Specialisation Wate	, ,	Commule	
	International Management and Engineering: Spe			ulsony
	Joint European Master in Environmental Studies	• •	i water: Elective Comp	uisury
	Water and Environmental Engineering: Specialis Water and Environmental Engineering: Specialis			
	Water and Environmental Engineering: Specialis			
		acon Environment. Compulsory		

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

Course L2008: Water Protect	ourse 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: Emer	ging Trends in Environmental En	gineering		
Courses				
Title		Тур	Hrs/wk	СР
Environmental Research Trends (L2	2752)	Seminar	2	2
Microplastics in Environment (L275	0)	Lecture	2	2
Scientific Communication and Meth	nods (L2751)	Lecture	1	2
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
Recommended Previous	Basic knowledge on water, soil and environmen	tal research.		
Knowledge				
Educational Objectives	After taking part successfully, students have rea	ached the following learning results		
Professional Competence				
Knowledge	The students will be exposed to up-to-date rese	earch topics focused on soil, water and	climate related challeng	ges with a particular
	focus on the effects of microplastics in enviror	nment. Data analysis, data measureme	ent, curation and preser	ntation will be other
	skills that the students will develop in this modu	ıle.		
Skills	Students' research skills will be improved in th	is module. How to prepare and delive	r an effective presentati	on, how to write an
	abstract, research paper and proposal will be d	liscussed in this module. Moreover, thr	ough Research-Based Le	earning approaches,
	the students will be exposed to current research	n trends in environmental engineering.		
Personal Competence				
•	Developing teamwork and problem solving skills	s through Research-Based Teaching app	oroaches will be at the co	ore of this module.
,	, 3	3		
Autonomy		·	will contribute to the s	tudents' ability and
	willingness to work independently and responsil	bly.		
Workload in Hours	Independent Study Time 110, Study Time in Led	cture 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 Traf	fic: Elective Compulsory		
Following Curricula	Environmental Engineering: Specialisation Wate	er: Elective Compulsory		
	Environmental Engineering: Specialisation Wast	e and Energy: Elective Compulsory		
	Environmental Engineering: Specialisation Biote	chnology: Elective Compulsory		
	Water and Environmental Engineering: Specialis	sation Cities: Elective Compulsory		
	Water and Environmental Engineering: Specialis	sation Environment: Elective Compulsor	Ту	
	Water and Environmental Engineering: Specialis	sation Water: Elective Compulsory		

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

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

Course L2751: Scientific Communication 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.	

Module M1779: Susta	ninable Nature-based Coastal Protection in a Changing Climate (SeaPiaC)
Courses	
Title Sustainable Nature-based Coastal F	Typ Hrs/wk CP Protection in a Changing Climate (SeaPiaC) (L2926) Project-/problem-based Learning 4 6
Module Responsible	Prof. Peter Fröhle
Recommended Previous Knowledge	Hydraulic Engineering Hydromechanics, Hydraulics Fundamentals of Coastal Engineering, Coastal- and Flood Protection
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence Knowledge	 Climate and Climate Change General Impacts of Climate Change on Wind Regime and Water Cycle Consequences of Climate Change for Coastal Processes Coastal Protection in Taiwan and Germany Fundamentals of Climate Adaptation Nature-based Solutions (NBS) for Coastal Protection
Skills	 Critical thinking: analysis of processes and relations, assessment of needs for action Creative thinking: development of adaptation strategies and adaptation measures Practical thinking: inclusion of restrictions, application of calculation approaches, methods, numerical models, plannin methods Consideration of complex tasks
Personal Competence Social Competence	 Working in heterogenous groups Working in international groups Working with different scientific / non-scientific disciplines
Autonomy	 Self reflection Application oriented use of knowledge and skills Autonomous work on complex tasks
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written elaboration
Examination duration and	Preparation of a written report on a complex task with a presentation and subsequent discussion. The work on the complex task
scale	happens in the course of the lecture.
Assignment for the	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory
Following Curricula	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 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	 Climate and Climate Change General Impacts of Climate Change on Wind Regime and Water Cycle Consequences of Climate Change for Coastal Processes Coastal Protection in Taiwan and Germany Fundamentals of Climate Adaptation Nature-Based Solutions (NBS) for Coastal Protection
Literature	Materials provided on eLearning Platform (HOOU Platform)

Module M1505: Adap	tation to Climate Change in Hydraulic Engineering (AKWAS)	
Courses		
Title daptation to climate change in hy	Typ Hrs/wk CP vdraulic engineering (L2291) Project-/problem-based Learning 4 6	
Module Responsible	Prof. Peter Fröhle	
Admission Requirements	None	
Recommended Previous Knowledge	Hydrology, Hydraulic Engineering Hydromechanic, Hydraulics Fundamentals of Coastal Engineering, Coastal- and Flood Protection Hydrological Systems	
Educational Objectives	After taking part successfully, students have reached the following learning results	
Professional Competence Knowledge Skills	 Climate protection and climate adaptation Insights into climate change and its regional characteristics - fundamentals, climate modelling / climate models Impacts of climate change on the components of the regional hydrological cycle Fundamentals of analysis of climate data Consequences of the impact of the climate change Measures for climate adaptation Assessment, prioritization and communication of adaptation measures Fundamentals of the analysis of hydrometeorological and hydrological data 	
Personal Competence Social Competence		
Autonomy	Application oriented use of knowledge and skills Autonomous work on complex tasks	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	
Credit points	6	
Course achievement	None	
Examination	Written elaboration	
Examination duration and scale		
-	e Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory	
Following Curricula	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	 Climate protection and climate adaptation Findings on climate change and its regional characteristics: fundamentals of climate change, climate modelling / climate models Impacts of climate change on the components of the regional hydrological cycle(climate science view) Fundamentals of the analysis of climate data Concequences of the impacts of climate change (ingenieering science view) Measures for climate change adaptation Assessment, prioritization and communication of measures Fundamentals of analysis of hydrometeorological and hydrological data 			
Literature	Bereitgestellte eLearning Plattform			

Thesis

Courses			
itle	Тур	Hrs/wk	СР
Module Responsible	Professoren der TUHH		
Admission Requirements			
	According to General Regulations §21 (1):		
	At least 60 credit points have to be achieved in study programme. The examinatio	ons hoard decides on (evcentions
	Acteuse of credit points have to be deficited in study programme. The examination	TIS BOUTH ACCIDES OF C	глеерионз.
Recommended Previous			
Knowledge			
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
Knowledge			
	• The students can use specialized knowledge (facts, theories, and methods) of	their subject compet	tently on specialize
	issues.		
	 The students can explain in depth the relevant approaches and terminologies 	s in one or more are	eas of their subject
	describing current developments and taking up a critical position on them.		
	The students can place a research task in their subject area in its context and or their subject area.	describe and critically	assess the state of
	research.		
Skills	The students are able:		
	To select, apply and, if necessary, develop further methods that are suitable for so		
	To apply knowledge they have acquired and methods they have learnt in the c	ourse of their studie	s to complex and/o
	incompletely defined problems in a solution-oriented way.		
	 To develop new scientific findings in their subject area and subject them to a critic 	al assessment.	
Personal Competence			
Social Competence	Students can		
Social Competence	Students can		
	Both in writing and orally outline a scientific issue for an expert audience accurately.	ately, understandably	and in a structure
	way.		
	• Deal with issues competently in an expert discussion and answer them in a man	ner that is appropria	te to the addressee
	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 according	ngly.	
	To work their way in depth into a largely unknown subject and to access the inform	nation required for the	em to do so.
	To apply the techniques of scientific work comprehensively in research of their ow	n.	
	Indexed at State Time 200 State Time in Land at 20		
	Independent Study Time 900, Study Time in Lecture 0		
Credit points			
Course achievement	None		
Examination	Thesis		
Examination duration and	According to General Regulations		
scale			
Assignment for the	Civil Engineering: Thesis: Compulsory		
Following Curricula	Bioprocess Engineering: Thesis: Compulsory		
_	Chemical and Bioprocess Engineering: Thesis: Compulsory		
	Computer Science: Thesis: Compulsory		
	Electrical Engineering: Thesis: Compulsory		
	Energy Systems: Thesis: Compulsory		
	Environmental Engineering: Thesis: Compulsory		
	Aircraft Systems Engineering: Thesis: Compulsory		
	Global Innovation Management: Thesis: Compulsory		
I.	Computer Science in Engineering: Thesis: Compulsory		
	Information and Communication Systems: Thesis: Compulsory		
	Information and Communication Systems: Thesis: Compulsory		
	Interdisciplinary Mathematics: Thesis: Compulsory		
	Interdisciplinary Mathematics: Thesis: Compulsory International Production Management: Thesis: Compulsory		
	Interdisciplinary Mathematics: Thesis: Compulsory International Production Management: Thesis: Compulsory International Management and Engineering: Thesis: Compulsory	dese	
	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: Compu	ılsory	
	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: Compulsory Logistics, Infrastructure and Mobility: Thesis: Compulsory	alsory	
	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: Compu	ulsory	

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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