

# **Module Manual**

Master of Science

# **Water and Environmental Engineering**

Cohort: Winter Term 2017

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# **Table of Contents**

	Contents	2
	description	4
Core qua	alification	5
	M0523: Business & Management	_5
	M0524: Nontechnical Elective Complementary Courses for Master	6
	M0826: Biology, Geology and Chemistry	8
	M0962: Sustainability and Risk Management	10
		12
	M0830: Environmental Protection and Management M0902: Wastewater Treatment and Air Pollution Abatement	12 14
	M0923: Integrated Transportation Planning	17
	M0525: Integrated Transportation Flamming M0511: Electricity Generation from Wind and Hydro Power	19
	M0703: Soil and Groundwater Contamination	22
Module	M0749: Waste Treatment and Solid Matter Process Technology	24
Module	M0827: Modeling in Water Management	26
	M0828: Urban Environmental Management	28
	M0857: Geochemical Engineering	30
	M0870: Management of Surface Water	32
	M0871: Hydrological Systems M0874: Wastewater Systems	34
	M0875: Nexus Engineering - Water, Soil, Food and Energy	36 39
	M0922: City Planning	41
	M0982: Transportation Modelling	43
	M0663: Marine Geotechnics and Numerics	44
Module	M0620: Special Aspects of Waste Resource Management	46
	M0581: Water Protection	48
	M0619: Waste Treatment Technologies	50
	M0705: Groundwater	52
	M0801: Water Resources and -Supply	54
	M0802: Membrane Technology	56
	M0822: Process Modeling in Water Technology M0847: Analytical Methods and Treatment Technologies for Wastewaters	58 61
	M0864: Practical Course in Water and Wastewater Technology	64
	M0894: Study Work Cities	65
	M0949: Rural Development and Resources Oriented Sanitation for different Climate Zones	66
	M0981: Operation of Public Transportation Systems	68
Specializ	zation Environment	70
Module	M0581: Water Protection	70
	M0830: Environmental Protection and Management	72
	M0902: Wastewater Treatment and Air Pollution Abatement	74
	M0511: Electricity Generation from Wind and Hydro Power	77
	M0513: System Aspects of Renewable Energies M0703: Soil and Groundwater Contamination	80
	M0749: Waste Treatment and Solid Matter Process Technology	83 85
	M0827: Modeling in Water Management	87
	M0828: Urban Environmental Management	89
	M0857: Geochemical Engineering	91
Module	M0870: Management of Surface Water	93
Module	M0871: Hydrological Systems	95
Module	M0874: Wastewater Systems	97
		00
		102
		104 106
	MOZOE: Overved water	108
		110
		112
		114
		117
		119
		122
		123
		125 127
		28
		20 128
		130
		132
		134
		137
Module	M0827: Modeling in Water Management	139

Module M0857: Geochemical Engineering	141
Module M0870: Management of Surface Water	143
Module M0871: Hydrological Systems	145
Module M0874: Wastewater Systems	147
Module M0875: Nexus Engineering - Water, Soil, Food and Energy	150
Module M0922: City Planning	152
Module M0663: Marine Geotechnics and Numerics	154
Module M0620: Special Aspects of Waste Resource Management	156
Module M0802: Membrane Technology	158
Module M0822: Process Modeling in Water Technology	160
Module M0847: Analytical Methods and Treatment Technologies for Wastewaters	163
Module M0864: Practical Course in Water and Wastewater Technology	166
Module M0902: Wastewater Treatment and Air Pollution Abatement	167
Module M0923: Integrated Transportation Planning	170
Module M0949: Rural Development and Resources Oriented Sanitation for different Climate Zones	172
Module M0948: Study Work Water/ Waste Water	174
Thesis	175
Module M-002: Master Thesis	175



### **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: Business	& 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 Skills	<ul> <li>Students are able to find their way around selected special areas of management within the scope of business management.</li> <li>Students are able to explain basic theories, categories, and models in selected special areas of business management.</li> <li>Students are able to interrelate technical and management knowledge.</li> </ul>
Personal Competence Social Competence 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: Nontechnical Elective Complementary Courses for Master		
Module Responsible	Dagmar Richter	
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 goal-oriented communication skills, e.g. the skills required by outgoing engineers in international and intercultural situations.

#### The Competence Level

of the courses offered in this area is different as regards the basic training objective in the Bachelor's and Master's fields. 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,
- $\bullet \quad \text{to handle simple and advanced questions in aforementioned scientific disciplines in a sucsessful manner},\\$
- 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
	<ul> <li>to learn to collaborate in different manner,</li> <li>to present and analyze problems in the abovementioned fields in a partner or group situation in a manner appropriate to the addressees,</li> <li>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),</li> <li>to explain nontechnical items to auditorium with technical background knowledge.</li> </ul>
Autonomy	Personal Competences (Self-reliance)
	Students are able in selected areas  • to reflect on their own profession and professionalism in the context of real-life fields of application
	to organize themselves and their own learning processes
	to reflect and decide questions in front of a broad education background
	to communicate a nontechnical item in a competent way in writen form or verbaly
	to organize themselves as an entrepreneurial subject country (as far as this study-focus would be chosen)
Workload in Hours	Depends on choice of courses
Credit points	6

#### Courses

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



Module M0826: Biology, G	eology and Chemistry			
Courses				
Title		Тур	Hrs/wk	СР
Biology (L1428)		Lecture	2	2
Geology and Soil Science (L0903)		Lecture	2	2
Environmental Analysis (L0354)		Lecture	2	2
Module Responsible	Dr. Dorothea Rechtenbach			
Admission Requirements	none			
Recommended Previous	Fundamentals of inorganic/organic chemistry	and biology (knowledge acquired at school)		
Knowledge				
Educational Objectives	After taking part successfully, students have it	reached the following learning results		
Professional Competence				
Knowledge				
	migrating compounds in soil and groundwate	er. They learn about methods to investigate sites for d	lifferent use.	
Clvilla	Skills With the completion of this module students can apply the acquired theoretical knowledge to model sites and assess the situation technically a			aituation tackning llu and
Skills	•	sons on different investigation strategies and techniq		•
	conceptually. They are able to draw compani	sons on different investigation strategies and techniq	ues. Moder projects carri	de devised and treated.
Personal Competence				
Social Competence	Students can discuss technical and scientific	tasks within a seminar subject specific and interdisci	plinary .	
Autonomy	Students can independently exploit sources	, acquire the particular knowledge of the subject and	apply it to new problems	•
Workload in Hours	Independent Study Time 96, Study Time in Lo	ecture 84		
Credit points	6			
Examination	Written exam			
Examination duration and scale	2 Std. 15 Min.			
Assignment for the Following	Water and Environmental Engineering: Core	qualification: Compulsory		
Curricula				

Course L1428: Biology		
Тур	Lecture	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Dr. Anna Krüger	
Language	DE	
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	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Dr. Joachim Gerth, Prof. Wilfried Schneider	
Language	DE	
Cycle	WiSe	
Content	Geology: formation of the Earth, plate tectonics, macroscopic rock identification, introduction to Earth history, introduction to halokinesis.	
	Soil science: soil use and function in ecosystems, faktors and processes of soil formation, mineral and organic components, surface types and properties, retention of nutrients and pollutants, hazards from faulty land use, erosion, salinization, and contamination, measures to preserve soils	
Literature	R. Vinx (2011): "Gesteinsbestimmung im Gelände"	
	H. Bahlburg & C. Breitkreutz (2012): "Grundlagen der Geologie", TUB Signatur GWB-318	
	R. Walter (2003): "Ergeschichte" TUB Signatur: 2816-1769	
	F.Scheffer und P. Schachtschabel (2002): "Lehrbuch der Bodenkunde" TUB Signatur AGG-308	
	W.E.H. Blum (2007): "Bodenkunde in Stichworten" TUB Signatur AGG-317	



Course L0354: Environmental Ana	ulysis		
Тур	Lecture		
Hrs/wk	2		
CP	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Dr. Dorothea Rechtenbach, Martin Wesselmann		
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			
	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)		
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Module M0962: Sustainab	ility and Risk Management			
Courses				
Title		Тур	Hrs/wk	СР
Safety, Reliability and Risk Assessment	(L1145)	Seminar	2	3
Environment and Sustainability (L0319)		Lecture	2	3
Module Responsible	Prof. Kerstin Kuchta			
Admission Requirements	none			
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the for	ollowing learning results		
Professional Competence				
Knowledge	Students are able to describe single techniques and to gi	ive an overview for the field of safety ar	nd risk assessment as wel	Il as environmental and
	sustainable engineering, in detail:			
	- basing in anfatr and valighility of to abound familities			
	basics in safety and reliability of technical facilities			
	<ul> <li>safety and reliability analysis methods</li> <li>risk assessment</li> </ul>			
	Production and usage of bio-char			
	<ul><li>energy production and supply</li><li>sustainable product design</li></ul>			
Skills	Students are able apply interdisciplinary system-oriented		tainability reporting. They	can evaluate the effort
	and costs for processes and select economically feasible	treatment concepts.		
Personal Competence				
Social Competence				
Autonomy	Students can gain knowledge of the subject area from gi	ven sources and transform it to new qu	estions. Furthermore, the	y can define targets for
	new application or research-oriented duties in for risk m	anagement and sustainability concepts	accordance with the pot	ential social, economic
	and cultural impact.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Examination	Written elaboration			
Examination duration and scale	Elaboration and presentation (45 minutes in groups)			
Assignment for the Following	Civil Engineering: Core qualification: Compulsory			
Curricula	International Management and Engineering: Specialisatio	n II. Civil Engineering: Elective Computer	sory	
Jannouna	Product Development, Materials and Production: Specialis			
	Product Development, Materials and Production: Specialis			
	Product Development, Materials and Production: Specialis			
	Water and Environmental Engineering: Core qualification:			
	Water and Environmental Engineering. One qualification.	. Compaisory		

Course L1145: Safety, Reliability and Risk Assessment		
Тур	Seminar	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Dr. Marco Ritzkowski	
Language	DE	
Cycle	WiSe	
	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	



Course L0319: Environment and Sustainability		
Тур	Lecture	
Hrs/wk	2	
CP	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	
Literature	Offshore Wind energy  Wird in der Veranstaltung bekannt gegeben.	
Literature	valid in del vetanolationing benamin gegeben.	



## **Specialization Cities**

	<b>Typ</b> Lecture	Hrs/wk	<b>CP</b> 2
	Lecture	2	3
ment (L0388)	Recitation Section (small)	1	1
Prof. Ralf Otterpohl			
none			
<ul> <li>Good knowledge in Technologies for Environmental Protection (end-of-pipe, integrated solutions)</li> <li>Good knowledge of the relevant Environmental Legislation</li> <li>Basic knowledge of instruments for Environmental Assessment</li> </ul>			
After taking part successfully, students have reached the follo	wing learning results		
The students are able to describe the basics of regulations, economic instruments, voluntary initiatives, fundamentals of HSE legislation ISO 14001, EMAS and Responsible Care ISO 14001 requirements. They can analyse and discuss industrial processes, substance cycles and approaches from end-of-pipe technology to eco-efficiency and eco-effectiveness, showing their sound knowledge of complex industry related problems. They are able to judge environmental issues and to widely consider, apply or carry out innovative technical solutions, remediation measures and further interventions as well as conceptual problem solving approaches in the full range of problems in different industrial sectors.			
Students are able to assess current problems and situations in the field of environmental protection. They can consider the best available techniques and to plan and suggest concrete actions in a company- or branch-specific context. By this means they can solve problems on a technical, administrative and legislative level.			
The students can work together in international groups.			
Students are able to organize their work flow to prepare themselves for presentations and contributions to the discussions. They can acquire appropriate knowledge by making enquiries independently.			
ndependent Study Time 110, Study Time in Lecture 70			
	onmental Engineering: Elective Compuls	sory	
	9g	•	
	Sustainability: Specialisation Water: Elec	ctive Compulsory	
loint European Master in Environmental Studies - Cities and	Sustainability: Specialisation Energy: Ele	ective Compulsory	
Product Development, Materials and Production: Specialisati	on Product Development: Elective Comp	ulsory	
Product Development, Materials and Production: Specialisati	on Production: Elective Compulsory		
Product Development, Materials and Production: Specialisati	on Materials: Elective Compulsory		
	Good knowledge of the relevant Environmental Legisl Basic knowledge of instruments for Environmental Assachter taking part successfully, students have reached the followant of the students are able to describe the basics of regulations and approaches from end-of-pipe technology to eco-efficience problems. They are able to judge environmental issues an measures and further interventions as well as conceptual problems. They are able to assess current problems and situation echniques and to plan and suggest concrete actions in a echnical, administrative and legislative level.  The students are able to organize their work flow to prepare the appropriate knowledge by making enquiries independently.  The students are able to organize their work flow to prepare the appropriate knowledge by making enquiries independently.  The students are able to organize their work flow to prepare the appropriate knowledge by making enquiries independently.  The students are able to organize their work flow to prepare the appropriate knowledge by making enquiries independently.  The students are able to organize their work flow to prepare the appropriate knowledge by making enquiries independently.  The students are able to organize their work flow to prepare the appropriate knowledge by making enquiries independently.  The students are able to organize their work flow to prepare the appropriate knowledge by making enquiries independently.	Lecture Lecture Rectation Section (small)  Prof. Ralf Otterpohl  Tone  Good knowledge in Technologies for Environmental Protection (end-of-pipe, integrated solution Good knowledge of the relevant Environmental Legislation Basic knowledge of instruments for Environmental Assessment  After taking part successfully, students have reached the following learning results  The students are able to describe the basics of regulations, economic instruments, voluntary initial (A001, EMAS and Responsible Care ISO 14001 requirements. They can analyse and discust and approaches from end-of-pipe technology to eco-efficiency and eco-effectiveness, showing their storoblems. They are able to judge environmental issues and to widely consider, apply or carry out measures and further interventions as well as conceptual problem solving approaches in the full range.  Students are able to assess current problems and situations in the field of environmental protect echniques and to plan and suggest concrete actions in a company- or branch-specific context. By echnical, administrative and legislative level.  The students can work together in international groups.  Students are able to organize their work flow to prepare themselves for presentations and contrib appropriate knowledge by making enquiries independently.  Independent Study Time 110, Study Time in Lecture 70  Students are able to organize their work flow to prepare themselves for presentations and contrib appropriate knowledge by making enquiries independently.  Independent Study Time 110, Study Time in Lecture 70  Students are able to organize their work flow to prepare themselves for presentations and contrib appropriate knowledge by making enquiries independently.  Students are able to organize their work flow to prepare themselves for presentations and contrib appropriate knowledge by making enquiries independently.	Lecture 2 Lecture 2 Lecture 2 Lecture 2 Lecture 2 Recitation Section (small) 1  Prof. Ralf Otterpohl  Once  Good knowledge in Technologies for Environmental Protection (end-of-pipe, integrated solutions) Good knowledge of the relevant Environmental Legislation Basic knowledge of the relevant Environmental Legislation Basic knowledge of instruments for Environmental Assessment  After taking part successfully, students have reached the following learning results  The students are able to describe the basics of regulations, economic instruments, voluntary initiatives, fundamentals approaches from end-of-pipe technology to eco-efficiency and eco-effectiveness, showing their sound knowledge of coroblems. They are able to judge environmental issues and to widely consider, apply or carry out innovative technica measures and further interventions as well as conceptual problem solving approaches in the full range of problems in differ an easier as able to assess current problems and situations in the field of environmental protection. They can consectingly and an eco-efficiency and eco-efficiency eco-efficiency and eco-efficiency eco-efficienc



Course L0502: Integrated Pollution	n 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	
Content	<ul> <li>The Regulatory Framework</li> <li>Pollution &amp; Impacts, Characteristics of Pollutants</li> <li>Approaches of Integrated Pollution Control</li> <li>Sevilla Process, Best Available Technologies &amp; BREF Documents</li> <li>Case Studies: paper industry, cement industry, automotive industry</li> <li>Field Trip</li> </ul>
Literature	Förstner, Ulrich (1998): Integrated Pollution Control, Springer-Verlag Berlin Heidelberg, ISBN 978-3-642-80313-0  Shen, Thomas T. (1999): Industrial Pollution Prevention, Springer-Verlag Berlin Heidelberg, ISBN 978-3-540-65208-3

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

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



Module M0902: Wastewate	er Treatment and Air Pollution Abate	ment		
Courses				
Courses Title		Тур	Hrs/wk	CP
Biological Wastewater Treatment (L0517		Lecture	2	3
Air Pollution Abatement (L0203)	)	Lecture	2	3
Module Responsible	Dr. Ernst-Ulrich Hartge			-
Admission Requirements	None			
Recommended Previous	Basic knowledge of biology and chemistry			
Knowledge				
Ü	basic knowledge of solids process engineering a	nd separation technology		
Educational Objectives	After taking part successfully, students have reach	ned the following learning results		
Professional Competence	2. 2. 2			
•	After successful completion of the module studen	ts are able to		
	name and explain biological processes for the second			
	characterize waste water and sewage slu     discuss legal regulations in the area of en			
	<ul> <li>discuss legal regulations in the area of en</li> <li>classify off gas tretament processes and to</li> </ul>			
	• classify on gas tretament processes and it	о ченне втен атеа от аррпсанот		
Skills	Students are able to			
	choose and design processs steps for the	hiological waste water treatment		
	<ul> <li>choose and design processs steps for the biological waste water treatment</li> <li>combine processes for cleaning of off-gases depending on the pollutants contained in the gases</li> </ul>			
	somethic processes for dreaming or on gas	oo doponanig on the pendanie contamou in the	94000	
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 124, Study Time in Lectu	ure 56		
Credit points	6			
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the Following	Bioprocess Engineering: Specialisation A - Gene			
Curricula	Chemical and Bioprocess Engineering: Specialis	• •		
	Energy and Environmental Engineering: Speciali	• •	npulsory	
	Environmental Engineering: Specialisation Waste			
	International Management and Engineering: Spe		-	У
	Joint European Master in Environmental Studies		Elective Compulsory	
	Renewable Energies: Specialisation Bioenergy S			
	Process Engineering: Specialisation Environmen			
	Process Engineering: Specialisation Process Eng	, ,		
	Water and Environmental Engineering: Specialism Water and Environmental Engineering: Specialism	· · ·		
	Water and Environmental Engineering: Specialist			
	vvaler and Environmental Engineering: Specialis	ation Ottles. Compulsory		

Course L0517: Biological Wastewater Treatment	
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Course work	No compulsory course work.
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



 $ISBN: \quad 3540343296 \qquad (Gb.) \qquad URL: \quad http://www.gbv.de/dms/bs/toc/516261924.pdf \qquad URL: \quad http://deposit.d-nb.de/cgi-bin/dokserv?$ 

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

 $\textbf{Lange, J\"{o}rg} \ (Otterpohl, Ralf; Steger-Hartmann, Thomas;)$ 

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

Weimar: Universitätsverl, 2006

TUB\_HH\_Katalog

Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall

DWA-Regelwerk
Hennef: DWA, 2004
TUB\_HH\_Katalog

 $\textbf{Wiesmann}, \textbf{Udo} \ (\textbf{Choi}, \textbf{In Su}; \textbf{Dombrowski}, \textbf{Eva-Maria};)$ 

Fundamentals of biological wastewater treatment

 $ISBN: 3527312196 \ (Gb.) \ URL: http://deposit.ddb.de/cgi-bin/dokserv?id=2774611\&prov=M\&dok\_var=1\&dok\_ext=htm. The proves the prov$ 

Weinheim: WILEY-VCH, 2007

TUB\_HH\_Katalog



Course L0203: Air Pollution Abate	ment
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Ernst-Ulrich Hartge
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 M0923: Integrated	I Transportation Planning
Courses	
Title Integrated Transportation Planning (L10)	Typ Hrs/wk CP  68) Problem-based Learning 4 6
Module Responsible	
Admission Requirements	None
Recommended Previous	some knowledge of transport planning, e.g. through taking the undergraduate class "Transport Planning and Traffic Engineerin
Knowledge	Some knowledge of transport planning, e.g. tillough taking the undergraduate class "Transport Framming and Traille Engineerin
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	This taking part odobosinity, stade no nave reached the following realising reaching
•	Students are able to:
Miowieage	Citation are able to.
	describe interdependencies between land-use/location choice and transportation/mobility behaviour
	explain and evaluate the social, ecological and economic effects of transport and land-use policy measures.
	relate current issues in the area of integrated transport planning and formulate an opinion on them.
Skills	Students are able to:
	quantify important parameters, which influence travel demand or are influenced by it.
	comprehensively examine a pre-defined or self-selected topic from a transportation studies perspective and document the results
	accordance with scientific conventions.
Personal Competence	
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:
. atonomy	
	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 for its execution.
Woulded in U	Independent Chidy Time 104 Chidy Time in Lecture 50
	Independent Study Time 124, Study Time in Lecture 56
Credit points	Written elaboration
Examination duration and scale	THIRDIT VILLOUILIUM
Assignment for the Following	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory
Curricula	
Curricula	Civil Engineering: Specialisation Coastal Engineering: 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 Water. Elective Compulsory
	Water and Environmental Engineering: Specialisation Cities: Compulsory



Course L1068: Integrated Transportation Planning		
Тур	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	
	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: Flectricity	Generation from Wind and Hydro Power			
module Mooti. Electricity	deficiation from wind and right of ower			
Courses				
Title		Тур	Hrs/wk	СР
Renewable Energy Projects in Emerged	Markets (L0014)	Project Seminar	1	1
Hydro Power Use (L0013)		Lecture	1	1
Wind Turbine Plants (L0011)		Lecture	2	3
Wind Energy Use - Focus Offshore (L00	012)	Lecture	1	1
Module Responsible	Dr. Joachim Gerth			
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 reached the follow	ving learning results		
Professional Competence				
Knowledge				
	Through active discussions of various topics within the semi theoretical background and are thus able to transfer what they		their understanding ar	nd the application of the
Skills	Students are able to apply the acquired theoretical foundations on exemplary water or wind power systems and evaluate and assess technically the resulting relationships in the context of dimensioning and operation of these energy systems. They can in compare critically the special procedure for the implementation of renewable energy projects in countries outside Europe with the in principle applied approach in Europe and can apply this procedure on exemplary theoretical projects.			
Personal Competence				
Social Competence	Students can discuss scientific tasks subjet-specificly and mu	Itidisciplinary within a seminar.		
Autonomy	Students can independently exploit sources in the context of the emphasis of the lecture material to clear the contents of the lecture and to acquire the particular knowledge about the subject area.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Examination	Written exam			
Examination duration and scale	3 hours written exam			
Assignment for the Following				
Curricula	Civil Engineering: Specialisation Geotechnical Engineering: E			
	Civil Engineering: Specialisation Coastal Engineering: Electiv	e Compulsory		
	Energy and Environmental Engineering: Specialisation Energ	y Engineering: Elective Compulsory		
	International Management and Engineering: Specialisation II.	Renewable Energy: Elective Compu	Isory	
	International Management and Engineering: Specialisation II.	Energy and Environmental Engineer	ing: Elective Compulsor	ту
	Product Development, Materials and Production: Specialisation	on Product Development: Elective Co	mpulsory	
	Product Development, Materials and Production: Specialisation	on Production: Elective Compulsory		
	Product Development, Materials and Production: Specialisation	on Materials: Elective Compulsory		
	Renewable Energies: Core qualification: Compulsory			
	Process Engineering: Specialisation Environmental Process E	Engineering: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Enviror	ment: Compulsory		
	Water and Environmental Engineering: Specialisation Cities: I	Elective Compulsory		



Course L0014: Renewable Energy	· · · · · ·
Тур	Project Seminar Project Seminar
Hrs/wk	1
СР	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Andreas Wiese
Language	DE
Cycle	SoSe
Content	
	1. Introduction
	Development of renewable energies worldwide
	<ul><li>History</li></ul>
	■ Future markets
	Special challenges in new markets - Overview
	Sample project wind farm Korea
	Survey
	Technical Description
	Project phases and characteristics
	3. Funding and financing instruments for EE projects in new markets
	Overview funding opportunitie
	Overview countries with feed-in laws
	Major funding programs
	CDM projects - why, how , examples
	Overview CDM process
	• Examples
	Exercise CDM
	5. Rural electrification and hybrid systems - an important future market for EE
	Rural Electrification - Introduction
	Types of Elektrizifierungsprojekten
	The role of the EEInterpretation of hybrid systems
	Project example: hybrid system Galapagos Islands
	6. Tendering process for EE projects - examples
	South Africa
	Brazil
	7. Selected projects from the perspective of a development bank - Wesley Urena Vargas, KfW Development Bank
	Geothermal
	Wind or CSP
	* Willia of Oof
	Within the seminar, the various topics are actively discussed and applied to various cases of application.
Literature	Folien der Vorlesung

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



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

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



Module M0703: Soil and G	roundwater Contamination			
Courses				
Title		Тур	Hrs/wk	СР
Contamination and Remediation (L0547)		Project Seminar	3	3
NAPL in Soil and Groundwater (L0545)		Lecture	1	1
NAPL in Soil and Groundwater (L0546)		Recitation Section (small)	2	2
Module Responsible	Prof. Wilfried Schneider			
Admission Requirements	None			
Recommended Previous Knowledge	<ul><li> Ground water hydrology</li><li> Geohydraulic and solute transport</li><li> Hydromechanics</li></ul>			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence Knowledge	The students are able to analyse contamination in soils and groundwater. They are able to create remediation concepts for LNAPL contamnations.  They are faminliar with Monitored Natural Attenuation .			
Skills	The students are able to analyse contaminations in soils and groundwater using special engineering methods. They can do transport modelling in the unsaturated zone, estimations of groundwater pollution and analyse the impacts of remediation measures. They can forecast die distribution, mobility and remediation of non aquaous phase liquids in soil and groundwater.			
Personal Competence				
Social Competence	The students are able to prepare complex contaminati	on issues in teamwork and are able to find reme	diation measures.	
Autonomy	None			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points				
Examination	Written exam			
Examination duration and scale	Klausur 60 min; Referat 15 min;			
Assignment for the Following	Water and Environmental Engineering: Specialisation Water: Elective Compulsory			
Curricula	Water and Environmental Engineering: Specialisation	Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation	Cities: Elective Compulsory		

ourse L0547: Contamination and Remediation		
Тур	Project Seminar	
Hrs/wk	3	
CP	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Prof. Wilfried Schneider	
Language	DE	
Cycle	SoSe	
Content	Processing of a complex soil and groundwater contamination site. Students perform analyses of data to detect the contamination and to analyse	
	the groundwater hazard and to develop a concept for remediation of the damage.	
Literature	entfällt	

Course L0545: NAPL in Soil and G	Course L0545: NAPL in Soil and Groundwater		
Тур	Lecture		
Hrs/wk	1		
CP	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Wilfried Schneider		
Language	DE		
Cycle	SoSe		
Content	concept of capillarity, multi phase distribution in poraus media, residual saturation, rellative permeability, infiltration of NAPL into the subsurface,		
	vertical distribution of LNAPL, specific volume		
Literature	Charbeneau, R.J. (2000): Groundwater Hydraulics and pollutant Transport		



Course L0546: NAPL in Soil and Groundwater	
Тур	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Wilfried Schneider
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course



Module M0749: Waste Tra	eatment and Solid Matter Process Techn	ology		
Wodule Wo749. Waste Tre	atment and Solid Matter Process recini	ology		
Courses				
Title		Тур	Hrs/wk	СР
Solid Matter Process Technology for Bio	omass (L0052)	Lecture	2	2
Thermal Waste Treatment (L0320)		Lecture	2	2
Thermal Waste Treatment (L1177)  Module Responsible	Prof. Kerstin Kuchta	Recitation Section (large)	1	2
Admission Requirements				
Recommended Previous				
Knowledge				
	thermo dynamics			
	fluid dynamics			
	chemistry			
Educational Objectives	After taking part successfully, students have reached the	ne following learning results		
Professional Competence				
Knowledge	The students can name, describe current issue and contemplate them in the context of their field.	problems in the field of thermal waste trea	atment and particle pr	rocess engineering an
	The industrial application of unit operations as part of partial solid biomass processes. Compostion, particle sizes, the described as important unit operations when producin recyclables.	ransportation and dosing, drying and agglome	eration of renewable re	esources and wastes ar
Skills	The students are able to select suitable processes for the treatment of wastes or raw material with respect to their characteristics and the process aims. They can evaluate the efforts and costs for processes and select economically feasible treatment concepts.			
Personal Competence				
Social Competence	Students can			
	respectfully work together as a team and discuss     participate in subject-specific and interdisciplin     develop cooperated solutions     promote the scientific development and accept	ary discussions,		
Autonomy	Students can independently tap knowledge of the	subject area and transform it to new quest	ions. They are capab	ole, in consultation wit
	supervisors, to assess their learning level and define	e further steps on this basis. Furthermore, the	ney can define target	s for new application-o
	research-oriented duties in accordance with the potent	tial social, economic and cultural impact.		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points				
Examination	Written exam			
Examination duration and scale	120 min			
Assignment for the Following	Bioprocess Engineering: Specialisation A - General Bi	oprocess Engineering: Elective Compulsory		
Curricula	Energy and Environmental Engineering: Specialisation	n Energy and Environmental Engineering: Ele	ctive Compulsory	
	International Management and Engineering: Specialis	ation II. Process Engineering and Biotechnolo	gy: Elective Compulso	ory
	International Management and Engineering: Specialis	ation II. Renewable Energy: Elective Compuls	sory	
	Renewable Energies: Specialisation Bioenergy System	ns: Elective Compulsory		
	Process Engineering: Specialisation Chemical Proces	s Engineering: Elective Compulsory		
	Process Engineering: Specialisation Process Enginee	ring: Elective Compulsory		
	Process Engineering: Specialisation Environmental Pr			
	Water and Environmental Engineering: Specialisation	' '		
	Water and Environmental Engineering: Specialisation	Cities: Elective Compulsory		



Course L0052: Solid Matter Process Technology for Biomass		
Тур	Lecture	
Hrs/wk	2	
CP	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 Waste Tre	eatment
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Kerstin Kuchta, Dr. Joachim Gerth, Dr. Ernst-Ulrich Hartge
Language	EN
Cycle	SoSe
Content	<ul> <li>Introduction, actual state-of-the-art of waste incineration, aims. legal background, reaction principals</li> <li>basics of incineration processes: waste composition, calorific value, calculation of air demand and flue gas composition</li> <li>Incineration techniques: grate firing, ash transfer, boiler</li> <li>Flue gas cleaning: Volume, composition, legal frame work and emission limits, dry treatment, scrubber, de-nox techniques, dioxin elimination, Mercury elimination</li> <li>Ash treatment: Mass, quality, treatment concepts, recycling, disposal</li> </ul>
Literature	Thomé-Kozmiensky, K. J. (Hrsg.): Thermische Abfallbehandlung Bande 1-7. EF-Verlag für Energie- und Umwelttechnik, Berlin, 196 - 2013.

Course L1177: Thermal Waste Treatment	
Тур	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Dr. Ernst-Ulrich Hartge, Dr. Joachim Gerth
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course



Module M0827: Modeling i	n Water Management			
Courses				
Title		Тур	Hrs/wk	СР
Applied Groundwater Modeling (L0543)		Lecture	1	1
Applied Groundwater Modeling (L0544)		Recitation Section (small)	2	2
Modeling of Water Supply and Sewer Ne	twork (L0875)	Problem-based Learning	2	3
Module Responsible	Prof. Wilfried Schneider			
Admission Requirements	none			
Recommended Previous	Groundwater			
Knowledge	groundwater hydraulics and transport of sub-	ostances		
	Pipe Systems			
	Knowledge on urban water infrastructures, in	n particular drinking water systemsand urban drai	nage systems includi	ng special structures
	Hydraulics of drinking water supply systems		,	
	Basic knowledge on water management			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge	The students are able to describe the modelling of	of groundwater flow and transport as well as urt	oan water infrastructu	ires. They can carry o
·	The students are able to describe the modelling of groundwater flow and transport as well as urban water infrastructures. They can carry out systems analyses and can detect technical and conceptual weak points within the systems in case studies. Besides they are able to analyse			
	interdependencies of hydraulic and toxic phenomer	na in soil and water.		
	, , , , , , , , , , , , , , , , , , , ,			
Skilla	The students are able to construct and apply eciant	ific groundwater models indipendently. They can	work on different coo	narios and san sampa
Skills	The students are able to construct and apply scientific groundwater models indipendently. They can work on different scenarios and can compare or assess different solutions for existing problems by application of selected software products. The students are able to use different software			
		by application of selected software products. The	ie students are able	to use different softwa
	solutions (e.g. EPANET, EPA-SWMM).			
Personal Competence				
Social Competence	Wird night vermittelt			
Suciai Curripetence	vviid mont vennittent.			
Autonomy	Wird nicht vermittelt.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture	e 70		
Credit points	6			
Examination	Oral exam			
Examination duration and scale	20 min			
Assignment for the Following	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory			
Curricula	Civil Engineering: Specialisation Geotechnical Eng	ineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineeri	ing: Elective Compulsory		
	Water and Environmental Engineering: Specialisati	on Water: Compulsory		
	Water and Environmental Engineering: Specialisati	on Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialisati	an Citias, Flactive Compulator		

Course L0543: Applied Groundwat	Course L0543: Applied Groundwater Modeling		
Тур	Lecture		
Hrs/wk	1		
CP	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Wilfried Schneider		
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: Applied Groundwater Modeling		
Тур	Recitation Section (small)	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Wilfried Schneider	
Language	DE/EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0875: Modeling of Water Supply and Sewer Network		
Тур	Problem-based Learning	
Hrs/wk	2	
CP	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.	



Courses  Title  Noise Protection (L1109) Urban Infrastructures (L0874)  Froblem-based Learning  Once  Recommended Previous Knowledge  Knowledge on Urban planning Knowledge on Urban drainage and stormwater management  Educational Objectives  After taking part successfully, students have reached the following learning results  Professional Competence Knowledge  Knowledge  Knowledge  Knowledge  Students can describe urban development corridors as well as current and future urban environmental problems. They are able to explain causes of environmental problems (like noise).  Students can specify applications for various technical innovations and explain why these contribute to the improvement of urban life. They can example, derive and discuss measures for effective noise abatement.  Skills  Students are able to develop specific solutions for correcting existing or future environment-related problems of urban development. The define a range of conceptual and technical solutions for environmental problems for different development paths. To solve specific environmental problems they can select technical innovations and integrate them into the urban context.	
Title Noise Protection (L1109) Urban Infrastructures (L0874)  Dr. Dorothea Rechtenbach  Admission Requirements Recommended Previous Knowledge Knowledge Knowledge  Knowledge  Fofessional Competence Knowledge  Knowledge  Knowledge  Knowledge  Students can describe urban development corridors as well as current and future urban environmental problems. They are able to explain causes of environmental problems (like noise).  Students can specify applications for various technical innovations and explain why these contribute to the improvement of urban life. They can define a range of conceptual and technical solutions for environmental problems for different development paths. To solve specific environmental problems they can select technical innovations and integrate them into the urban context.	
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Noise Protection (L1109) Lecture 2 2 Urban Infrastructures (L0874)  Module Responsible Admission Requirements Recommended Previous Knowledge Knowledge Knowledge  **Nowledge on Urban planning **Nowledge in urban drainage and stormwater management  **Educational Objectives Professional Competence Knowledge  **Students can describe urban development corridors as well as current and future urban environmental problems. They are able to explain causes of environmental problems (like noise).  Students can specify applications for various technical innovations and explain why these contribute to the improvement of urban life. They cause in the improvement of urban development. The define a range of conceptual and technical solutions for environmental problems for different development paths. To solve specific environmental problems they can select technical innovations and integrate them into the urban context.	
Module Responsible   Dr. Dorothea Rechtenbach   Dr. Dorothea Rechtenbach   Admission Requirements   None    Recommended Previous   Knowledge   Knowledge on Urban planning   Knowledge on measures for climate protection and climate change adaptation   Basics knowledge in urban drainage and stormwater management    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 environmental problems. They are able to explain causes of environmental problems (like noise).    Students can specify applications for various technical innovations and explain why these contribute to the improvement of urban life. They cause in the province of the improvement of urban life. They cause in the province of the improvement of urban life. They cause in the province of the improvement of urban life. They cause in the province of the improvement of urban life. They cause in the province of the improvement of urban life. They cause in the province of the improvement of urban life. They cause in the province of the province of the improvement of urban life. They cause in the province of the improvement of urban life. They cause in the province of the pro	
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Personal Competence	a. oa
Autonomy Students are able to organize their work flow to prepare themselves for presentations and contributions to the discussions. They can accompany	quire
appropriate knowledge by making enquiries independently.	
Workload in Hours Independent Study Time 124, Study Time in Lecture 56	
Credit points 6	
Examination Project	
Examination duration and scale Written Report plus oral Presentation	
Assignment for the Following Civil Engineering: Specialisation Structural Engineering: Elective Compulsory	
Curricula Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory	
Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory	
Environmental Engineering: Core qualification: Elective Compulsory	
Joint European Master in Environmental Studies - Cities and Sustainability: Core qualification: Compulsory	
Logistics, Infrastructure and Mobility: Specialisation Infrastructure and Mobility: Elective Compulsory	
Water and Environmental Engineering: Specialisation Environment: Elective Compulsory	
Water and Environmental Engineering: Specialisation Cities: Compulsory	

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



Course L0874: Urban Infrastructures		
Тур	Problem-based Learning	
Hrs/wk	2	
CP	4	
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28	
Lecturer	Dr. Dorothea Rechtenbach	
Language	EN	
Cycle	SoSe	
Content	Problem/Project Based Learning  Main topics are:	
	<ul> <li>Design of future cities, concepts and technical approaches for future-proof drinking water supply and wastewater disposal</li> <li>Climate Change Impacts, Adaptation and Mitigation</li> <li>Rainwater Management &amp; urban flash floods</li> <li>New water sources: rainwater harvesting and wastewater reuse</li> <li>Urban greening &amp; urban agriculture</li> <li>Water sensitive urban design</li> <li>How to better link urban planning and urban water issues</li> </ul>	
Literature	Depends on chosen topic.	



Module M0857: Geochem	ical Engineering			
Courses				
Title		Тур	Hrs/wk	CP
Contaminated Sites and Landfilling (L090		Lecture	2	2
Contaminated Sites and Landfilling (L090	07)	Recitation Section (large)	1	2
Geochemical Engineering (L0904)		Lecture	2	2
Module Responsible	Dr. Joachim Gerth			
Admission Requirements	none			
Recommended Previous	Module: General and Inorganic Chemistry,			
Knowledge	Module:Organic Chemistry,			
	Biology (Basic Knowledge)			
Educational Objectives	After taking part successfully, students have reached the 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 contaminated waste material. They are able to describe in principle the behaviour of chemicals in			iour of chemicals in the
	environment. Students can explain and report the ap	environment. Students can explain and report the approach to remediate contaminated sites.		
Skills	With the completion of this module students can app	ly the acquired theoretical knowledge to model ca	ses of site pollution	and critically assess the
	situation technically and conceptually. They are able			
	be devised and treated.			
Personal Competence				
Social Competence	Students can discuss technical and scientific tasks v	vithin a seminar subject specific and interdisciplina	ary .	
Autonomy	Students can independently exploit sources, acquire the particular knowledge of the subject and apply it to new problems.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture	70		
Credit points	6			
Examination	Written exam			
Examination duration and scale	2 hours			
Assignment for the Following	Energy and Environmental Engineering: Specialisati	on Environmental Engineering: Elective Compulse	ory	
Curricula	Environmental Engineering: Core qualification: Elec	ive Compulsory		
	Water and Environmental Engineering: Specialisation	n Water: Elective Compulsory		
	Water and Environmental Engineering: Specialisation	n Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation	n Cities: Elective Compulsory		

Course L0906: Contaminated Sites	s and Landfilling
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Joachim Gerth, Dr. Marco Ritzkowski
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	
CP	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Dr. Joachim Gerth, Dr. Marco Ritzkowski	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

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



Module M0870: Manageme	ent of Surface Water			
Courses				
Title		Тур	Hrs/wk	СР
Modelling of Flow in Rivers and Estuarie	s (L0810)	Lecture	3	4
Nature-Oriented Hydraulic Engineering /	draulic Engineering / Integrated Flood Protection (L0961) Problem-based Learning 2 2		2	
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous	Fundamentals of Hydromechanics, Hydraulics, Hydrology and Hydraulic Engineering; Hydraulic Engineering I and Hydraulic Engineering II			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	ne following learning results		
Professional Competence				
Knowledge	Students are able to define in detail the basic proces	sses that are related to the modelling of flow	s in hydraulic enginee	ering. Besides, they car
	describe the basic aspects of numerical modelling and actual numerical models for the simulation of flows and waves. They can also depire			hey can also depict the
	concepts of nature oriented hydraulic engineering.			
Skills	Students are able to apply hydrodynamic pumorical models to practical hydroulis analysaving tasks. Furthermore the students are able to set up			
O.M.O	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.			
	nood not management concepts and alle able to apply	production of the state of the	00.0	
Personal Competence				
Social Competence	The students are able to deploy their gained knowledg	e in applied problems of the practical nature	based hydraulic engin	eering. Additionaly, the
	will be able to work in team with engineers of other disc	ciplines.		
Autonomy	The students will be able to independently extend their	r knowledge and apply it to new problems.		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70	)		
Credit points	6			
Examination				
Examination duration and scale	The duration of the examination is 150 min. The exam	ination includes tasks with respect to the ger	eral understanding of	the lecture contents and
	calculations tasks.			
Assignment for the Following	Environmental Engineering: Core qualification: Elective	e Compulsory		
Curricula	Joint European Master in Environmental Studies - Cities	es and Sustainability: Core qualification: Com	pulsory	
	Water and Environmental Engineering: Specialisation	Water: Compulsory		
	Water and Environmental Engineering: Specialisation	Environment: Compulsory		
	Water and Environmental Engineering: Specialisation	Cities: Elective Compulsory		

Course L0810: Modelling of Flow in	n Rivers and Estuaries
Тур	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Peter Fröhle
Language	DE/EN
Cycle	SoSe
Content	Basics of numerial models / application of models
	classification of models
	model concept
	modelling
	1D Working Equation
	Mathematical description of physical processes
	Equation of motions
	conservation of mass
	conservation of momentum
	Initial conditions and boundary conditions
	Numerical Methods
	Time step procedure
	• Finite differences
	Finite volumes
Literature	Vorlesungsskript



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



Module M0871: Hydrologi	cal Systems			
Courses				
Title		Тур	Hrs/wk	CP
Applied Surface Hydrology (L0289)		Lecture	2	2
Applied Surface Hydrology (L1412)		Problem-based Learning	1	2
Interaction Water - Environment in Fluvia	ll Areas (L0295)	Problem-based Learning	1	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	none			
Recommended Previous	Fundamentals of Hydromechanics and Hydraulic Engineering: Hydraulic Engineering I and Hydraulic Engineering II			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge	The students are able to define the basic concepts of hydrology and water management. They are able to describe and quantify the relevant			
	processes of the hydrological water cycle. Besides,	the students know the main aspects of rainfall-r	un-off-models and	are able to theoretically
	derive established reservoir / storage models and a u	nit-hydrograph.		
Skills	The students are able to use the basic hydrological concepts and approaches and are able to theoretically derive established reservoir / storage			
	models or a unit-hydrograph as the basis for rainfa	•		'
	hydrological and hydrodynamic values in nature and		ess these measurer	nents. Furthermore, they
	are able to apply a hydrological model to basic hydrol	ogical problems.		
Personal Competence				
Social Competence	The students are able to deploy their gained knowle	dge in applied problems of the hydrology and w	ater management.	Additionaly, they will be
•	able to work in team with engineers of other discipline		0	
Autonomy	The students will be able to independently extend the			
,				
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	6		
Credit points	6			
Examination	Written exam			
Examination duration and scale	The duration of the examination is 90 min. The exam	ination includes tasks with respect to the genera	I understanding of	the lecture contents and
	calculations tasks.			
Assignment for the Following	Environmental Engineering: Core qualification: Elective Compulsory			
Curricula	Joint European Master in Environmental Studies - Citi	es and Sustainability: Core qualification: Compul	sory	
	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 L0289: Applied Surface Hy	ydrology	
Тур	Lecture	
Hrs/wk	2	
CP	2	
Workload in Hours	ndependent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Peter Fröhle, Sandra Hellmers	
Language	DE/EN	
Cycle	SoSe	
Content	Basics of hydrology:	
	<ul> <li>Hydrological cycle</li> <li>Data acquisition</li> <li>Data analyses and statistical assessment</li> <li>Statistics of extremes</li> <li>Regionalization methods for hydrological values</li> <li>Rainfall-run-off modelling on the basis of a unit hydrograph conceps</li> <li>Application of rainfall-run-off models on the basis of Kalypso-Hydrology which is an OpenSource Software Tool.</li> </ul>	
Literature	http://de.wikipedia.org/wiki/Kalypso_(Software)  http://kalypso.bjoernsen.de/  http://sourceforge.net/projects/kalypso/	
	mpriodi dala garia pia dala manjara	



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

Course L0295: Interaction Water -	Environment in Fluvial Areas
Тур	Problem-based Learning
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Peter Fröhle, Sandra Hellmers
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: Wastewate	er Systems			
Courses				
Title		Тур	Hrs/wk	СР
Wastewater Systems - Collection, Treatment and Reuse (L0934)		Lecture	2	2
Wastewater Systems - Collection, Treatment and Reuse (L0943)		Recitation Section (large)	1	1
Advanced Wastewater Treatment (L0357)		Lecture	2	2
Advanced Wastewater Treatment (L035		Recitation Section (large)	1	1
· · · · · · · · · · · · · · · · · · ·	Prof. Ralf Otterpohl			
Admission Requirements	None			
Recommended Previous	Knowledge of wastewater management and the key processes involved in wastewater treatment.			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the fo	ollowing learning results		
Professional Competence				
Knowledge	Students are able to outline key areas of the full range of treatment systems in waste water management, as well as their mutual dependence for			
	sustainable water protection. They can describe relevant e	conomic, environmental and social factors.		
Skills	Students are able to pre-design and explain the available	wastewater treatment processes and the so	one of their applicat	ion in municinal and for
OKIIIS	some industrial treatment plants.	wastewater treatment processes and the sc	ope of their applicat	ion in mamcipal and lo
	some mederal realment plants.			
Personal Competence				
Social Competence				
Autonomy	Students are in a position to work on a subject and to orga	nize their work flow independently. They car	also present on this	subject.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Examination	Written exam			
Examination duration and scale	120 min			
Assignment for the Following	Civil Engineering: Specialisation Structural Engineering: E	Elective Compulsory		
Curricula	Civil Engineering: Specialisation Geotechnical Engineerin	g: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Ele	ctive Compulsory		
	Bioprocess Engineering: Specialisation A - General Biopro	ocess Engineering: Elective Compulsory		
	Energy and Environmental Engineering: Specialisation En	vironmental Engineering: Elective Compulse	ory	
	International Management and Engineering: Specialisation	n II. Energy and Environmental Engineering:	Elective Compulsor	у
	International Management and Engineering: Specialisation	n II. Process Engineering and Biotechnology	: Elective Compulso	ry
	Process Engineering: Specialisation Environmental Proce	ss Engineering: Elective Compulsory		
	Process Engineering: Specialisation Process Engineering	: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Wat	er: Compulsory		
	Water and Environmental Engineering: Specialisation Env	ironment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Cities	es: Compulsory		

Course L0934: Wastewater Systems - Collection, Treatment and Reuse		
Тур	Lecture	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Ralf Otterpohl	
Language	EN	
Cycle	SoSe	
Content	•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 System	se 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 Wastew	ater Treatment
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Joachim Behrendt
Language	DE
Cycle	SoSe
Content	Survey on advanced wastewater treatment
	reuse of reclaimed municipal wastewater
	Precipitation
	Flocculation
	Depth filtration
	Membrane Processes
	Activated carbon adsorption
	Ozonation
	"Advanced Oxidation Processes"
	Disinfection
Literature	Metcalf & Eddy, Wastewater Engineering: Treatment and Reuse, McGraw-Hill, Boston 2003
	Wassertechnologie, H.H. Hahn, Springer-Verlag, Berlin 1987
	Membranverfahren: Grundlagen der Modul- und Anlagenauslegung, T. Melin und R. Rautenbach, Springer-Verlag, Berlin 2007
	Trinkwasserdesinfektion: Grundlagen, Verfahren, Anlagen, Geräte, Mikrobiologie, Chlorung, Ozonung, UV-Bestrahlung, Membranfiltration, Qualitätssicherung, W. Roeske, Oldenbourg-Verlag, München 2006
	Organische Problemstoffe in Abwässern, H. Gulyas, GFEU, Hamburg 2003



Course L0358: Advanced Wastew	ater Treatment
Тур	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Joachim Behrendt
Language	DE
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 En	gineering - Water, Soil, Food and I	Energy		
Courses				
Title		Тур	Hrs/wk	СР
Ecological Town Design - Water, Energy	, Soil and Food Nexus (L1229)	Seminar	2	2
Water & Wastewater Systems in a Glob	al Context (L0939)	Lecture	2	4
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
Recommended Previous	Basic knowledge of the global situation with ri	sing poverty, soil degradation, migration to cities, la	ck of water resources and	sanitation
Knowledge				
Educational Objectives	After taking part successfully, students have re	eached the following learning results		
Professional Competence				
Knowledge	Students can describe the facets of the global water situation. Students can judge the enormous potential of the implementation of synerg			
	systems in Water, Soil, Food and Energy supply.			
Skills	Students are able to design ecological settlements for different geographic and socio-economic conditions for the main climates around the world			
Personal Competence				
Social Competence				
Autonomy	Students are in a position to work on a subject	t and to organize their work flow independently. The	ey can also present on this	subject.
Workload in Hours	Independent Study Time 124, Study Time in L	ecture 56		
Credit points	6			
Examination	Project			
Examination duration and scale	During the course of the semester, the studen	nts work towards mile stones. The work includes pre	esentations and papers. [	Detailed information ca
	be found at the beginning of the smester in the	e StudIP course module handbook.		
Assignment for the Following	Bioprocess Engineering: Specialisation A - Ge	eneral Bioprocess Engineering: Elective Compulsor	ry	
Curricula	Chemical and Bioprocess Engineering: Speci	alisation General Process Engineering: Elective Co	ompulsory	
	Environmental Engineering: Core qualification	n: Elective Compulsory		
	Joint European Master in Environmental Studi	ies - Cities and Sustainability: Core qualification: Co	ompulsory	
	Process Engineering: Specialisation Environn	nental Process Engineering: Elective Compulsory		
	Process Engineering: Specialisation Process	Engineering: Elective Compulsory		
	Water and Environmental Engineering: Specia	alisation Water: Elective Compulsory		
	Water and Environmental Engineering: Specia	alisation Environment: Elective Compulsory		
	Water and Environmental Engineering: Specia	alisation Cities: Elective Compulsory		

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



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



Module M0922: City Plann	ning			
Courses				
Courses Title		Tue	Hrs/wk	CD.
Prinicples of City Planning (L1066)		Typ Problem-based Learning	2	<b>CP</b> 3
Street Design (L1067)		Problem-based Learning	2	3
Module Responsible	Prof. Carsten Gertz			
Admission Requirements	None			
Recommended Previous	for "Principles of Urban Planning": none			
Knowledge	for "Designing Lish on Chrostopenes", some knowledge of transport	nlanning of through taking the co	doravo di ioto ologo	Transport Dianning and
	for "Designing Urban Streetscapes": some knowledge of transport Traffic Engineering"	pianning, e.g. through taking the ur	idergraduate class "	Transport Flamming and
	Traino Engineering			
Educational Objectives	After taking part successfully, students have reached the following I	earning results		
Professional Competence				
Knowledge	Students are able to:			
	use technical terms of urban planning.			
	describe the main determinants of urban development.			
	<ul> <li>explain and compare different possibilities of how urban de</li> </ul>	velopment can be influenced.		
	discuss requirements for public streetscapes.			
	explain the importance of street design.			
Ckilla	Students are able to:			
SKIIIS	Students are able to:			
	read and analyze urban development concepts and design.	s for streetscapes		
	appraise such concepts in the context of competing requirer			
	<ul> <li>design, justify and reflect their own solutions for concrete ex</li> </ul>	amples.		
Personal Competence				
	Students are able to:			
	discuss intermediate results with each other.			
	constructively accept feedback on their own work.      provide constructive feedback to others.			
	provide constructive feedback to others.			
Autonomy	Students are able to:			
	independently complete a written report including drawings	tollowing a broadly pre-defined pro	cess.	
	<ul> <li>assess the consequences of their proposed solutions.</li> <li>independently acquire knowledge and apply this to new iss</li> </ul>	uos or problem areas		
	independently acquire knowledge and apply this to new iss	ues of problem areas.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Examination	Project			
Examination duration and scale				
Assignment for the Following				
Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Electiv Civil Engineering: Specialisation Coastal Engineering: Elective Co			
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure a			
	Water and Environmental Engineering: Specialisation Water: Electi			
	Water and Environmental Engineering: Specialisation Environment			
	Water and Environmental Engineering: Specialisation Cities: Comp	pulsory		



Course L1066: Prinicples of City F	Planning
Тур	Problem-based Learning
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Carsten Gertz
Language	DE
Cycle	SoSe
Content	"Principles of Urban Planning" deals with the determinants of urban development and their interactions. Topics include:
	<ul> <li>legal framework,</li> <li>instruments and methods of planning,</li> <li>functional requirements,</li> <li>stakeholders and actors</li> <li>basic design requirements</li> <li>different planning levels and</li> <li>historical contexts.</li> </ul> The objective of the course is for students to acquire a basic understanding of urban development problems and approaches for solving them. They will also be able to comprehend the process of urban planning. The project work deals with a real life scenario and includes drawing up a development plan, an urban design concept as well as a building masterplan.
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.

Course L1067: Street Design	
ŭ	
	Problem-based Learning
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Carsten Gertz
Language	DE
Cycle	SoSe
Content	"Designing Urban Streetscapes" covers the various functional and aesthetic requirements for designing streetscape as the most important
	elements of public space. The class deals with:
	technical and design requirements,
	the effects of streetscapes on the behaviour of their users,      ""
	possible measures relating to changes in traffic development.
	For their applied project, students will be required to redesign the streetscape of an actual case study.
Literature	Forschungsgesellschaft für Straßen- und Verkehrswesen (2011) Empfehlungen zur Straßenraumgestaltung innerhalb bebauter Gebiete - ESG.
	FGSV-Verlag. Köln (FGSV, 230).
	Forschungsgesellschaft für Straßen- und Verkehrswesen (2007) Richtlinien für die Anlage von Stadtstraßen – RASt 06. FGSV-Verlag. Köln
	(FGSV, 200).



Module M0982: Transport	tation Modelling			
<b>N</b>				
Courses		T	Here fords	CP
Fitle Fransportation Modelling (L1180)		Typ Problem-based Learning	Hrs/wk	6
Module Responsible	Prof. Carsten Gertz	Trobeni based Learning	7	
Admission Requirements				
Recommended Previous		the undergraduate class "Transport Plannin	g and Traffic Engine	ering"
Knowledge		,	3 3 .	3
Educational Objectives	After taking part successfully, students have reached the for	ollowing learning results		
Professional Competence				
Knowledge	Students are able to understand the operation and potenti	al applications of transport models.		
Skills	Students are able to:			
	use travel demand modelling software packages for	or solving practical problems.		
	design a database structure for travel demand mod			
	assess modelling results.			
	appraise potential applications and limitations of significant contents.	uch models.		
Personal Competence				
•	Students are able to independently develop and documer	tt solutions.		
Autonomy	Students are able to:			
	independently organise, manage and solve set tas	sks.		
	<ul> <li>independently prepare written reports.</li> </ul>			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Examination	Project			
Examination duration and scale				
Assignment for the Following	Aircraft Systems Engineering: Specialisation Air Transport	ation Systems: Elective Compulsory		
Curricula				
	Water and Environmental Engineering: Specialisation Citi	es: Elective Compulsory		

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



Module M0663: Marine Ge	otechnics and Numerics			
Courses				
Title		Тур	Hrs/wk	СР
Marine Geotechnics (L0548)		Lecture	1	2
Marine Geotechnics (L0549)		Recitation Section (large)	1	1
Numerical Methods in Geotechnics (L03	75)	Lecture	3	3
Module Responsible	Prof. Jürgen Grabe			
Admission Requirements	none			
Recommended Previous	complete modules: Geotechnics I-II, Mathema	atics I-III		
Knowledge	courses: Soil laboratory course			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 110, Study Time in L	Lecture 70		
Credit points				
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the Following	Civil Engineering: Specialisation Geotechnical Engineering: Compulsory			
Curricula	Civil Engineering: Specialisation Structural E	ngineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Eng	gineering: Compulsory		
	Theoretical Mechanical Engineering: Special	lisation Maritime Technology: Elective Compulsory		
	Theoretical Mechanical Engineering: Technic	cal Complementary Course: Elective Compulsory		
	Water and Environmental Engineering: Speci	ialisation Cities: Elective Compulsory		
	Water and Environmental Engineering: Speci	ialisation Environment: Elective Compulsory		
	Water and Environmental Engineering: Speci	ialisation Water: Elective Compulsory		

Course L0548: Marine Geotechnic	s
Тур	Lecture
Hrs/wk	1
CP	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 Collif erosion Sea dikes Port structures Flood protection structures
Literature	<ul> <li>EAK (2002): Empfehlungen für Küstenschutzbauwerke</li> <li>EAU (2004): Empfehlungen des Arbeitsausschusses Uferbauwerke</li> <li>Poulos H.G. (1988): Marine Geotechnics. Unwin Hyman, London</li> <li>Wagner P. (1990): Meerestechnik: Eine Einführung für Bauingenieure. Ernst &amp; Sohn, Berlin</li> </ul>

Course L0549: Marine Geotechnics	
Тур	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course



Course L0375: Numerical Methods in Geotechnics	
Тур	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Dr. Hans Mathäus Hügel
Language	DE
Cycle	SoSe
Content	Topics:
	<ul> <li>numerical simulations</li> <li>numerical algorithms</li> <li>finite element method</li> <li>application of finite element method in geomechanics</li> <li>constitutive models for soils</li> <li>contact models for soil structure interaction</li> <li>selected applications</li> </ul>
Literature	<ul> <li>Wriggers P. (2001): Nichtlineare Finite-Elemente-Methoden, Springer Verlag, Berlin</li> <li>Bathe Klaus-Jürgen (2002): Finite-Elemente-Methoden. Springer Verlag, Berlin</li> </ul>



Module M0620: Special As	pects of Waste Resource Manageme	ent		
Courses				
Title		Тур	Hrs/wk	СР
Advanced Topics in Waste Resource M	anagement (L1055)	Problem-based Learning	3	3
International Waste Management (L0317		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 successfully, students have reache	ed the following learning results		
Professional Competence				
Knowledge	The students are able to describe waste as a reso	ource as well as advanced technologies for recy	cling and recovery of	resources from waste in
	detail. This covers collection, transport, treatment a	nd disposal in national and international contexts	s.	
Skilla	Students are able to select suitable processes fo	r the treatment with respect to the national or	cultural and dayalanm	ontal contaxt. They con
SKIIIS	evaluate the ecological impact and the technical ef	'	·	ieniai context. They car
	evaluate the ecological impact and the technical er	ion of unletern technologies and management sy	sterris.	
Personal Competence				
Social Competence	Students can work together as a team of 2-5 pe	ersons, participate in subject-specific and inter	disciplinary discussio	ns, develop cooperated
	solutions and defend their own work results in fro	nt of others and promote the scientific development	ent of colleagues. Fur	rthermore, they can give
	and accept professional constructive criticisms.			
Autonomy	Students can independently gain additional knowled	edge of the subject area and apply it in solving th	e given course tasks a	nd projects
riatoriomy	Guadino dan maapanaanay gam adamanan ma		given eediee kache a	a p. 0,0000.
Workload in Hours	Independent Study Time 110, Study Time in Lectur	e 70		
Credit points	6			
Examination	Project			
Examination duration and scale	PowerPoint presentation (10-15 minutes)			
Assignment for the Following	Environmental Engineering: Specialisation Waste a	and Energy: Elective Compulsory		
Curricula	Joint European Master in Environmental Studies - 0	Cities and Sustainability: Specialisation Energy: E	Elective Compulsory	
	Water and Environmental Engineering: Specialisat	ion Water: Elective Compulsory		
	Water and Environmental Engineering: Specialisat	ion Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialisat	ion Cities: Elective Compulsory		

Course L1055: Advanced Topics i	n Waste Resource Management
Тур	Problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Rüdiger Siechau
Language	EN
Cycle	WiSe
Content	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	Problem-based Learning	
Hrs/wk	2	
CP	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 M0581: Water Pro	tection			
Courses				
		Тур	Hrs/wk	СР
Title Geo-Information-Systems in Water Management and Hydraulic Engineering (L0963)		Problem-based Learning	2	2
Water Protection and Wastewater Management (L0226)		Seminar	2	2
Vater Protection and Wastewater Mana		Recitation Section (large)	1	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	none			
Recommended Previous	- Paris Impulados in victor mana comenti			
Knowledge	<ul> <li>Basic knowledge in water management;</li> <li>Good knowledge in urban drainage;</li> </ul>			
	Good knowledge of wastewater treatment technique:	3:		
	Good knowledge of pollutants (e.g. COD, BOD, TS, N			
		-,··/		
Educational Objectives	After taking part successfully, students have reached the foll	owing learning results		
Professional Competence			!! F	
Knowledge	, , ,			
	explain limnological processes, substance cycles and wa problems. Finally, the students can demonstrate to achieve			
	able to judge environmental and wastewater related issu			
	interventions as well as conceptual problem solving approach		idaono, romedidaor	i measures and later
Skills	Students can accurately assess current problems and situ	uations in a country-specific or local cont	ext. They can sugo	est concrete actions
	contribute to the planning of tomorrow's urban water cycle			
	solutions to solve these problems.			-
Personal Competence				
	The students can work together in international groups.			
oodal oompetence	The statents can work together in international groups.			
Autonomy	Students are able to organize their work flow to prepar	e themselves before presentations and	discussion. They c	an acquire appropriat
	knowledge by making enquiries independently.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Examination				
Examination duration and scale	60 min			
Assignment for the Following		ective Compulsory		
Curricula		, ,		
2 3.774 414	Civil Engineering: Specialisation Coastal Engineering: Elec-			
	Environmental Engineering: Specialisation Water: Elective (	, ,		
	International Management and Engineering: Specialisation			
	Joint European Master in Environmental Studies - Cities and	Sustainability: Specialisation Water: Elect	ive Compulsory	
	Water and Environmental Engineering: Specialisation Water	r: Compulsory		
	Water and Environmental Engineering: Specialisation Environmental	onment: Compulsory		
	Water and Environmental Engineering: Specialisation Cities	: Elective Compulsory		



Course L0963: Geo-Information-S	Course L0963: Geo-Information-Systems in Water Management and Hydraulic Engineering	
Тур	Problem-based Learning	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Peter Fröhle	
Language	DE/EN	
Cycle	WiSe	
Content	Theoretical basics of Geo-Information-Systems	
	<ul> <li>Data models, geographical coordinates, geo-referencing, map-views</li> <li>Data mining and – analyses of geo-data</li> <li>Analysis techniques</li> </ul>	
Literature	None	

Course L0226: Water Protection a	nd Wastewater Management
Тур	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Ralf Otterpohl
Language	EN
Cycle	WiSe
	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 L0227: Water Protection and Wastewater Management		
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
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.	



Module M0619: Waste Tre	eatment Technologies			
Courses				
Title Waste and Environmental Chemistry (LC Biological Waste Treatment (L0318)	0328)	Typ Laboratory Course Problem-based Learning	Hrs/wk 2 3	<b>CP</b> 2 4
Module Responsible	Prof. Kerstin Kuchta	Troblem based Esaming		
Admission Requirements				
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following	learning results		
Professional Competence				
Knowledge	The module aims possess knowledge concerning the planning layout of anaerobic and aerobic waste treatment plants in detail, treatment plants and explain different methods for waste analytics	describe different techniques for wa		-
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				
Autonomy	Students can independently tap knowledge from literature, busi consultation with supervisors as well as in the interim prese Furthermore, they can define targets for new application-or resea impact.	ntation, to assess their learning le	vel and define furthe	r steps on this basis.
Workload in Hours				
Credit points				
Examination Examination duration and scale	,	ful participation at Praktikum		
Assignment for the Following	3 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -			
	Civil Engineering: Specialisation Studdina Engineering: Elective			
	Civil Engineering: Specialisation Coastal Engineering: Elective C			
	Energy and Environmental Engineering: Specialisation Environmental	ental Engineering: Elective Compuls	sory	
	Environmental Engineering: Core qualification: Compulsory			
	International Management and Engineering: Specialisation II. En	ergy and Environmental Engineering	: Elective Compulsory	
	Joint European Master in Environmental Studies - Cities and Sus		ective Compulsory	
	Water and Environmental Engineering: Specialisation Environme			
	Water and Environmental Engineering: Specialisation Cities: Elec	ctive Compulsory		



Course L0328: Waste and Environmental Chemistry		
Тур	Laboratory 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 To	course L0318: Biological Waste Treatment		
Тур	oblem-based Learning		
Hrs/wk	3		
CP	4		
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42		
Lecturer	Prof. Kerstin Kuchta		
Language	EN		
Cycle	WiSe		
Content	<ol> <li>Introduction</li> <li>biological basics</li> <li>determination process specific material characterization</li> <li>aerobic degradation (Composting, stabilization)</li> <li>anaerobic degradation (Biogas production, fermentation)</li> <li>Technical layout and process design</li> <li>Flue gas treatment</li> <li>Plant design practical phase</li> </ol>		
Literature			



Module M0705: Groundwa	iter			
Courses				
		T	Hankada	0.0
Title	200)	Тур	Hrs/wk	<b>CP</b> 2
Geohydraulic and Solute Transport (L05 Geohydraulic and Solute Transport (L05	·	Lecture  Recitation Section (small)	1	1
Simulation in Groundwater Hydrology (L	·	Lecture	1	1
Simulation in Groundwater Hydrology (L		Recitation Section (small)	2	2
Module Responsible	Prof. Wilfried Schneider			
Admission Requirements	None			
Recommended Previous Knowledge	Ground water hydrology     Hydromechanics			
Educational Objectives	After taking part successfully, students have reached the follow	ing learning results		
Professional Competence				
Knowledge	The students are able to describe the fate of solutes in the sub	surface along the path between soil and	water body quantit	atively and qualitatively.
	They are able to do this with simulation models.			
Skills	The students are able to describe conceptually movement and storage of water in the unsaturated zone. They are able to analyse pF- function			
	and Ku functions. They can model transport of solutes in the unsaturated and saturated zoned. They are able to determine dispersiities,			
	coefficients, decay rates and dissolution rates for organic and inorganic substances.			
Personal Competence				
Social Competence	The students can help to each other.			
Autonomy	none			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Examination	Written exam			
Examination duration and scale	60 min written exam and written papers			
Assignment for the Following	Civil Engineering: Specialisation Structural Engineering: Electi	ve Compulsory		
Curricula	Civil Engineering: Specialisation Geotechnical Engineering: El	ective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Elective	Compulsory		
	Process Engineering: Specialisation Environmental Process En	ngineering: Elective Compulsory		
	Process Engineering: Specialisation Process Engineering: Ele	ctive Compulsory		
	Water and Environmental Engineering: Specialisation Water: C	compulsory		
	Water and Environmental Engineering: Specialisation Environmental	ment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Cities: E	lective Compulsory		

Course L0539: Geohydraulic and S	ourse L0539: Geohydraulic and Solute Transport		
Тур	Lecture		
Hrs/wk	2		
CP	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Wilfried Schneider		
Language	DE		
Cycle	MiSe		
Content	Pump test analysis, water content-water suction functions, unsaturated hydraulic conductivity function, Brooks-Corey relation, van Genuchte		
	relation, solute transport in unsaturated zone, solute transport and reactions in groundwater		
Literature	Todd; K. (2005): Groundwater Hydrology		
	Fetter, C.W. (2001): Applied Hydrogeology		
	Hölting & Coldewey (2005): Hydrogeologie		
	Charbeneau, R.J. (2000): Groundwater Hydraulics and pollutant Transport		

Course L0540: Geohydraulic and Solute Transport		
Тур	Recitation Section (small)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Wilfried Schneider	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	



Course L0541: Simulation in Groundwater Hydrology				
Тур	Lecture			
Hrs/wk	1			
CP	1			
Workload in Hours	Workload in Hours Independent Study Time 16, Study Time in Lecture 14			
Lecturer	Prof. Wilfried Schneider			
Language	DE			
Cycle	WiSe			
Content	Basics and theoretical background of simulation models frequently used in science and practise for pumping test analysis, water movement in			
	vadose zone, solute transport in vadose zone, groundwater recharge, solute transport in groundwater			
Literature	Handbücher der verwendeten Slumationsmodelle werden bereitgestellt.			

Course L0542: Simulation in Groundwater Hydrology		
Тур	Recitation Section (small)	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Wilfried Schneider	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	



es and -Supply	Typ Lecture Recitation Section (large) Lecture	Hrs/wk	СР	
	Lecture Recitation Section (large)		СР	
	Lecture Recitation Section (large)		СР	
	Lecture Recitation Section (large)		СР	
	Recitation Section (large)	2		
	· ·		1	
	Lecture	1	2	
		2	2	
	Recitation Section (small)	1	1	
Mathias Ernst				
ledge of water management and the key	processes involved in water treatment.			
aking part successfully, students have rea	ached the following learning results			
nts will be able to outline key areas of co	onflict in water management, as well as their mutual den	pendence for sustain	nable water supply. They	
•				
		_		
	·			
nts will be able to assess complex proble	ems in drinking water production and establish solution	s involving water ma	nagement and technical	
ures. They will be able to assess the eval	uation methods that can be used for this. Students will	be able to carry out o	chemical calculations for	
selected treatment processes and apply generally accepted technical rules and standards to these processes.				
ng in a diverse group of specialists, stude	ents will be able to develop and document complex so	lutions for the manage	gement and treatment of	
			-	
		<b>3</b>	,	
·				
nts will be in a position to work on a subje	ect independently and present on this subject.			
endent Study Time 96, Study Time in Lec	ture 84			
n exam				
n (chemistry) + presentation				
Engineering: Specialisation Structural Eng	gineering: Elective Compulsory			
Engineering: Specialisation Geotechnical	Engineering: Elective Compulsory			
y and Environmental Engineering: Specia	alisation Energy and Environmental Engineering: Elect	ive Compulsory		
ational Management and Engineering: Sp	pecialisation II. Energy and Environmental Engineering	: Elective Compulsor	ry	
and Environmental Engineering: Special	lisation Water: Compulsory			
Water and Environmental Engineering: Specialisation Environment: Elective Compulsory Water and Environmental Engineering: Specialisation Cities: Elective Compulsory				

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



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

Course L0402: Water Resource M	anagement
Тур	Lecture
Hrs/wk	2
CP	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 Resource Management	
Тур	Recitation Section (small)
Hrs/wk	1
CP	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: Membrane	e Technology				
Courses					
Title		Тур	Hrs/wk	СР	
Membrane Technology (L0399)		Lecture	2	3	
Membrane Technology (L0400)		Recitation Section (small)	1	2	
Membrane Technology (L0401)		Laboratory Course	1	1	
Module Responsible	Prof. Mathias Ernst				
Admission Requirements	None				
Recommended Previous	Basic knowledge of water chemistry. Knowledge of the core pro	ocesses involved in water, gas and stea	am treatment		
Knowledge					
Educational Objectives	After taking part successfully, students have reached the follow	ing learning results			
Professional Competence					
Knowledge			•	•	
	driving forces behind existing membrane separation processes. Students will be able to name materials used in membrane filtration and th advantages and disadvantages. Students will be able to explain the key differences in the use of membranes in water, other liquid media, gas and in liquid/gas mixtures.				
Skills	Students will be able to prepare mathematical equations for material transport in porous and solution-diffusion membranes and calculate in parameters in the membrane separation process. They will be able to handle technical membrane processes using available boundary data a provide recommendations for the sequence of different treatment processes. Through their own experiments, students will be able to classify the separation efficiency, filtration characteristics and application of different membrane materials. Students will be able to characterise the formation of the fouling layer in different waters and apply technical measures to control this.				
Personal Competence					
Social Competence	Students will be able to work in diverse teams on tasks in the fi	eld of membrane technology. They will	be able to make dec	cisions within their gro	
,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	on laboratory experiments to be undertaken jointly and present			3 -	
Autonomy	Students will be in a position to solve homework on the topic	of membrane technology independed	ntly They will be car	nable of finding creati	
Autonomy	solutions to technical questions.	of membrane technology macpender	miy. They will be cap	Jable of illiding creat	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56				
Credit points	6				
Examination	Written exam				
Examination duration and scale	90 min				
Assignment for the Following	Bioprocess Engineering: Specialisation A - General Bioprocess	Engineering: Elective Compulsory			
Curricula	Bioprocess Engineering: Specialisation B - Industrial Bioproces	ss Engineering: Elective Compulsory			
	Chemical and Bioprocess Engineering: Specialisation Chemic	al Process Engineering: Elective Comp	oulsory		
	Chemical and Bioprocess Engineering: Specialisation General	Process Engineering: Elective Compu	lsory		
Energy and Environmental Engineering: Specialisation Energy and Environmental Engineering: Elective Compulsory					
	Environmental Engineering: Specialisation Water: Elective Compulsory				
	Joint European Master in Environmental Studies - Cities and S	ustainability: Specialisation Water: Elec	ctive Compulsory		
	Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory				
	Process Engineering: Specialisation Process Engineering: Elective Compulsory				
	Water and Environmental Engineering: Specialisation Water: Elective Compulsory				
	Water and Environmental Engineering: Specialisation Environi	nent: Elective Compulsory			
	Water and Environmental Engineering: Specialisation Cities: E	lective Compulsory			



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

Course L0400: Membrane Techno	Course L0400: Membrane Technology	
Тур	Recitation Section (small)	
Hrs/wk	1	
CP	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Course work	Students can voluntarily hand in solutions to exercises. They can gather extra points with the handed-in solutions. The students are given more	
	detailed information at the beginning of the course.	
Lecturer	Prof. Mathias Ernst	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0401: Membrane Technology	
Тур	Laboratory Course
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Course work	Compulsory report: Students hand in a report about the carried out experiments.
Lecturer	Prof. Mathias Ernst
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course



Module M0822: Process Modeling in Water Technology				
Courses				
Title		Тур	Hrs/wk	СР
Process Modelling of Wastewater Treatr	ment (L0522)	Problem-based Learning	2	3
Process Modeling in Drinking Water Tre	atment (L0314)	Problem-based Learning	2	3
Module Responsible	Dr. Klaus Johannsen			
Admission Requirements	none			
Recommended Previous	Knowledge of the most important processes in drinking water a	and waste water treatment.		
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follow	ing learning results		
Professional Competence				
Knowledge	Students are able to explain selected processes of drinking w	ater and waste water treatment in detail	. They are able to e	xplain basics as well as
	possibilities and limitations of dynamic modeling.			
Ol::II-	Oh alamba ana alala ka wasa ka masa kimu antan kifa ak wasa Mandali	- Hann There are also to the second		dalda
Skills	Students are able to use the most important features Modelica			-
	water treatment into a mathematical model in Modelica with re	spect to equilibrium, kinetics and mass i	balances. They are a	able to set up and apply
	models and assess their possibilities and limitations.			
Personal Competence				
Social Competence	·		echnical background	i. They are able to give
	appropriate feedback and can work constructively with feedback	ck concerning their work.		
Autonomy	Students are able to define a problem, gain the required knowl	edge and set up a model.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Examination	Written exam			
Examination duration and scale	1,5 hours			
Assignment for the Following	Environmental Engineering: Specialisation Water: Elective Co	mpulsory		
Curricula	Joint European Master in Environmental Studies - Cities and S	ustainability: Specialisation Water: Elect	tive Compulsory	
	Water and Environmental Engineering: Specialisation Water: E	Elective Compulsory		
	Water and Environmental Engineering: Specialisation Environ	ment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Cities: E	lective Compulsory		



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



Course L0314: Process Modeling i	in Drinking Water Treatment
Тур	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 M0847: Analytical	Methods and Treatment Technologies for V	Vastewaters		
Courses				
Title		Тур	Hrs/wk	СР
Low-Cost Procedures for Water and Wa	stewater Analysis (L0505)	Lecture	2	3
Physico-Chemical Water Treatment (L0-	482)	Lecture	2	3
Module Responsible	NN			
Admission Requirements	none			
Recommended Previous	Fundamental knowledge in chemistry and physics (knowledge)	lge acquired at school)		
Knowledge				
Educational Objectives	After taking part successfully, students have reached the foll	owing learning results		
Professional Competence				
Knowledge	The students know some non-biological processes for the tr	eatment of water and wastewater as	well as the fundamentals of r	mass transfer which is
	essential for many treatment processes. They have knowled	lge about analytical procedures whi	ich can be applied even witho	out the availability of a
	laboratory and which are useful for evaluating the performa	ance of (waste)water treatment proc	esses and the assessment of	surface water quality
	in an economically feasible way.			
Skills	The students are able to select suitable processes for the	treatment of wastewaters with resp	pect to their characteristics. T	hey can evaluate the
	efforts and costs for analytical procedures for the characterize	ration of waters/wastewaters and se	lect economically feasible and	alytical procedures.
Personal Competence				
Social Competence	The students have the competence to plan and to perform wastewater analyses together with colleagues in small groups and to efficiently			
	distribute the respective tasks within the group.			
Autonomy	The students are capable to make their own decisions with	respect to the selection of suitable	water/wastewater treatment	processes as well as
	economically feasible analytical procedures for water/waste	water characterization.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Examination	Oral exam			
Examination duration and scale	30 min			
Assignment for the Following	Bioprocess Engineering: Specialisation A - General Bioproc	ess Engineering: Elective Compuls	ory	
Curricula	Energy and Environmental Engineering: Specialisation Ene	rgy and Environmental Engineering	: Elective Compulsory	
	Environmental Engineering: Specialisation Water: Elective 0	Compulsory		
	Joint European Master in Environmental Studies - Cities and	d Sustainability: Specialisation Wate	er: Elective Compulsory	
	Process Engineering: Specialisation Environmental Process	s Engineering: Elective Compulsory		
	Process Engineering: Specialisation Process Engineering: I	Elective Compulsory		
	Water and Environmental Engineering: Specialisation Wate	r: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Envir	onment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Cities	: Elective Compulsory		



Course L0505: Low-Cost Procedu	res for Water and Wastewater Analysis	
	Lecture	
Hrs/wk	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	NN	
Language	N stock	
Cycle		
	2 Costing of wastewater and water analyses	
	3 Parameters routinely measured in municipal wastewater effluents	
	4 Surrogate parameters	
	5 Field methods	
	6 Basic laboratory instruments and equipment	
	6.1 Balances	
	6.2 Volumetric dosing instruments	
	6.3 Photometer	
	6.3.1 General	
	6.3.2 Principle of photometry	
	6.3.3 Elements of a photometer	
	6.4 Deionised water supply	
	6.5 Safety equipment	
	7 Inorganic parameters	
	7.1 Inorganic parameters by probes/electrodes	
	7.1.1 Dissolved oxygen	
	7.1.1.1 Polarographic measurement of dissolved oxygen	
	7.1.1.2 Optical probe for measuring dissolved oxygen utilising luminescence quenching of oxygen	
	7.1.1.3 Titrimetric determination of dissolved oxygen	
	7.1.2 pH	
	7.1.3 Alkalinity	
	7.1.4 Electric conductivity/salinity	
	7.2 Nitrogen and phosphorus compounds (nutrients)	
	7.2.1 Colorimetric methods without expensive instruments	
	7.2.2 Reflectometric methods	
	7.2.3 Photometric methods	
	8 Particles in water and wastewater	
	9 Organic sum parameters	
	9.1 Overview	
	9.2 Chemical Oxygen Demand: Why to avoid COD analyses by the dichromate method?	
	9.3 TOC cuvette tests	
	9.4 Absorption of UV light (254 nm) as a surrogate parameter for COD	
	9.5 Volatile Solids as surrogate for COD	
	9.6 Biological oxygen demand	
	10 Microbiological parameters determined in a low-cost way	
	11 Toxicity toward activated sludge	
Literature	Skript auf StudIP	



Course L0482: Physico-Chemical	Water Treatment
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	NN
Language	EN
Cycle	WiSe
Content	- Stripping
	- Evaporation
	- Wastewater Incineration
	- Wet Air Oxidation
	- Ozonation
	- Advanced Oxidation Processes
l ita natana	District Observed Tracks and Wester and Westernston A.D. Circus C.A. Circus C.D.O. Dura Description (2000)
Literature	Physical-Chemical Treatment of Water and Wastewater, A.P. Sincero, G.A. Sincero, CRC Press, Boca Raton 2003;
	Handbook of Separation Techniques for Chemical Engineers, P.A. Schweitzer, ed., McGraw-Hill, New York 1988
	Perry's Chemical Engineers' Handbook, R.H. Perry, D.W. Green, J.O. Maloney, eds., McGraw-Hill, New York 1984
	Chemical Engineering, Vol. 2, J.M. Coulson, J.F. Richardson, Pergamon Press, Oxford 1991
	Ozone in Water Treatment, B. Langlais, D.A. Reckhow, D.R. Brink, eds., Lewis Publishers, Chelsea 1991



Module M0864: Practical (	Course in Water and Wastewater Tec	hnology		
Courses				
Title		Тур	Hrs/wk	СР
Practical Course in Water and Wastewa	ter Technology I (L0503)	Laboratory Course	2	3
Practicle Course of Wastewater Techno	logy II (L0607)	Laboratory Course	3	3
Module Responsible	Dr. Dorothea Rechtenbach			
Admission Requirements	none			
Recommended Previous	Basic knowledge in chemistry and physics (knowledge	edge acquired at school)		
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge	The students know basic analytical procedures	for evaluating the quality of water and wastewate	er. They have knowle	dge about fundamenta
	process engineering features of important water and wastewater treatment technologies.			
Skills	The students are able to understand and to practically apply methodologies for wastewater analysis as well as descriptions of experiments and			
	experimental setups in wastewater technology.			
Personal Competence				
Social Competence				
Autonomy	The students are able to conduct experiments follo	owing written procedures without external assistan	ce.	
Workload in Hours	Independent Study Time 110, Study Time in Lectu	re 70		
Credit points	6			
Examination	Written elaboration			
Examination duration and scale	ca. 5 Stunden			
Assignment for the Following	Water and Environmental Engineering: Specialisa	tion Water: Elective Compulsory		
Curricula	Water and Environmental Engineering: Specialisa	tion Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialisa	tion Cities: Elective Compulsory		

Course L0503: Practical Course in	Course L0503: Practical Course in Water and Wastewater Technology I	
Тур	Laboratory Course	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Dr. Dorothea Rechtenbach	
Language	DE/EN	
Cycle	WiSe	
Content	- Impact of pretreatment of wastewater samples on analytical results	
	- Analysis of nutrients in wastewater samples (different methods for nitrate analysis)	
	- Alkalinity	
	- TOC, COD	
	- microscopic analysis of microorganisms relevant in wastewater treatment	
Literature	Skript auf StudIP	

Course L0607: Practicle Course of Wastewater Technology II	
Тур	Laboratory Course
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Dr. Joachim Behrendt
Language	DE/EN
Cycle	WiSe
Content	Experiments:
	Oxygen transfer
	Oxygen Uptake rate
	Sludge dewatering
	Tracer
	Flocculation
Literature	Skript/Script



Module M0894: Study Wo	rk Cities			
Courses				
Title	Typ Hrs/wk CP			
Module Responsible	Dozenten des SD B			
Admission Requirements	none			
Recommended Previous				
Knowledge	Basics of Urban Planning     Urban Infrastructures (Water, Energy, Heat)			
	Orban initiastructures (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.			
Personal Competence Social Competence				
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			
Examination	Project (accord. to Subject Specific Regulations)			
Examination duration and scale				
Assignment for the Following Curricula				
Guilicula				



Module M0949: Rural Dev	elopment and Resources Oriented Sanitati	on for different Climate Zon	ies	
Courses				
Title		Тур	Hrs/wk	СР
Rural Development and Resources Orie	ented Sanitation for different Climate Zones (L0942)	Seminar	2	3
Rural Development and Resources Orie	ented 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 resour	ces and sanitation	
Knowledge				
Educational Objectives	After taking part successfully, students have reached the fo	llowing learning results		
Professional Competence				
Knowledge	Students can describe resources oriented wastewater s	vstems mainly based on source cor	ntrol in detail. They can co	mment on techniques
, u.e.meage	designed for reuse of water, nutrients and soil conditioners	•	are in dotain may can be	quo
	g			
	Students are able to discuss a wide range of proven appro	aches in Rural Development from and	for many regions of the wo	rld.
Skille	Students are able to design low-tech/low-cost sanitation,	rural water cupply, rainwater hanvest	ng eyetome moseuroe for t	ha rababilitation of tan
Skills	soil quality combined with food and water security. Stude			
	developed by Allan Savory.	ents can consult on the basics of so	ii ballallig tillbagii Tiblisit	, I lallifed Grazing as
	developed by Alian Savory.			
Personal Competence				
Social Competence				
Autonomy	Students are in a position to work on a subject and to organ	nize their work flow independently. Th	ey can also present on this	subject.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Examination	Project			
	•	urde mile etones. The work includes n	resentations and naners D	etailed information will
Examination adiation and sould	be provided at the beginning of the smester.	and time defices. The work indiades p	resentations and papers. D	otalica ililolilitation will
Assignment for the Following	Bioprocess Engineering: Specialisation A - General Biopro	cass Engineering: Flective Compuler	nrv	
Curricula	Chemical and Bioprocess Engineering: Specialisation Ger		•	
Gurricula	Energy and Environmental Engineering: Specialisation En	• •		
	Environmental Engineering: Specialisation Water: Elective	• •	Liective Compaisory	
	International Management and Engineering: Specialisation		pering: Flective Compulsors	
	Joint European Master in Environmental Studies - Cities ar	•		
	Process Engineering: Specialisation Environmental Process	, ,	. Liective Compulsory	
	Process Engineering: Specialisation Process Engineering:			
	Water and Environmental Engineering: Specialisation Water			
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory  Water and Environmental Engineering: Specialisation Cities: Elective Compulsory			
	water and Environmental Engineering: Specialisation Citie	s. Elective Compulsory		

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



Course L0941: Rural Developmen	t and Resources Oriented Sanitation for different Climate Zones
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Ralf Otterpohl
Language	EN
Cycle	WiSe
Content	<ul> <li>Living Soil - THE key element of Rural Development</li> <li>Participatory Approaches</li> <li>Rainwater Harvesting</li> <li>Ecological Sanitation Principles and practical examples</li> <li>Permaculture Principles of Rural Development</li> <li>Performance and Resilience of Organic Small Farms</li> <li>Going Further: The TUHH Toolbox for Rural Development</li> <li>EMAS Technologies, Low cost drinking water supply</li> </ul>
Literature	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



rses				
		Тур	Hrs/wk	CP
ation of Public Transportation Syst		Problem-based Learning	4	6
Module Responsible				
Admission Requirements			I.T. (6. F. :	. "
Recommended Previous Knowledge	some knowledge of transport planning, e.g. through taking the ur	ndergraduate class "Transport Plannin	g and Traffic Engine	ering"
Knowledge				
Educational Objectives	After taking part successfully, students have reached the followin	a learning results		
Professional Competence	, ,	g rearring results		
Knowledge				
Milowieage	Students are able to.			
	describe public transport (PT) systems in technical langua	age.		
	outline the entire PT system including the interdependence			
	explain the requirements for a PT system from different per	erspectives.		
	explain the role of PT in the transport system.			
Skills	Students are able to:			
	systematically develop a public transport system when the	ere are no clear cut correct or incorrec	t approaches.	
	cope with imprecise and incomplete data.			
	<ul> <li>develop and appraise alternative solutions.</li> </ul>			
	<ul> <li>distinguish or develop appropriate methods of analysis at</li> </ul>	nd modes of presentation.		
	reflect and evaluate their own transport concept, consider	ring competing requirements.		
Personal Competence				
	Students are able to:			
oodal competence	Ciddents are able to.			
	<ul> <li>carry out and complete a group project, inclusive of an ap</li> </ul>	propriate allocation of tasks.		
	constructively provide and accept feedback.			
	present their own results to others.			
Autonomy	independently develop a bus PT concept within a given fr	amework.		
	determine and justify the focus of their work.			
	organize and follow their work process regarding time and	d content.		
	independently author a written report.			
	<ul> <li>assess the consequences of the solutions they develop.</li> </ul>			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Examination	Project			
amination duration and scale				
Assignment for the Following	Logistics, Infrastructure and Mobility: Core qualification: Compuls	sory		
Curricula				



Course L1179: Operation of Public	Transportation Systems
Тур	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:
	<ul> <li>PT network planning</li> <li>timetabling</li> <li>operational concepts</li> <li>requirements for vehicle technology and operation</li> <li>infrastructural requirements</li> <li>inter- and multimodal connections</li> <li>financing and competition</li> <li>organisational structures</li> </ul> The topics are discussed with guests lecturers from the public transport sector and are considered in practice during an excursion.
Literature	Verband Deutscher Verkehrsunternehmen / VDV-Förderkreis (Hrsg.) (2010) Nachhaltiger Nahverkehr. Köln. (2 Bände)  Wuppertal Institut (2009) Handbuch zur Planung flexibler Bedienungsformen im ÖPNV: ein Beitrag zur Sicherung 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.



## **Specialization Environment**

Module M0581: Water Pro	tection			
Courses		T	Han toda	0.00
Title Geo-Information-Systems in Water Man	agement and Hydraulic Engineering (L0963)	Typ Problem-based Learning	Hrs/wk 2	<b>CP</b> 2
Water Protection and Wastewater Mana		Seminar	2	2
Water Protection and Wastewater Mana		Recitation Section (large)	1	2
Module Responsible				
Admission Requirements	none			
Recommended Previous				
Knowledge	Basic knowledge in water management;			
	Good knowledge in urban drainage;  Cood knowledge of westewater treatment to chair years.			
	<ul> <li>Good knowledge of wastewater treatment techniques;</li> <li>Good knowledge of pollutants (e.g. COD, BOD, TS, N, P) a</li> </ul>	ad their properties:		
	Good knowledge of politicarits (e.g. COD, BOD, 13, N, F) a	nd their properties,		
Educational Objectives	After taking part successfully, students have reached the following	learning results		
Professional Competence				
Knowledge	The students can describe the basic principles of the regulator	framework related to the internation	onal and European	water sector. They can
	explain limnological processes, substance cycles and water m	orphology in detail. Thereby they	are able to assess	complex water related
	problems. Finally, the students can demonstrate to achieve signif	· · · · · · · · · · · · · · · · · · ·	-	
	able to judge environmental and wastewater related issues ar	d to widely consider innovative so	olutions, remediation	measures and further
	interventions as well as conceptual problem solving approaches.			
			_	
Skills	Students can accurately assess current problems and situation			
	contribute to the planning of tomorrow's urban water cycle. Furth	nermore, they can suggest appropri	ate technical, admin	istrative and legislative
	solutions to solve these problems.			
Personal Competence				
Social Competence	The students can work together in international groups.	The students can work together in international groups.		
A	Other lands are a label to a superior the investor flavor to a superior the		diamenta Theore	
Autonomy	Students are able to organize their work flow to prepare their knowledge by making enquiries independently.	nserves before presentations and	discussion. They ca	an acquire appropriate
	knowledge by making enquines independently.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Examination	Written exam			
Examination duration and scale	60 min			
Assignment for the Following	Civil Engineering: Specialisation Structural Engineering: Elective	Compulsory		
Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elect	ve Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Elective Co	ompulsory		
	Environmental Engineering: Specialisation Water: Elective Compu	lsory		
	International Management and Engineering: Specialisation II. Civi	Engineering: Elective Compulsory		
	Joint European Master in Environmental Studies - Cities and Sust	ainability: Specialisation Water: Elec	tive Compulsory	
	Water and Environmental Engineering: Specialisation Water: Compulsory			
Water and Environmental Engineering: Specialisation Environment: Compulsory				
	Water and Environmental Engineering: Specialisation Cities: Elec	tive Compulsory		



Course L0963: Geo-Information-S	Course L0963: Geo-Information-Systems in Water Management and Hydraulic Engineering		
Тур	Problem-based Learning		
Hrs/wk	2		
CP	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Peter Fröhle		
Language	DE/EN		
Cycle	WiSe		
Content	Theoretical basics of Geo-Information-Systems		
	<ul> <li>Data models, geographical coordinates, geo-referencing, map-views</li> <li>Data mining and – analyses of geo-data</li> <li>Analysis techniques</li> </ul>		
Literature	None		

Course L0226: Water Protection a	nd Wastewater Management
Тур	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Ralf Otterpohl
Language	EN
Cycle	WiSe
	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 L0227: Water Protection a	nd Wastewater Management
Тур	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Ralf Otterpohl
Language	EN
Cycle	WiSe
	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.



Module M0830: Environme	ental Protection and Management			
Courses				
Title		Тур	Hrs/wk	СР
Integrated Pollution Control (L0502)		Lecture	2	2
Health, Safety and Environmental Manag		Lecture	2	3
Health, Safety and Environmental Management (L0388)  Recitation Section (small)			1	
Module Responsible				
Admission Requirements Recommended Previous	none			
	Good knowledge in Technologies for Environmental Prote	ction (end-of-pipe, integrated solutio	ons)	
Knowledge	Good knowledge of the relevant Environmental Legislation	n		
	Basic knowledge of instruments for Environmental Assess	ment		
Educational Objectives	After taking part successfully, students have reached the following	learning results		
Professional Competence	7,	,		
Knowledge	The students are able to describe the basics of regulations, ed	conomic instruments, voluntary initia	atives, fundamentals	of HSE legislation ISO
	14001, EMAS and Responsible Care ISO 14001 requireme	nts. They can analyse and discu	ss industrial proces	ses, substance cycles
	and approaches from end-of-pipe technology to eco-efficiency ar	nd eco-effectiveness, showing their s	ound knowledge of c	complex industry related
	problems. They are able to judge environmental issues and to	widely consider, apply or carry out	t innovative technica	I solutions, remediation
	measures and further interventions as well as conceptual problem	n solving approaches in the full range	e of problems in differ	rent industrial sectors.
Skills	Students are able to assess current problems and situations i	n the field of environmental protect	ction. They can cons	ider the best available
	techniques and to plan and suggest concrete actions in a com	pany- or branch-specific context. By	y this means they ca	in solve problems on a
	technical, administrative and legislative level.			
Personal Competence	The children con well togeth as is international argues			
Social Competence	The students can work together in international groups.			
A	Other design and the second se	-1 4		
Autonomy	Students are able to organize their work flow to prepare thems appropriate knowledge by making enquiries independently.	eives for presentations and contrib	utions to the discuss	ions. They can acquire
	appropriate knowledge by making enquines independently.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the Following	Energy and Environmental Engineering: Specialisation Environm	ental Engineering: Elective Compuls	sory	
Curricula	Environmental Engineering: Core qualification: Compulsory			
	Joint European Master in Environmental Studies - Cities and Sus	ainability: Specialisation Water: Elec	ctive Compulsory	
	Joint European Master in Environmental Studies - Cities and Sus			
	Product Development, Materials and Production: Specialisation F	·	ulsory	
	Product Development, Materials and Production: Specialisation F			
	Product Development, Materials and Production: Specialisation N			
	Water and Environmental Engineering: Specialisation Environment: Compulsory			
	Water and Environmental Engineering: Specialisation Cities: Con	ipuisoty		



Course L0502: Integrated Pollution	n 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	<ul> <li>The Regulatory Framework</li> <li>Pollution &amp; Impacts, Characteristics of Pollutants</li> <li>Approaches of Integrated Pollution Control</li> <li>Sevilla Process, Best Available Technologies &amp; BREF Documents</li> <li>Case Studies: paper industry, cement industry, automotive industry</li> <li>Field Trip</li> </ul>
Literature	Förstner, Ulrich (1998): Integrated Pollution Control, Springer-Verlag Berlin Heidelberg, ISBN 978-3-642-80313-0  Shen, Thomas T. (1999): Industrial Pollution Prevention, Springer-Verlag Berlin Heidelberg, ISBN 978-3-540-65208-3

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

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



Module M0902: Wastewate	er Treatment and Air Pollution Abate	ment			
Courses					
Title	7)	Тур	Hrs/wk	CP	
Biological Wastewater Treatment (L0517 Air Pollution Abatement (L0203)	)	Lecture Lecture	2	3	
Module Responsible	Dr. Ernst-Ulrich Hartge	2001.0	_		
Admission Requirements	None				
Recommended Previous	Basic knowledge of biology and chemistry				
Knowledge	Easie Miewieage of Biology and Gremiery				
	basic knowledge of solids process engineering at	nd separation technology			
Educational Objectives	After taking part successfully, students have reach	ned the following learning results			
Professional Competence					
Knowledge	After successful completion of the module student	ts are able to			
	<ul> <li>name and explain biological processes for</li> </ul>	or waste water treatment,			
	characterize waste water and sewage sluce	dge			
	discuss legal regulations in the area of em	nissions and air quality			
	<ul> <li>classify off gas tretament processes and to</li> </ul>	define their area of application			
Skills	Students are able to				
	choose and design processs steps for the	biological waste water treatment			
	<ul> <li>choose and design processs steps for the biological waste water treatment</li> <li>combine processes for cleaning of off-gases depending on the pollutants contained in the gases</li> </ul>				
		, , ,	•		
Personal Competence					
Social Competence					
Autonomy					
Workload in Hours	Independent Study Time 124, Study Time in Lectu	ure 56			
Credit points	6				
Examination	Written exam				
Examination duration and scale	90 min	18: 5: 1.51.11.0			
Assignment for the Following Curricula	Bioprocess Engineering: Specialisation A - Gener				
Curricula	Chemical and Bioprocess Engineering: Specialis Energy and Environmental Engineering: Specialis	• •			
	Environmental Engineering: Specialisation Waste	• • •	ouisory		
	International Management and Engineering: Specialisation waste	. ,	ring: Flective Compulsor	v	
	Joint European Master in Environmental Studies		-	j	
	Renewable Energies: Specialisation Bioenergy S	• •			
	Process Engineering: Specialisation Environment				
	Process Engineering: Specialisation Process Eng				
	Water and Environmental Engineering: Specialisa				
	Water and Environmental Engineering: Specialisa	ation Environment: Compulsory			
	Water and Environmental Engineering: Specialisa	ation Cities: Compulsory			

Course L0517: Biological Wastewater Treatment		
Тур	Lecture	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Course work	No compulsory course work.	
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	



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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

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Tchobanoglous, George (Metcalf & Eddy, Inc., ;)

Wastewater engineering: treatment and reuse

ISBN: 0070418780 (alk. paper) ISBN: 0071122508 (ISE (\*pbk))

Boston [u.a.]: McGraw-Hill, 2003

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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

Weimar: Universitätsverl, 2006

TUB\_HH\_Katalog

Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall

DWA-Regelwerk
Hennef: DWA, 2004
TUB\_HH\_Katalog

 $\textbf{Wiesmann}, \textbf{Udo} \ (\textbf{Choi}, \textbf{In Su}; \textbf{Dombrowski}, \textbf{Eva-Maria};)$ 

Fundamentals of biological wastewater treatment

 $ISBN: 3527312196 \ (Gb.) \ URL: http://deposit.ddb.de/cgi-bin/dokserv?id=2774611\&prov=M\&dok\_var=1\&dok\_ext=htm. The proves the provesting of the provesting of the provesting that the provesting of the provesti$ 

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. Ernst-Ulrich Hartge			
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 treate			
	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 M0511: Electricity	Generation from Wind and Hydro Power			
Courses				
Courses				
Title		Тур	Hrs/wk	CP
Renewable Energy Projects in Emerged	Markets (L0014)	Project Seminar	1	1
Hydro Power Use (L0013)		Lecture	1	1
Wind Turbine Plants (L0011) Wind Energy Use - Focus Offshore (L0)	212)	Lecture Lecture	2	3
		Lecture	'	
Module Responsible				
Admission Requirements				
Recommended Previous	Module: Technical Thermodynamics I,			
Knowledge	Module: Technical Thermodynamics II,			
	Module: Fundamentals of Fluid Mechanics			
Educational Objectives	After taking part successfully, students have reached the fol	lowing learning results		
Professional Competence				
Knowledge	By ending this module students can explain in detail knowledge of wind turbines with a particular focus of wind energy use in offshore conditionand can critical comment these aspects in consideration of current developments. Furthermore, they are able to describe fundamentally the use water power to generate electricity. The students reproduce and explain the basic procedure in the implementation of renewable energy project in countries outside Europe.			undamentally the use o
	Through active discussions of various topics within the seminar of the module, students improve their understanding and the application of theoretical background and are thus able to transfer what they have learned in practice.			
Skills	Students are able to apply the acquired theoretical foundations on exemplary water or wind power systems and evaluate and assess technical the resulting relationships in the context of dimensioning and operation of these energy systems. They can in compare critically the speci procedure for the implementation of renewable energy projects in countries outside Europe with the in principle applied approach in Europe are can apply this procedure on exemplary theoretical projects.			are critically the specia
Personal Competence				
Social Competence	Students can discuss scientific tasks subjet-specificly and n	nultidisciplinary within a seminar.		
Autonomy	Students can independently exploit sources in the context of the particular knowledge about the subject area.	f the emphasis of the lecture material to	clear the contents of th	ne lecture and to acquire
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Examination	Written exam			
Examination duration and scale	3 hours written exam	<u> </u>		
Assignment for the Following	Civil Engineering: Specialisation Structural Engineering: Ele	ective Compulsory		
Curricula	Civil Engineering: Specialisation Geotechnical Engineering	: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Elec			
	Energy and Environmental Engineering: Specialisation Ene	rgy Engineering: Elective Compulsory		
	International Management and Engineering: Specialisation	II. Renewable Energy: Elective Compul	sory	
	International Management and Engineering: Specialisation	II. Energy and Environmental Engineer	ing: Elective Compulsor	ry
	Product Development, Materials and Production: Specialisa	tion Product Development: Elective Cor	mpulsory	
	Product Development, Materials and Production: Specialisa	tion Production: Elective Compulsory		
	Product Development, Materials and Production: Specialisa	tion Materials: Elective Compulsory		
	Renewable Energies: Core qualification: Compulsory			
	Process Engineering: Specialisation Environmental Proces	s Engineering: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Envir	onment: Compulsory		
	Water and Environmental Engineering: Specialisation Cities	s: Elective Compulsory		



Course L0014: Renewable Energy Project is Emerged Markets  Hrswk CP Workload in Hours Lecture Dr. Andreas Wiese Language Cycle SoSe Content  1. Introduction Development of renewable energies worldwide I History I Future markets Special challenges in new markets - Overview 2. Sample project wind farm Korea Survey Technical Description Project phases and characteristics J. Funding and financing instruments for EE projects in new markets Overview funding opportunitie Overview funding opportunitie Overview funding opportunitie Overview Countries with feed-in laws Major funding programs 4. CDM projects - why, how, examples Overview Countries with feed-in laws Bear and the Countries with feed-in laws Description Strangles Exercise CDM 5. Rural electrification and hybrid systems - an important future market for EE Project examples First Electrification - Introduction Types of Elektrititerungsprojekten The role of the EEtinerpresition of hybrid systems Project example: hybrid system Galapagos Islands First Electrification on the perspective of a development bank - Wesley Urena Vargas, KIW Development Bank Geothermal Wind or CSP		
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Language DE Cycle SoSe Content  1. Introduction	CP	1
Language Cycle SoSe Content  1. Introduction	Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Content  1. Introduction  Development of renewable energies worldwide  History  Future markets  Special challenges in new markets - Overview  Sample project wind farm Korea  Survey  Technical Description  Project phases and characteristics  Funding and financing instruments for EE projects in new markets  Overview vountries with feed-in laws  Najor funding programs  CDM projects - why, how, examples  Verview CDM process  Examples  Examples  Examples  Project phases and characteristics  Funding and financing instruments for EE projects in new markets  Overview countries with feed-in laws  Najor funding programs  ACDM projects - why, how, examples  Examples  Examples  Examples  Furual electrification and hybrid systems - an important future market for EE  Rural Electrification - Introduction  Types of Elektrizifierungsprojekten  The role of the EEInterpretation of hybrid systems  Project example: hybrid system Galapagos Islands  Furdering process for EE projects - examples  South Africa  Brazil  7. Selected projects from the perspective of a development bank - Wesley Urena Vargas, KIW Development Bank  Geothermal	Lecturer	Dr. Andreas Wiese
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○ Wind or CSP		
		Wind or USP
Within the seminar, the various topics are actively discussed and applied to various cases of application.		Within the seminar, the various topics are actively discussed and applied to various cases of application.
Literature Folien der Vorlesung	Literature	Folien der Vorlesung

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



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

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



Module M0513: System As	spects of Renewable Energies				
Courses					
Title		Тур	Hrs/wk	СР	
	New Materials for Energy Production and Storage (L0021)	Lecture	2	2	
Energy Trading (L0019)		Lecture	1	1	
Energy Trading (L0020)		Recitation Section (small)	1	1	
Deep Geothermal Energy (L0025)		Lecture	2	2	
Module Responsible	Prof. Martin Kaltschmitt				
Admission Requirements	none				
Recommended Previous	Module: Technical Thermodynamics I				
Knowledge	Module: Technical Thermodynamics II				
Educational Objectives	After taking part successfully, students have reached the follow	ing learning results			
Professional Competence					
Knowledge	Students are able to describe the processes in energy trading	g and the design of energy markets a	nd can critically eval	uate them in relation	
	current subject specific problems. Furthermore, they are able to	explain the basics of thermodynamics	of electrochemical e	nergy conversion in f	
	cells and can establish and explain the relationship to diffe	cells and can establish and explain the relationship to different types of fuel cells and their respective structure. Students can compare			
	technology with other energy storage options. In addition, stud	ents can give an overview of the proce	dure and the energe	etic involvement of de	
	geothermal energy.				
0.111					
Skills	Students can apply the learned knowledge of storage systems	= -			
	ensure a secure energy supply. In particular, they can plan a		_		
		storage systems in an energy-efficient way and can assess them in relation to complex power systems. In this context, students can assess			
	potential and limits of geothermal power plants and explain the	ir 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 of				
	renewable energy projects. In this context they can unassisted	y carry out analysis and evaluations of	energie markets and	energy trades.	
Personal Competence					
Social Competence	Students are able to discuss issues in the thematic fields in the	renewable energy sector addressed w	ithin the module.		
		, , , , , , , , , , , , , , , , , , ,			
Autonomy	Students can independently exploit sources, acquire the partic	ular knowledge about the subject area	and transform it to ne	ew questions.	
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84				
Credit points	6				
Examination	Written exam				
Examination duration and scale	3 hours written exam				
Assignment for the Following	Bioprocess Engineering: Specialisation A - General Bioproces	s Engineering: Elective Compulsory			
Curricula	Energy and Environmental Engineering: Specialisation Energy	and Environmental Engineering: Elect	ive Compulsory		
	International Management and Engineering: Specialisation II. I	Renewable Energy: Elective Compulsor	ry		
	International Management and Engineering: Specialisation II. I	Energy and Environmental Engineering	: Elective Compulsor	ту	
	International Management and Engineering: Specialisation II. I	Process Engineering and Biotechnology	y: Elective Compulso	ry	
	Renewable Energies: Core qualification: Compulsory				
	Process Engineering: Specialisation Environmental Process E	ngineering: Elective Compulsory			
	Process Engineering: Specialisation Process Engineering: Ele	ctive Compulsory			
	Water and Environmental Engineering: Specialisation Water: E	lective Compulsory			
	Water and Environmental Engineering: Specialisation Environ	ment: Elective Compulsory			
		The state of the s			



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

Course L0019: Energy Trading	
Тур	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Michael Sagorje
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 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
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course



Course L0025: Deep Geothermal	Energy		
Тур	Lecture		
Hrs/wk	2		
СР			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Dr. Ben Norden		
Language	DE		
Cycle	SoSe		
Content	1. Introduction to the deep geothermal use 2. Geological Basics I 3. Geological Basics II 4. Geology and thermal aspects 5. Rock Physical Aspects 6. Geochemical aspects 7. Exploration of deep geothermal reservoirs 8. Drilling technologies, piping and expansion 9. Borehole Geophysics 10. Underground system characterization and reservoir engineering 11. Microbiology and Upper-day system components 12. Adapted investment concepts, cost and environmental aspect		
Literature	<ul> <li>Dipippo, R.: Geothermal Power Plants: Principles, Applications, Case Studies and Environmental Impact. Butterworth Heinemann; 3rd revised edition. (29. Mai 2012)</li> <li>www.geo-energy.org</li> <li>Edenhofer et al. (eds): Renewable Energy Sources and Climate Change Mitigation; Special Report of the Intergovernmental Panel or Climate Change. Cambridge University Press, 2012.</li> <li>Kaltschmitt et al. (eds): Erneuerbare Energien: Systemtechnik, Wirtschaftlichkeit, Umweltaspekte. Springer, 5. Aufl. 2013.</li> <li>Kaltschmitt et al. (eds): Energie aus Erdwärme. Spektrum Akademischer Verlag; Auflage: 1999 (3. September 2001)</li> <li>Huenges, E. (ed.): Geothermal Energy Systems: Exploration, Development, and Utilization. Wiley-VCH Verlag GmbH &amp; Co. KGaA; Auflage 1. Auflage (19. April 2010)</li> </ul>		



Module M0703: Soil and G	roundwater Contamination			
Courses				
Title		Тур	Hrs/wk	СР
Contamination and Remediation (L0547)		Project Seminar	3	3
NAPL in Soil and Groundwater (L0545)		Lecture	1	1
NAPL in Soil and Groundwater (L0546)		Recitation Section (small)	2	2
Module Responsible	Prof. Wilfried Schneider			
Admission Requirements	None			
Recommended Previous Knowledge	<ul> <li>Ground water hydrology</li> <li>Geohydraulic and solute transport</li> <li>Hydromechanics</li> </ul>			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence Knowledge	The students are able to analyse contamination in soils and groundwater. They are able to create remediation concepts for LNAPL contamnations. They are faminiliar with Monitored Natural Attenuation  .			
Skills	The students are able to analyse contaminations in soils and groundwater using special engineering methods. They can do transport modelling in the unsaturated zone, estimations of groundwater pollution and analyse the impacts of remediation measures. They can forecast die distribution, mobility and remediation of non aquaous phase liquids in soil and groundwater.			
Personal Competence				
Social Competence	The students are able to prepare complex contamina	ation issues in teamwork and are able to find reme	ediation measures.	
Autonomy	None			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Examination	Written exam			
Examination duration and scale	Klausur 60 min; Referat 15 min;			
Assignment for the Following	Water and Environmental Engineering: Specialisation	on Water: Elective Compulsory		
Curricula	Water and Environmental Engineering: Specialisation	on Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation	on Cities: Elective Compulsory		

Course L0547: Contamination and Remediation		
Тур	Project Seminar	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Prof. Wilfried Schneider	
Language	DE	
Cycle	SoSe	
Content	Processing of a complex soil and groundwater contamination site. Students perform analyses of data to detect the contamination and to analyse	
	the groundwater hazard and to develop a concept for remediation of the damage.	
Literature	entfällt	

Course L0545: NAPL in Soil and G	roundwater	
Тур	Lecture	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Wilfried Schneider	
Language	DE	
Cycle	SoSe	
Content	concept of capillarity, multi phase distribution in poraus media, residual saturation, rellative permeability, infiltration of NAPL into the subsurface	
	vertical distribution of LNAPL, specific volume	
Literature	Charbeneau, R.J. (2000): Groundwater Hydraulics and pollutant Transport	



Course L0546: NAPL in Soil and Groundwater	
Тур	Recitation Section (small)
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Wilfried Schneider
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course



Courses				
Title		Тур	Hrs/wk	СР
Solid Matter Process Technology for Bio	omass (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	I the following learning results		
Professional Competence				
Knowledge	The students can name, describe current issue as	nd problems in the field of thermal waste tre	atment and particle pr	ocess engineering a
	contemplate them in the context of their field.			
	The industrial application of unit operations as part of	of process engineering is explained by actual ex	amples of waste incine	ration technologies a
	solid biomass processes. Compostion, particle sizes		•	•
	described as important unit operations when produc			
	recyclables.			
0.44				
Skills	'			eristics and the proce
	aims. They can evaluate the efforts and costs for pro-	cesses and select economically feasible treatm	ent concepts.	
Personal Competence				
Social Competence	Students can			
	<ul> <li>respectfully work together as a team and disc</li> </ul>	nues tochnical tacks		
	participate in subject-specific and interdisciple			
	develop cooperated solutions	mary disoussions,		
	promote the scientific development and acceptable.	ept professional constructive criticism.		
	,	, , , , , , , , , , , , , , , , , , ,		
Autonomy	Students can independently tap knowledge of the	e subject area and transform it to new ques	tions. They are capab	le, in consultation w
	supervisors, to assess their learning level and def	· ·	hey can define targets	for new application-
	research-oriented duties in accordance with the pote	ential social, economic and cultural impact.		
Workload in Hours	Independent Study Time 110, Study Time in Lecture	70		
Credit points	6			
Examination	Written exam			
Examination duration and scale	120 min			
Assignment for the Following	Bioprocess Engineering: Specialisation A - General	Bioprocess Engineering: Elective Compulsory		
Curricula	Energy and Environmental Engineering: Specialisat	ion Energy and Environmental Engineering: Ele	ective Compulsory	
	International Management and Engineering: Specia	• •		ry
	International Management and Engineering: Specia	lisation II. Renewable Energy: Elective Compul	sory	
	Renewable Energies: Specialisation Bioenergy Syst	tems: Elective Compulsory		
	Process Engineering: Specialisation Chemical Process			
	Process Engineering: Specialisation Process Engine	eering: Elective Compulsory		
	la	Barrage Francisco Flactico Communicación		
	Process Engineering: Specialisation Environmental	Process Engineering: Elective Compulsory		
	Water and Environmental Engineering: Specialisation			



Course L0052: Solid Matter Process Technology for Biomass		
Тур	Lecture	
Hrs/wk	2	
CP	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 Waste Tre	eatment
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Kerstin Kuchta, Dr. Joachim Gerth, Dr. Ernst-Ulrich Hartge
Language	EN
Cycle	SoSe
Content	<ul> <li>Introduction, actual state-of-the-art of waste incineration, aims. legal background, reaction principals</li> <li>basics of incineration processes: waste composition, calorific value, calculation of air demand and flue gas composition</li> <li>Incineration techniques: grate firing, ash transfer, boiler</li> <li>Flue gas cleaning: Volume, composition, legal frame work and emission limits, dry treatment, scrubber, de-nox techniques, dioxin elimination, Mercury elimination</li> <li>Ash treatment: Mass, quality, treatment concepts, recycling, disposal</li> </ul>
Literature	Thomé-Kozmiensky, K. J. (Hrsg.): Thermische Abfallbehandlung Bande 1-7. EF-Verlag für Energie- und Umwelttechnik, Berlin, 196 - 2013.

Course L1177: Thermal Waste Treatment	
Тур	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Dr. Ernst-Ulrich Hartge, Dr. Joachim Gerth
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course



Courses				
Title		Тур	Hrs/wk	СР
Applied Groundwater Modeling (L0543)		Lecture	1	1
Applied Groundwater Modeling (L0544)		Recitation Section (small)	2	2
Modeling of Water Supply and Sewer Ne	etwork (L0875)	Problem-based Learning	2	3
Module Responsible	Prof. Wilfried Schneider			
Admission Requirements	none			
Recommended Previous	Groundwater			
Knowledge	groundwater hydraulics and transport of s	substances		
	Pipe Systems			
	Knowledge on urban water infrastructures	s, in particular drinking water systemsand urban dra	inage systems includi	ng special structures
	Hydraulics of drinking water supply syster		J - 1,111 1 101001	0 ,
	Basic knowledge on water management			
<b>Educational Objectives</b>	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge	The students are able to describe the modelling	g of groundwater flow and transport as well as u	ban water infrastructu	ires. They can carry of
	systems analyses and can detect technical and conceptual weak points within the systems in case studies. Besides they are able to analyse			
	interdependencies of hydraulic and toxic phenomena in soil and water.			
Skille	The students are able to construct and apply science	entific groundwater models indipendently. They car	work on different sce	narios and can compa
Skills				
		ns by application of selected software products. T	ne students are able	to use anierent sollwa
	solutions (e.g. EPANET, EPA-SWMM).			
B				
Personal Competence	Me I I I I I I I I I I I I I I I I I I I			
Social Competence	Wird nicht vermittelt.			
Autonomy	Wird nicht vermittelt.			
Workload in Hours	Independent Study Time 110, Study Time in Lect	ure 70		
Credit points	6			
Examination	Oral exam			
Examination duration and scale	20 min			
Assignment for the Following	Civil Engineering: Specialisation Structural Engir	neering: Elective Compulsory		
Curricula	Civil Engineering: Specialisation Geotechnical E	ngineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engine	ering: Elective Compulsory		
	Water and Environmental Engineering: Specialis	ation Water: Compulsory		
	Water and Environmental Engineering: Specialis	ation Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialis			

Course L0543: Applied Groundwater Modeling			
Тур	Lecture		
Hrs/wk	1		
CP	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Wilfried Schneider		
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: Applied Groundwat	Course L0544: Applied Groundwater Modeling		
Тур	Recitation Section (small)		
Hrs/wk	2		
CP	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Wilfried Schneider		
Language	DE/EN		
Cycle	SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L0875: Modeling of Water Supply and Sewer Network			
Тур	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 M0828: Urban Env	vironmental Management			
Courses				
Title		Тур	Hrs/wk	CP
Noise Protection (L1109)		Lecture	2	2
Urban Infrastructures (L0874)		Problem-based Learning	2	4
Module Responsible	Dr. Dorothea Rechtenbach			
Admission Requirements	none			
Recommended Previous	a Manufadaa ay Ushay ylayyiya			
Knowledge	Knowledge on Urban planning			
	Knowledge on measures for climate protection	• •		
	<ul> <li>Basics knowledge in urban drainage and storr</li> </ul>	nwater management		
Educational Objectives	After taking part successfully, students have reached t	he following learning results		
Professional Competence				
Knowledge	Students can describe urban development corridors	as well as current and future urban environn	nental problems. They	are able to explain the
	causes of environmental problems (like noise).			
	Students can specify applications for various technical innovations and explain why these contribute to the improvement of urban life. They can, the students can specify applications for various technical innovations and explain why these contribute to the improvement of urban life.			
	example, derive and discuss measures for effective noise abatement.			
Skills	Students are able to develop specific solutions for o	orrecting existing or future environment relate	od problems of urban	dovolonment They can
Skills	Students are able to develop specific solutions for correcting existing or future environment-related problems of urban development. They can be a second of the second of			
	define a range of conceptual and technical solutions for environmental problems for different development paths. To solve specific urba environmental problems they can select technical innovations and integrate them into the urban context.			
Personal Competence	environmental problems they can select technical mile	ovalions and integrate them into the urban con	lext.	
Social Competence				
Social Competence	me students can work together in memational group	<b>5.</b>		
Autonomy	Students are able to organize their work flow to pre	pare themselves for presentations and contr	butions to the discuss	ions. They can acquire
	appropriate knowledge by making enquiries independently.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	6		
Credit points	6			
Examination	Project			
Examination duration and scale	Written Report plus oral Presentation			
Assignment for the Following	Civil Engineering: Specialisation Structural Engineering	ng: Elective Compulsory		
Curricula	Civil Engineering: Specialisation Geotechnical Engine	eering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering	: Elective Compulsory		
	Environmental Engineering: Core qualification: Electiv	re Compulsory		
	Joint European Master in Environmental Studies - Citi	es and Sustainability: Core qualification: Com	oulsory	
	Logistics, Infrastructure and Mobility: Specialisation In	frastructure and Mobility: Elective Compulsory		
	Water and Environmental Engineering: Specialisation	Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation	Cities: Compulsory		

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



Course L0874: Urban Infrastructures			
Тур	Problem-based Learning		
Hrs/wk	2		
CP	4		
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28		
Lecturer	Dr. Dorothea Rechtenbach		
Language	EN		
Cycle	SoSe		
Content	Problem/Project Based Learning		
	Main topics are:  Design of future cities, concepts and technical approaches for future-proof drinking water supply and wastewater disposal  Climate Change Impacts, Adaptation and Mitigation  Rainwater Management & urban flash floods  New water sources: rainwater harvesting and wastewater reuse  Urban greening & urban agriculture  Water sensitive urban design  How to better link urban planning and urban water issues		
Literature	Depends on chosen topic.		



Module M0857: Geochemic	cal Engineering			
	ou. =goog			
Courses				
Title		Тур	Hrs/wk	СР
Contaminated Sites and Landfilling (L0906	6)	Lecture	2	2
Contaminated Sites and Landfilling (L090)	7)	Recitation Section (large)	1	2
Geochemical Engineering (L0904)		Lecture	2	2
Module Responsible	Dr. Joachim Gerth			
Admission Requirements	none			
Recommended Previous	Module: General and Inorganic Chemistry,			
Knowledge	Module:Organic Chemistry,			
	Biology (Basic Knowledge)			
Educational Objectives	After taking part successfully, students have reached the 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 ar			
	groundwater, and techniques to deposit contam	inated waste material. They are able to describe in	principle the behav	iour of chemicals in the
	environment. Students can explain and report the	e approach to remediate contaminated sites.		
Skille	With the completion of this module students can	apply the acquired theoretical knowledge to model ca	sees of site pollution	and critically assess the
	•	able to draw comparisons on different remediation st	•	•
	be devised and treated.	able to draw domparisons on different remediation of	rategies and teering	aco. Moder projecto dari
	be devised and freated.			
Personal Competence				
Social Competence	Students can discuss technical and scientific tas	ks within a seminar subject specific and interdisciplina	ary .	
A	Chudonto con independenti cominitario	unive the execution less than the extra continue to	u ikka manu	
Autonomy	Students can independently exploit sources , acc	quire the particular knowledge of the subject and appl	y it to new problems.	
Workload in Hours	Independent Study Time 110, Study Time in Lect	ure 70		
Credit points	6			
Examination	Written exam			
Examination duration and scale	2 hours			
Assignment for the Following	Energy and Environmental Engineering: Speciali	isation Environmental Engineering: Elective Compuls	ory	
Curricula	Environmental Engineering: Core qualification: E	Elective Compulsory		
	Water and Environmental Engineering: Specialis	ation Water: Elective Compulsory		
	Water and Environmental Engineering: Specialis	ation Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialis	ation Cities: Elective Compulsory		

Course L0906: Contaminated Sites	s and Landfilling
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Joachim Gerth, Dr. Marco Ritzkowski
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	
CP	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Dr. Joachim Gerth, Dr. Marco Ritzkowski	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

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



Module M0870: Manageme	ent of Surface Water			
Courses				
Title		Тур	Hrs/wk	СР
Modelling of Flow in Rivers and Estuarie	s (L0810)	Lecture	3	4
Nature-Oriented Hydraulic Engineering /	Integrated Flood Protection (L0961)	Problem-based Learning	2	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous	Fundamentals of Hydromechanics, Hydraulics, Hydrolo	ogy and Hydraulic Engineering; Hydraulic En	gineering I and Hydrau	lic Engineering II
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	ne following learning results		
Professional Competence				
Knowledge	Students are able to define in detail the basic processes that are related to the modelling of flows in hydraulic engineering. Besides, they can			
	describe the basic aspects of numerical modelling and actual numerical models for the simulation of flows and waves. They can also depict			
	concepts of nature oriented hydraulic engineering.			
Skills	Students are able to apply hydrodynamic-numerical m	nodels to practical hydraulic engineering task	s Furthermore the stu	dents are able to set u
O.M.O	flood-risk management concepts and are able to apply			dente die dele te set u
	nood not management concepts and alle able to apply	production of the state of the	00.0	
Personal Competence				
Social Competence	The students are able to deploy their gained knowledg	e in applied problems of the practical nature	based hydraulic engin	eering. Additionaly, the
	will be able to work in team with engineers of other disc	ciplines.		
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			
Examination	Written exam			
Examination duration and scale	The duration of the examination is 150 min. The exam	ination includes tasks with respect to the ger	eral understanding of	the lecture contents and
	calculations tasks.			
Assignment for the Following	Environmental Engineering: Core qualification: Elective	e Compulsory		
Curricula	Joint European Master in Environmental Studies - Cities	es and Sustainability: Core qualification: Com	pulsory	
	Water and Environmental Engineering: Specialisation	Water: Compulsory		
	Water and Environmental Engineering: Specialisation	Environment: Compulsory		
	Water and Environmental Engineering: Specialisation Cities: Elective Compulsory			

Course L0810: Modelling of Flow in	Course L0810: Modelling of Flow in Rivers and Estuaries				
Тур	cture				
Hrs/wk					
СР	4				
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42				
Lecturer	Prof. Peter Fröhle				
Language	DE/EN				
Cycle	SoSe				
Content	Basics of numerial models / application of models				
	classification of models				
	model concept				
	modelling				
	- modeling				
	D Working Equation				
	Mathematical description of physical processes				
	Equation of motions				
	conservation of mass				
	<ul> <li>conservation of momentum</li> <li>Initial conditions and boundary conditions</li> </ul>				
	Numerical Methods				
	Time step procedure				
	• Finite differences				
	Finite volumes				
11.					
Literature	Vorlesungsskript				



Course L0961: Nature-Oriented Hydraulic Engineering / Integrated Flood Protection				
Тур	bblem-based Learning			
Hrs/wk	2			
CP	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Peter Fröhle			
Language	DE/EN			
Cycle	)Se			
Content	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: Hydrologi	cal Systems			
Courses				
Title		Тур	Hrs/wk	CP
Applied Surface Hydrology (L0289)		Lecture	2	2
Applied Surface Hydrology (L1412)		Problem-based Learning	1	2
Interaction Water - Environment in Fluvia	al Areas (L0295)	Problem-based Learning	1	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	none			
Recommended Previous	Fundamentals of Hydromechanics and Hydraulic Engi	neering: Hydraulic Engineering I and Hydraulic E	Ingineering II	
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	ne following learning results		
Professional Competence				
Knowledge	The students are able to define the basic concepts of	of hydrology and water management. They are	able to describe a	nd quantify the relevant
	processes of the hydrological water cycle. Besides, t	he students know the main aspects of rainfall-re	un-off-models and	are able to theoretically
	derive established reservoir / storage models and a un	it-hydrograph.		
Skills	The students are able to use the basic hydrological co	oncepts and approaches and are able to theoret	ically derive establi	shed reservoir / storage
	models or a unit-hydrograph as the basis for rainfal	I-run-off-models. The student are able to explain	in the basic concep	pts of measurements of
	hydrological and hydrodynamic values in nature and are able to perform, analyze and statistically assess these measurements. Furthermore, they			
	are able to apply a hydrological model to basic hydrological	ogical problems.		
Personal Competence				
Social Competence	The students are able to deploy their gained knowledge in applied problems of the hydrology and water management. Additionaly, they will be			
eesia. eempetemee				radiaonaly, aloy wiii bo
Autonomy	able to work in team with engineers of other disciplines.  The students will be able to independently extend their knowledge and apply it to new problems			
Autonomy	The students will be able to independently extend their	Trilowiedge and apply it to new problems		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	6		
Credit points	6			
Examination	Written exam			
Examination duration and scale	The duration of the examination is 90 min. The examination includes tasks with respect to the general understanding of the lecture contents and			
	calculations tasks.			
Assignment for the Following	Environmental Engineering: Core qualification: Electiv	e Compulsory		
Curricula	Joint European Master in Environmental Studies - Citie	es and Sustainability: Core qualification: Compuls	sory	
	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 L0289: Applied Surface Hy	course L0289: Applied Surface Hydrology			
Тур	Lecture			
Hrs/wk				
CP	2			
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28			
Lecturer	Prof. Peter Fröhle, Sandra Hellmers			
Language	DE/EN			
Cycle	SoSe			
Content	Basics of hydrology:			
	<ul> <li>Hydrological cycle</li> <li>Data acquisition</li> <li>Data analyses and statistical assessment</li> <li>Statistics of extremes</li> <li>Regionalization methods for hydrological values</li> <li>Rainfall-run-off modelling on the basis of a unit hydrograph conceps</li> <li>Application of rainfall-run-off models on the basis of Kalypso-Hydrology which is an OpenSource Software Tool.</li> </ul>			
Literature	http://de.wikipedia.org/wiki/Kalypso_(Software)			
	http://kalypso.bjoernsen.de/			
	http://sourceforge.net/projects/kalypso/			



Course L1412: Applied Surface Hydrology			
Тур	blem-based Learning		
Hrs/wk	1		
CP			
Workload in Hours	dependent Study Time 46, Study Time in Lecture 14		
Lecturer	rof. Peter Fröhle		
Language	DE/EN		
Cycle	Cycle SoSe		
Content	See interlocking course		
Literature	See interlocking course		

Course L0295: Interaction Water -	Environment in Fluvial Areas
Тур	Problem-based Learning
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Peter Fröhle, Sandra Hellmers
Language	DE/EN
Cycle	SoSe
	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: Wastewate	er Systems			
Courses				
Title	Title		Hrs/wk	СР
Wastewater Systems - Collection, Treat	ment and Reuse (L0934)	Lecture	2	2
Wastewater Systems - Collection, Treat	· · · ·	Recitation Section (large)	1	1
Advanced Wastewater Treatment (L035		Lecture	2	2
Advanced Wastewater Treatment (L035		Recitation Section (large)	1	1
· · · · · · · · · · · · · · · · · · ·	Prof. Ralf Otterpohl			
Admission Requirements	None			
Recommended Previous	Knowledge of wastewater management and the key proce	sses involved in wastewater treatment.		
Knowledge				
Educational Objectives	After taking part successfully, students have reached the fo	ollowing learning results		
Professional Competence				
Knowledge	Students are able to outline key areas of the full range of	treatment systems in waste water managem	ent, as well as their	mutual dependence for
	sustainable water protection. They can describe relevant e	conomic, environmental and social factors.		
Skills	Students are able to pre-design and explain the available	wastewater treatment processes and the so	one of their applicat	ion in municinal and for
OKIIIS	Skills Students are able to pre-design and explain the available wastewater treatment processes and the scope of their application in some industrial treatment plants.			
	some mederal realment plants.			
Personal Competence				
Social Competence				
Autonomy	Students are in a position to work on a subject and to orga	nize their work flow independently. They car	also present on this	subject.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Examination	Written exam			
Examination duration and scale	120 min			
Assignment for the Following	Civil Engineering: Specialisation Structural Engineering: E	Elective Compulsory		
Curricula	Civil Engineering: Specialisation Geotechnical Engineerin	g: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Ele	ctive Compulsory		
	Bioprocess Engineering: Specialisation A - General Biopro	ocess Engineering: Elective Compulsory		
	Energy and Environmental Engineering: Specialisation En	vironmental Engineering: Elective Compulse	ory	
	International Management and Engineering: Specialisation	n II. Energy and Environmental Engineering:	Elective Compulsor	у
	International Management and Engineering: Specialisation	n II. Process Engineering and Biotechnology	: Elective Compulso	ry
	Process Engineering: Specialisation Environmental Proce	ss Engineering: Elective Compulsory		
	Process Engineering: Specialisation Process Engineering: Elective Compulsory			
	Water and Environmental Engineering: Specialisation Wat	er: Compulsory		
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory			
	Water and Environmental Engineering: Specialisation Cities	es: Compulsory		

·	ourse L0934: Wastewater Systems - Collection, Treatment and Reuse				
Тур	octure				
Hrs/wk					
CP	2				
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28				
Lecturer	Prof. Ralf Otterpohl				
Language	EN				
Cycle	SoSe				
Content	•Understanding the global situation with water and wastewater				
	Regional planning and decentralised systems				
	*Overview on innovative approaches				
	•In depth knowledge on advanced wastewater treatment options for different situations, for end-of-pipe and reuse				
	Mathematical Modelling of Nitrogen Removal     Exercises with calculations and design				
Literature	Henze, Mogens:				
	Wastewater Treatment: Biological and Chemical Processes, Springer 2002, 430 pages				
	George Tchobanoglous, Franklin L. Burton, H. David Stensel:				
	Wastewater Engineering: Treatment and Reuse, Metcalf & Eddy				
	McGraw-Hill, 2004 - 1819 pages				



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

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



Course L0358: Advanced Wastewater Treatment		
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Dr. Joachim Behrendt	
Language	DE	
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 En	gineering - Water, Soil, Food and E	nergy		
Courses				
Title		Тур	Hrs/wk	СР
Ecological Town Design - Water, Energy	, Soil and Food Nexus (L1229)	Seminar	2	2
Water & Wastewater Systems in a Globa	al Context (L0939)	Lecture	2	4
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
Recommended Previous	Basic knowledge of the global situation with ris	sing poverty, soil degradation, migration to cities, lack	of water resources and	sanitation
Knowledge				
Educational Objectives	After taking part successfully, students have rea	ached the following learning results		
Professional Competence				
Knowledge	Students can describe the facets of the global	Il water situation. Students can judge the enormous	s potential of the impler	mentation of synergistic
	systems in Water, Soil, Food and Energy suppl	y.		
Skills	Students are able to design ecological settlements for different geographic and socio-economic conditions for the main climates around the world.			
Personal Competence				
Social Competence				
Autonomy	Students are in a position to work on a subject	and to organize their work flow independently. They	can also present on this	subject.
Workload in Hours	Independent Study Time 124, Study Time in Le	ecture 56		
Credit points	6			
Examination	Project			
Examination duration and scale	During the course of the semester, the student	s work towards mile stones. The work includes pres	entations and papers. D	Detailed information car
	be found at the beginning of the smester in the	StudIP course module handbook.		
Assignment for the Following	Bioprocess Engineering: Specialisation A - Ge	neral Bioprocess Engineering: Elective Compulsory		
Curricula	Chemical and Bioprocess Engineering: Specia	alisation General Process Engineering: Elective Com	pulsory	
	Environmental Engineering: Core qualification	: Elective Compulsory		
	Joint European Master in Environmental Studie	es - Cities and Sustainability: Core qualification: Cor	npulsory	
	Process Engineering: Specialisation Environm	ental Process Engineering: Elective Compulsory		
	Process Engineering: Specialisation Process E	Engineering: Elective Compulsory		
	Water and Environmental Engineering: Specia	lisation Water: Elective Compulsory		
	Water and Environmental Engineering: Specia	· · ·		
	Water and Environmental Engineering: Specia	lisation Cities: Elective Compulsory		

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



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



Module M0922: City Plann	ling			
Courses				
Title		Тур	Hrs/wk	CP
Prinicples of City Planning (L1066)		Problem-based Learning	2	3
Street Design (L1067)	T	Problem-based Learning	2	3
Module Responsible				
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 ur	ndergraduate class "	Transport Planning an
	Traffic Engineering"			
Educational Objectives	After taking part successfully, students have reached the following la	oarning roculto		
Professional Competence	After taking part successium, students have reached the following in	earning results		
Knowledge	Students are able to:			
Knowledge	Students are able to:			
	use technical terms of urban planning.			
	describe the main determinants of urban development.			
	<ul> <li>explain and compare different possibilities of how urban dev</li> </ul>	velopment can be influenced.		
	<ul> <li>discuss requirements for public streetscapes.</li> </ul>			
	<ul> <li>explain the importance of street design.</li> </ul>			
Skills	Students are able to:			
	<ul> <li>read and analyze urban development concepts and designs</li> </ul>	s for streetscapes		
	appraise such concepts in the context of competing requirer	nents.		
	<ul> <li>design, justify and reflect their own solutions for concrete ex-</li> </ul>	amples.		
Personal Competence				
Social Competence	Students are able to:			
	discuss intermediate results with each other.			
	constructively accept feedback on their own work.			
	<ul> <li>provide constructive feedback to others.</li> </ul>			
Autonomy	Students are able to:			
	a independently complete a south-secretical distriction.	following a broadly are deferred		
	independently complete a written report including drawings     accept the consequences of their proposed solutions.	iollowing a proadly pre-defined pro	cess.	
	assess the consequences of their proposed solutions.      independently acquire knowledge and apply this to now issue.	ios or problem areas		
	independently acquire knowledge and apply this to new issu	aes of problem areas.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Examination Examination duration and scale	Project			
Assignment for the Following	Civil Engineering: Specialisation Structural Engineering: Elective C	ompulsory		
Curricula				
Guilledia	Civil Engineering: Specialisation Geolecumcal Engineering: Elective Cor			
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure at			
	Water and Environmental Engineering: Specialisation Water: Electi			
	Water and Environmental Engineering: Specialisation Environment			
	Water and Environmental Engineering: Specialisation Cities: Comp			



Course L1066: Prinicples of City P	Planning
Тур	Problem-based Learning
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
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:
I throaten	<ul> <li>legal framework,</li> <li>instruments and methods of planning,</li> <li>functional requirements,</li> <li>stakeholders and actors</li> <li>basic design requirements</li> <li>different planning levels and</li> <li>historical contexts.</li> </ul> The objective of the course is for students to acquire a basic understanding of urban development problems and approaches for solving them. They will also be able to comprehend the process of urban planning. The project work deals with a real life scenario and includes drawing up a development plan, an urban design concept as well as a building masterplan. Althors Cardy Wellah, Indian (2000) Started and planning in the project work deals with a planning and planning in the project work deals with a real life scenario and includes drawing up a development plan, an urban design concept as well as a building masterplan.
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.

Course L1067: Street Design	
ŭ	
	Problem-based Learning
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Carsten Gertz
Language	DE
Cycle	SoSe
Content	"Designing Urban Streetscapes" covers the various functional and aesthetic requirements for designing streetscape as the most important
	elements of public space. The class deals with:
	technical and design requirements,
	the effects of streetscapes on the behaviour of their users,      ""
	possible measures relating to changes in traffic development.
	For their applied project, students will be required to redesign the streetscape of an actual case study.
Literature	Forschungsgesellschaft für Straßen- und Verkehrswesen (2011) Empfehlungen zur Straßenraumgestaltung innerhalb bebauter Gebiete - ESG.
	FGSV-Verlag. Köln (FGSV, 230).
	Forschungsgesellschaft für Straßen- und Verkehrswesen (2007) Richtlinien für die Anlage von Stadtstraßen – RASt 06. FGSV-Verlag. Köln
	(FGSV, 200).



Courses				
litle		Тур	Hrs/wk	CP
Marine Geotechnics (L0548)		Lecture	1	2
Marine Geotechnics (L0549)  Numerical Methods in Geotechnics (L03	75)	Recitation Section (large) Lecture	3	3
Module Responsible	Prof. Jürgen Grabe	Ecotaro		-
Admission Requirements	none			
· · · · · · · · · · · · · · · · · · ·		1 10		
Recommended Previous	complete modules: Geotechnics I-II, 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 Le	ecture 70		
Credit points	6			
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the Following	Civil Engineering: Specialisation Geotechnical	Engineering: Compulsory		
Curricula	Civil Engineering: Specialisation Structural Eng	gineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engin	neering: Compulsory		
	Theoretical Mechanical Engineering: Specialis	ation Maritime Technology: Elective Compulsory		
	Theoretical Mechanical Engineering: Technical	l Complementary Course: Elective Compulsory		
	Water and Environmental Engineering: Specia	lisation Cities: Elective Compulsory		
	Water and Environmental Engineering: Specia	lisation Environment: Elective Compulsory		
	Water and Environmental Engineering: Specia	lisation Water: Elective Compulsory		

Course L0548: Marine Geotechnic	s
Тур	Lecture
Hrs/wk	1
CP	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	<ul> <li>EAK (2002): Empfehlungen für Küstenschutzbauwerke</li> <li>EAU (2004): Empfehlungen des Arbeitsausschusses Uferbauwerke</li> <li>Poulos H.G. (1988): Marine Geotechnics. Unwin Hyman, London</li> <li>Wagner P. (1990): Meerestechnik: Eine Einführung für Bauingenieure. Ernst &amp; Sohn, Berlin</li> </ul>

Course L0549: Marine Geotechnics	
Тур	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course



Course L0375: Numerical Methods in Geotechnics		
Тур	Lecture	
Hrs/wk	3	
CP	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Dr. Hans Mathäus Hügel	
Language	DE	
Cycle	SoSe	
Content	Topics:	
	<ul> <li>numerical simulations</li> <li>numerical algorithms</li> <li>finite element method</li> <li>application of finite element method in geomechanics</li> <li>constitutive models for soils</li> <li>contact models for soil structure interaction</li> <li>selected applications</li> </ul>	
Literature	<ul> <li>Wriggers P. (2001): Nichtlineare Finite-Elemente-Methoden, Springer Verlag, Berlin</li> <li>Bathe Klaus-Jürgen (2002): Finite-Elemente-Methoden. Springer Verlag, Berlin</li> </ul>	



Module M0620: Special As	spects of Waste Resource Manager	ment			
Courses					
Title		Тур		Hrs/wk	СР
Advanced Topics in Waste Resource M	anagement (L1055)	Problen	n-based Learning	3	3
International Waste Management (L0317	)	Problen	n-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 successfully, students have read	ched the following learning resu	Its		
Professional Competence					
Knowledge	The students are able to describe waste as a re	resource as well as advanced to	echnologies for recycl	ling and recovery of i	resources from waste i
	detail. This covers collection, transport, treatmen	nt and disposal in national and ir	ternational contexts.		
Skills	s 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	i enort of different technologies a	and management syst	ems.	
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 developme	nt of colleagues. Fur	thermore, they can give
	and accept professional constructive criticisms.				
A	Objects and in deep and authorizing additional loss		and the factor and the second		
Autonomy	Students can independently gain additional kno	iwiedge of the Subject area and a	apply it in solving the	giveri course tasks ar	ia projects.
Workload in Hours	Independent Study Time 110, Study Time in Lec	cture 70			
Credit points	6				
Examination	Project				
Examination duration and scale	PowerPoint presentation (10-15 minutes)				
Assignment for the Following	Environmental Engineering: Specialisation Was	te and Energy: Elective Compul	sory		
Curricula	Joint European Master in Environmental Studies	s - Cities and Sustainability: Spe	cialisation Energy: Ele	ective Compulsory	
	Water and Environmental Engineering: Specialis	sation Water: Elective Compulso	ory		
	Water and Environmental Engineering: Specialis	sation Environment: Elective Co	mpulsory		
	Water and Environmental Engineering: Specialis	sation Cities: Elective Compulso	ry		

Course L1055: Advanced Topics i	n Waste Resource Management
Тур	Problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Rüdiger Siechau
Language	EN
Cycle	WiSe
Content	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	e Management
Тур	Problem-based Learning
Hrs/wk	2
CP	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



Madula M0705 Occurred	A			
Module M0705: Groundwa	iter			
Courses				
Title		Тур	Hrs/wk	СР
Geohydraulic and Solute Transport (L0539)		Lecture	2	2
Geohydraulic and Solute Transport (L0540)		Recitation Section (small)	1	1
Simulation in Groundwater Hydrology (L	0541)	Lecture	1	1
Simulation in Groundwater Hydrology (L	0542)	Recitation Section (small)	2	2
Module Responsible	Prof. Wilfried Schneider			
Admission Requirements	None			
Recommended Previous	Ground water hydrology			
Knowledge	Hydromechanics			
	Tiyuromeenames			
Educational Objectives	After taking part successfully, students have reached the fol	lowing learning results		
Professional Competence	3,	3 3		
Knowledge	The students are able to describe the fate of solutes in the s	subsurface along the path between soil and	l water body quantit	atively and qualitatively
ranomoago	They are able to do this with simulation models.	accounted along the path settled to and	. water body quarter	aurory and quantaurory.
Skills	The students are able to describe conceptually movement	and storage of water in the unsaturated zo	one. They are able	to analyse pF- functions
	and Ku functions. They can model transport of solutes in the	•	•	
	coefficients, decay rates and dissolution rates for organic ar	·		
Personal Competence		-		
Social Competence	The students can help to each other.			
Autonomy	none			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Examination	Written exam			
Examination duration and scale	60 min written exam and written papers			
Assignment for the Following				
Curricula	Civil Engineering: Specialisation Geotechnical Engineering	: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Elec	tive Compulsory		
	Process Engineering: Specialisation Environmental Proces	s Engineering: Elective Compulsory		
	Process Engineering: Specialisation Process Engineering:	Elective Compulsory		
	Water and Environmental Engineering: Specialisation Water	r: Compulsory		
	Water and Environmental Engineering: Specialisation Envir	conment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Cities	s: Elective Compulsory		

Course L0539: Geohydraulic and Solute Transport		
Тур	Lecture	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Wilfried Schneider	
Language	DE	
Cycle	WiSe	
Content	Pump test analysis, water content-water suction functions, unsaturated hydraulic conductivity function, Brooks-Corey relation, van Genuchter	
	relation, solute transport in unsaturated zone, solute transport and reactions in groundwater	
Literature	Todd; K. (2005): Groundwater Hydrology	
	Fetter, C.W. (2001): Applied Hydrogeology	
	Hölting & Coldewey (2005): Hydrogeologie	
	Charbeneau, R.J. (2000): Groundwater Hydraulics and pollutant Transport	

Course L0540: Geohydraulic and Solute Transport		
Тур	Recitation Section (small)	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Wilfried Schneider	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	



Course L0541: Simulation in Groun	ndwater Hydrology
Тур	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Wilfried Schneider
Language	DE
Cycle	WiSe
Content	Basics and theoretical background of simulation models frequently used in science and practise for pumping test analysis, water movement in
	vadose zone, solute transport in vadose zone, groundwater recharge, solute transport in groundwater
Literature	Handbücher der verwendeten Slumationsmodelle werden bereitgestellt.

Course L0542: Simulation in Groun	ourse L0542: Simulation in Groundwater Hydrology	
Тур	Recitation Section (small)	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Wilfried Schneider	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	



Module M0619: Waste Tre	atment Technologies			
Courses				
Title		Тур	Hrs/wk	СР
Waste and Environmental Chemistry (L0	0328)	Laboratory Course	2	2
Biological Waste Treatment (L0318)		Problem-based Learning	3	4
Module Responsible	Prof. Kerstin Kuchta			
Admission Requirements	none			
Recommended Previous	chemical and biological basics			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	ne following learning results		
Professional Competence				
Knowledge	The module aims possess knowledge concerning the layout of anaerobic and aerobic waste treatment plant treatment plants and explain different methods for was	ts in detail, describe different techniques for		
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 from literaconsultation with supervisors as well as in the inte Furthermore, they can define targets for new application impact.	erim presentation, to assess their learning	level and define furth	er steps on this basis
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70	0		
Credit points				
Examination	Project			
Examination duration and scale	· ·	s), successful participation at Praktikum		
Assignment for the Following	Civil Engineering: Specialisation Structural Engineerin			
Curricula				
	Civil Engineering: Specialisation Coastal Engineering:	: Elective Compulsory		
	Energy and Environmental Engineering: Specialisation	• •	ulsory	
	Environmental Engineering: Core qualification: Compu		-	
	International Management and Engineering: Specialis	·	ing: Elective Compulsor	y
	Joint European Master in Environmental Studies - Citie	• • • • • • • • • • • • • • • • • • • •		-
	Water and Environmental Engineering: Specialisation	, ,	,	
	Water and Environmental Engineering: Specialisation			
1		• •		



Course L0328: Waste and Environ	mental Chemistry
Тур	Laboratory 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 To	ourse L0318: Biological Waste Treatment	
Тур	Problem-based Learning	
Hrs/wk	3	
CP	4	
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42	
Lecturer	Prof. Kerstin Kuchta	
Language	EN	
Cycle	WiSe	
Content	<ol> <li>Introduction</li> <li>biological basics</li> <li>determination process specific material characterization</li> <li>aerobic degradation (Composting, stabilization)</li> <li>anaerobic degradation (Biogas production, fermentation)</li> <li>Technical layout and process design</li> <li>Flue gas treatment</li> <li>Plant design practical phase</li> </ol>	
Literature		



Module M0801: Water Res	sources and Supply			
wodule wood: water hes	sources and -Supply			
Courses				
Title		Тур	Hrs/wk	CP
Chemistry of Drinking Water Treatment	(1.0311)	Lecture	2	1
Chemistry of Drinking Water Treatment		Recitation Section (large)	1	2
Water Resource Management (L0402)	(	Lecture	2	2
Water Resource Management (L0403)		Recitation Section (small)	1	1
Module Responsible	Prof. Mathias Ernst			
Admission Requirements	None			
Recommended Previous	Knowledge of water management and the key processes invo	olved in water treatment.		
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follow	wing learning results		
Professional Competence				
Knowledge	Students will be able to outline key areas of conflict in water r	management, as well as their mutual depe	endence for sustain	able water supply. They
	will understand relevant economic, environmental and social	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 w	rater treatment processes and the scope o	f their application.	
Skills	Students will be able to assess complex problems in drinking	·	-	•
	measures. They will be able to assess the evaluation method			hemical calculations for
	selected treatment processes and apply generally accepted to	echnical rules and standards to these prod	cesses.	
Personal Competence				
Social Competence	Working in a diverse group of specialists, students will be ab	le to develop and document complex solu	itions for the manag	gement and treatment of
	drinking water. They will be able to take an appropriate profes	ssional position, for example representing	user interests. The	y will be able to develop
	joint solutions in teams of diverse experts and present these s	solutions to others.		
Autonomy	Students will be in a position to work on a subject independer	ntly and present on this subject.		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Examination	Written exam			
Examination duration and scale	60 min (chemistry) + presentation			
Assignment for the Following	Civil Engineering: Specialisation Structural Engineering: Elec	tive Compulsory		
Curricula	Civil Engineering: Specialisation Geotechnical Engineering: E	Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Electiv	ve Compulsory		
	Energy and Environmental Engineering: Specialisation Energ	gy and Environmental Engineering: Electiv	e Compulsory	
	International Management and Engineering: Specialisation II.	Energy and Environmental Engineering:	Elective Compulsor	у
	Water and Environmental Engineering: Specialisation Water:	Compulsory		
	Water and Environmental Engineering: Specialisation Environmental	nment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Cities:	Elective Compulsory		

Course L0311: Chemistry of Drink	ing 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 Drink	Course L0312: Chemistry of Drinking Water Treatment	
Тур	Recitation Section (large)	
Hrs/wk	1	
CP	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Dr. Klaus Johannsen	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0402: Water Resource M	anagement
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
	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	<ul> <li>Aktuelle UN World Water Development Reports</li> <li>Branchenbild der deutschen Wasserwirtschaft, VKU (2011)</li> <li>Aktuelle Artikel wissenschaftlicher Zeitschriften</li> <li>Ppt der Vorlesung</li> </ul>

Course L0403: Water Resource M	Course L0403: Water Resource Management	
Тур	Recitation Section (small)	
Hrs/wk	1	
CP	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 M0822: Process M	lodeling in Water Technology			
Courses				
Title		Тур	Hrs/wk	СР
Process Modelling of Wastewater Treati	ment (L0522)	Problem-based Learning	2	3
Process Modeling in Drinking Water Tre	atment (L0314)	Problem-based Learning	2	3
Module Responsible	Dr. Klaus Johannsen			
Admission Requirements	none			
Recommended Previous	Knowledge of the most important processes in drinking water as	nd waste water treatment.		
Knowledge				
Educational Objectives	After taking part successfully, students have reached the followi	ng learning results		
Professional Competence				
Knowledge	Students are able to explain selected processes of drinking warpossibilities and limitations of dynamic modeling.	ter and waste water treatment in detai	I. They are able to ex	xplain basics as well as
Skills	Students are able to use the most important features Modelica offers. They are able to transpose selected processes in drinking water and waste water treatment into a mathematical model in Modelica with respect to equilibrium, kinetics and mass balances. They are able to set up and apply models and assess their possibilities and limitations.			
Personal Competence				
Social Competence	Students are able to solve problems and document solutions appropriate feedback and can work constructively with feedback	•	echnical background	. They are able to give
Autonomy	Students are able to define a problem, gain the required knowledge and set up a model.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Examination	Written exam			
Examination duration and scale	1,5 hours			
Assignment for the Following	Environmental Engineering: Specialisation Water: Elective Compulsory			
Curricula	Joint European Master in Environmental Studies - Cities and Su	stainability: Specialisation Water: Elec	tive Compulsory	
	Water and Environmental Engineering: Specialisation Water: El	ective Compulsory		
	Water and Environmental Engineering: Specialisation Environm	nent: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Cities: El	ective Compulsory		



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



Course L0314: Process Modeling in	n Drinking Water Treatment
Тур	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
	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.
	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 M0802: Membrane	e Technology			
Courses				
Title		Тур	Hrs/wk	CP
Membrane Technology (L0399)		Lecture	2	3
Membrane Technology (L0400)		Recitation Section (small)	1	2
Membrane Technology (L0401)		Laboratory Course	1	1
Module Responsible	Prof. Mathias Ernst			
Admission Requirements	None			
Recommended Previous	Basic knowledge of water chemistry. Knowledge of the core pr	ocesses involved in water, gas and ste	am treatment	
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follow	ving learning results		
Professional Competence				
Knowledge	Students will be able to rank the technical applications of industrially important membrane processes. They will be able to explain the differer driving forces behind existing membrane separation processes. Students will be able to name materials used in membrane filtration and the advantages and disadvantages. Students will be able to explain the key differences in the use of membranes in water, other liquid media, gase and in liquid/gas mixtures.			
Skills	Students will be able to prepare mathematical equations for material transport in porous and solution-diffusion membranes and calculate ke parameters in the membrane separation process. They will be able to handle technical membrane processes using available boundary data and provide recommendations for the sequence of different treatment processes. Through their own experiments, students will be able to classify the separation efficiency, filtration characteristics and application of different membrane materials. Students will be able to characterise the formation of the fouling layer in different waters and apply technical measures to control this.			
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 grou on laboratory experiments to be undertaken jointly and present these to others.			
Autonomy	Students will be in a position to solve homework on the topic of membrane technology independently. They will be capable of finding creative solutions to technical questions.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the Following Curricula	Bioprocess Engineering: Specialisation A - General Bioprocess Bioprocess Engineering: Specialisation B - Industrial Bioproces Chemical and Bioprocess Engineering: Specialisation Chemic Chemical and Bioprocess Engineering: Specialisation General Energy and Environmental Engineering: Specialisation Energes Environmental Engineering: Specialisation Water: Elective Condoint European Master in Environmental Studies - Cities and Standard Environmental Process Engineering: Specialisation Environmental Process Engineering: Specialisation Process Engineering: Elective Condoint Environmental Engineering: Specialisation Water: Water and Environmental Engineering: Specialisation Environmental Engineering:	ass Engineering: Elective Compulsory and Process Engineering: Elective Compulsory and Process Engineering: Elective Compulsory and Environmental Engineering: Elective Compulsory	ulsory ctive Compulsory	



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

Course L0400: Membrane Techno	logy
Тур	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Course work	Students can voluntarily hand in solutions to exercises. They can gather extra points with the handed-in solutions. The students are given more
	detailed information at the beginning of the course.
Lecturer	Prof. Mathias Ernst
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L0401: Membrane Techno	ourse L0401: Membrane Technology		
Тур	Laboratory Course		
Hrs/wk	1		
CP	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Course work	Compulsory report: Students hand in a report about the carried out experiments.		
Lecturer	Prof. Mathias Ernst		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		



Module M0847: Analytical	Methods and Treatment Technologies for V	Vastewaters		
Courses				
Title		Тур	Hrs/wk	СР
Low-Cost Procedures for Water and Wa	stewater Analysis (L0505)	Lecture	2	3
Physico-Chemical Water Treatment (L04	482)	Lecture	2	3
Module Responsible	NN			
Admission Requirements	none			
Recommended Previous	Fundamental knowledge in chemistry and physics (knowledge)	dge acquired at school)		
Knowledge				
Educational Objectives	After taking part successfully, students have reached the fol	lowing learning results		
Professional Competence				
Knowledge	The students know some non-biological processes for the tr	reatment of water and wastewater as v	well as the fundamentals of	mass transfer which is
	essential for many treatment processes. They have knowled	dge about analytical procedures whic	h can be applied even with	out the availability of a
	laboratory and which are useful for evaluating the performa	ance of (waste)water treatment proces	sses and the assessment o	f surface water quality
	in an economically feasible way.			
Skills	The students are able to select suitable processes for the	treatment of wastewaters with respec	ect to their characteristics.	They can evaluate the
	efforts and costs for analytical procedures for the characterize	zation of waters/wastewaters and sele	ect economically feasible an	alytical procedures.
Personal Competence				
Social Competence	The students have the competence to plan and to perfo	rm wastewater analyses together wi	th colleagues in small gro	ups and to efficiently
	distribute the respective tasks within the group.			
Autonomy	The students are capable to make their own decisions with	n respect to the selection of suitable	water/wastewater treatment	processes as well as
	economically feasible analytical procedures for water/waste	water characterization.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Examination	Oral exam			
Examination duration and scale	30 min			
Assignment for the Following	Bioprocess Engineering: Specialisation A - General Bioproc	cess Engineering: Elective Compulsor	ry	
Curricula	Energy and Environmental Engineering: Specialisation Energy and Environmental Engineering: Elective Compulsory			
	Environmental Engineering: Specialisation Water: Elective	Compulsory		
	Joint European Master in Environmental Studies - Cities and	d Sustainability: Specialisation Water	: Elective Compulsory	
	Process Engineering: Specialisation Environmental Proces	s Engineering: Elective Compulsory		
	Process Engineering: Specialisation Process Engineering:	Elective Compulsory		
	Water and Environmental Engineering: Specialisation Water	r: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Envir	conment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Cities	s: Elective Compulsory		



Course L0505: Low-Cost Procedu	res for Water and Wastewater Analysis
Тур	Lecture
Hrs/wk	2
CP Workload in Hours	
Workload in Hours Lecturer	Independent Study Time 62, Study Time in Lecture 28  NN
Language	EN
Cycle	
Content	1 Introduction
	2 Costing of wastewater and water analyses
	3 Parameters routinely measured in municipal wastewater effluents
	4 Surrogate parameters
	5 Field methods
	6 Basic laboratory instruments and equipment
	6.1 Balances
	6.2 Volumetric dosing instruments
	6.3 Photometer
	6.3.1 General
	6.3.2 Principle of photometry
	6.3.3 Elements of a photometer
	6.4 Deionised water supply
	6.5 Safety equipment
	7 Inorganic parameters
	7.1 Inorganic parameters by probes/electrodes
	7.1.1 Dissolved oxygen
	7.1.1.1 Polarographic measurement of dissolved oxygen
	7.1.1.2 Optical probe for measuring dissolved oxygen utilising luminescence quenching of oxygen
	7.1.1.3 Titrimetric determination of dissolved oxygen
	7.1.2 pH
	7.1.3 Alkalinity
	7.1.4 Electric conductivity/salinity
	7.2 Nitrogen and phosphorus compounds (nutrients)
	7.2.1 Colorimetric methods without expensive instruments
	7.2.2 Reflectometric methods
	7.2.3 Photometric methods
	8 Particles in water and wastewater
	9 Organic sum parameters
	9.1 Overview
	9.2 Chemical Oxygen Demand: Why to avoid COD analyses by the dichromate method?
	9.3 TOC cuvette tests
	9.4 Absorption of UV light (254 nm) as a surrogate parameter for COD
	9.5 Volatile Solids as surrogate for COD
	9.6 Biological oxygen demand
	10 Microbiological parameters determined in a low-cost way
	11 Toxicity toward activated sludge
Literature	Skript auf StudIP



Course L0482: Physico-Chemical	Water Treatment
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	NN
Language	EN
Cycle	WiSe
Content	- Stripping
	- Evaporation
	- Wastewater Incineration
	- Wet Air Oxidation
	- Ozonation
	- Advanced Oxidation Processes
Literature	Dhysical Chamical Treatment of Weter and Westerveter A.D. Cinears C.A. Cinears CDC Press Resp. Date 2000.
Literature	Physical-Chemical Treatment of Water and Wastewater, A.P. Sincero, G.A. Sincero, CRC Press, Boca Raton 2003;
	Handbook of Separation Techniques for Chemical Engineers, P.A. Schweitzer, ed., McGraw-Hill, New York 1988
	Perry's Chemical Engineers' Handbook, R.H. Perry, D.W. Green, J.O. Maloney, eds., McGraw-Hill, New York 1984
	Chemical Engineering, Vol. 2, J.M. Coulson, J.F. Richardson, Pergamon Press, Oxford 1991
	Ozone in Water Treatment, B. Langlais, D.A. Reckhow, D.R. Brink, eds., Lewis Publishers, Chelsea 1991



Module M0864: Practical (	Course in Water and Wastewater Ted	chnology		
Courses				
Title		Тур	Hrs/wk	СР
Practical Course in Water and Wastewa	ter Technology I (L0503)	Laboratory Course	2	3
Practicle Course of Wastewater Techno	logy II (L0607)	Laboratory Course	3	3
Module Responsible	Dr. Dorothea Rechtenbach			
Admission Requirements	none			
Recommended Previous	Basic knowledge in chemistry and physics (know	rledge acquired at school)		
Knowledge				
Educational Objectives	After taking part successfully, students have reac	hed the following learning results		
Professional Competence				
Knowledge	The students know basic analytical procedures	for evaluating the quality of water and wastewater	er. They have knowle	edge about fundamenta
	process engineering features of important water and wastewater treatment technologies.			
Skills	The students are able to understand and to pract	ctically apply methodologies for wastewater analys	sis as well as descripti	ions of experiments and
	experimental setups in wastewater technology.			
Personal Competence				
Social Competence				
Autonomy	The students are able to conduct experiments fol	lowing written procedures without external assistan	ce.	
Workload in Hours	Independent Study Time 110, Study Time in Lect	ure 70		
Credit points	6			
Examination	Written elaboration			
Examination duration and scale	ca. 5 Stunden			
Assignment for the Following	Water and Environmental Engineering: Specialis	ation Water: Elective Compulsory		
Curricula	Water and Environmental Engineering: Specialis	ation Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialis	ation Cities: Elective Compulsory		

Course L0503: Practical Course in	n Water and Wastewater Technology I
Тур	Laboratory Course
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Dorothea Rechtenbach
Language	DE/EN
Cycle	WiSe
Content	- Impact of pretreatment of wastewater samples on analytical results
	- Analysis of nutrients in wastewater samples (different methods for nitrate analysis)
	- Alkalinity
	- TOC, COD
	- microscopic analysis of microorganisms relevant in wastewater treatment
Literature	Skript auf StudIP

Course L0607: Practicle Course of Wastewater Technology II		
Тур	Laboratory Course	
Hrs/wk	3	
CP	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Dr. Joachim Behrendt	
Language	DE/EN	
Cycle	WiSe	
Content	Experiments:	
	Oxygen transfer	
	Oxygen Uptake rate	
	Sludge dewatering	
	Tracer	
	Flocculation	
Literature	Skript/Script	



Module M0923: Integrated	Transportation Planning			
Courses				
Title	Тур		Hrs/wk	СР
Integrated Transportation Planning (L106	Problem-ba	ased 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	s "Transport Plannin	g and Traffic Engine	erin
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge	Students are able to:			
	a describe interdence dencine behave a lend use //esotion above and transport	utatian/mahilitubaha	, dans	
	<ul> <li>describe interdependencies between land-use/location choice and transpo</li> <li>explain and evaluate the social, ecological and economic effects of transpo</li> </ul>			
	relate current issues in the area of integrated transport planning and formula			
	Telate current issues in the area of megrated transport planning and formula	ate an opinion on the	5111.	
Skille	Students are able to:			
Ciuno	Statement and able to.			
	<ul> <li>quantify important parameters, which influence travel demand or are influen</li> </ul>	nced by it.		
	<ul> <li>comprehensively examine a pre-defined or self-selected topic from a tra</li> </ul>	ansportation studies	perspective and d	locument the results
	accordance with scientific conventions.			
Personal Competence				
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	essary knowledge ar	nd use appropriate n	neans for its execution.
	11. 1.00.17. 404.0.17. 1.1.			
Credit points  Examination	6 Written elaboration			
Examination duration and scale	willen eigborghon			
Assignment for the Following	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory			
Assignment for the Following  Curricula	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory  Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Geolectifical Engineering: Elective Compulsory			
Ouricula				
Garricula		ctive Compulsory		
diricula	Logistics, Infrastructure and Mobility: Specialisation Infrastructure and Mobility: Elec			
Guinedia				



Course L1068: Integrated Transportation Planning		
Тур	Problem-based Learning	
Hrs/wk	4	
CP	6	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	
Lecturer	Prof. Carsten Gertz, Dr. Philine Gaffron, Jacqueline Bianca Maaß	
Language	DE	
Cycle	WiSe	
	The course will provide students with an understanding of interdependencies between land-use and transportation. Specific topics include a.o.:  • interactions between transport and the environment and consequent limitations  • characteristics of integrated planning  • complex planning processes  • interdependencies of location choice and mobility behaviour  • transport and land-use policies  • project on current issues in transportation studies	
Literature	Kutter, Eckhard (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 Dev	elopment and Resources Oriented Sanitatio	n for different Climate Zor	nes	
Courses				
Title		Тур	Hrs/wk	СР
Rural Development and Resources Orie	ented Sanitation for different Climate Zones (L0942)	Seminar	2	3
Rural Development and Resources Orie	ented 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, s	soil degradation, lack of water resour	rces and sanitation	
Knowledge	0 0 0	,		
Educational Objectives	After taking part successfully, students have reached the foll	owing learning results		
Professional Competence	, , , , , , , , , , , , , , , , , , ,			
Knowledge	Students can describe resources oriented wastewater sys	stems mainly based on source cor	ntrol in detail. They can co	mment on techniques
rinowicago	designed for reuse of water, nutrients and soil conditioners.	some manny based on source con	nioi in dotaii. They can co	milent on teeningues
	accignous or reason or mater, national and conscious contains in con-			
	Students are able to discuss a wide range of proven approa	ches in Rural Development from and	d for many regions of the wor	ld.
Skille	Students are able to design low-tech/low-cost sanitation, ru	iral water supply rainwater harvest	ing evetame massures for th	ne rehabilitation of ton
Skills	soil quality combined with food and water security. Studen			
	developed by Allan Savory.	ins can consult on the basics of sc	in bullaring throught Hollsite	Flatilied Grazing as
	developed by Alian Savory.			
Personal Competence				
Social Competence				
Autonomy	Students are in a position to work on a subject and to organi	ze their work flow independently. Th	ey can also present on this s	subject.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Examination	Project			
Examination duration and scale	During the course of the semester, the students work towar	ds mile stones. The work includes p	resentations and papers. De	etailed information will
	be provided at the beginning of the smester.			
Assignment for the Following	Bioprocess Engineering: Specialisation A - General Bioproc	ess Engineering: Elective Compulso	orv	
Curricula	Chemical and Bioprocess Engineering: Specialisation Gene		•	
	Energy and Environmental Engineering: Specialisation Ene	• •		
	Environmental Engineering: Specialisation Water: Elective (	• •	, ,	
	International Management and Engineering: Specialisation		eering: Elective Compulsorv	
	Joint European Master in Environmental Studies - Cities and	•		
	Process Engineering: Specialisation Environmental Process	, ,		
	Process Engineering: Specialisation Process Engineering: I			
	Water and Environmental Engineering: Specialisation Water			
	Water and Environmental Engineering: Specialisation			
	Water and Environmental Engineering: Specialisation Cities			
	2 2 2 2ginooning. opoolanoation Otilos			

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



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



Module M0950: Study Wo	rk Environment
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
Examination	Project (accord. to Subject Specific Regulations)
Examination duration and scale	
Assignment for the Following Curricula	Water and Environmental Engineering: Specialisation Environment: Compulsory



## **Specialization Water**

Typ Hrs/wk CP  ormation-Systems in Water Management and Hydraulic Engineering (L0963)  rotection and Wastewater Management (L0226)  rotection and Wastewater Management (L0227)  Recitation Section (large)  Recitation Requirements  Admission Requirements  Typ Hrs/wk CP  Seminar  2 2 2  2  4  Module Responsible  Prof. Peter Fröhle  Admission Requirements  none	Module M0581: Water Pro
Typ Hrs/wk CP  ormation-Systems in Water Management and Hydraulic Engineering (L0963)  rotection and Wastewater Management (L0226)  rotection and Wastewater Management (L0227)  Recitation Section (large)  Recitation Requirements  Admission Requirements  Typ Hrs/wk CP  Seminar  2 2 2  2  4  Module Responsible  Prof. Peter Fröhle  Admission Requirements  none	
ormation-Systems in Water Management and Hydraulic Engineering (L0963) Problem-based Learning 2 2 2 rotection and Wastewater Management (L0226) Seminar 2 2 2 rotection and Wastewater Management (L0227) Recitation Section (large) 1 2 Module Responsible Prof. Peter Fröhle Admission Requirements none	Courses
rotection and Wastewater Management (L0226)  Seminar  2 2 2 rotection and Wastewater Management (L0227)  Recitation Section (large)  1 2  Module Responsible  Admission Requirements  none	Title
rotection and Wastewater Management (L0227)  Module Responsible Prof. Peter Fröhle  Admission Requirements none	Geo-Information-Systems in Water Mana
Module Responsible Prof. Peter Fröhle  Admission Requirements none	Water Protection and Wastewater Manage
Admission Requirements none	Water Protection and Wastewater Manage
	Module Responsible
	Admission Requirements
Recommended Previous	Recommended Previous
Basic knowledge in water management;	Knowledge
Good knowledge in urban drainage;	
Good knowledge of wastewater treatment techniques;	
<ul> <li>Good knowledge of pollutants (e.g. COD, BOD, TS, N, P) and their properties;</li> </ul>	
Educational Objectives After taking part successfully, students have reached the following learning results	Educational Objectives
Professional Competence	Professional Competence
Knowledge The students can describe the basic principles of the regulatory framework related to the international and European water sector. They can	Knowledge
explain limnological processes, substance cycles and water morphology in detail. Thereby they are able to assess complex water related	
problems. Finally, the students can demonstrate to achieve significant improvements in the full range of existing water quality problems. They are	
able to judge environmental and wastewater related issues and to widely consider innovative solutions, remediation measures and further	
interventions as well as conceptual problem solving approaches.	
Skills Students can accurately assess current problems and situations in a country-specific or local context. They can suggest concrete actions to	Skills
contribute to the planning of tomorrow's urban water cycle. Furthermore, they can suggest appropriate technical, administrative and legislative	
solutions to solve these problems.	
Personal Competence	Personal Competence
Social Competence The students can work together in international groups.	Social Competence
Autonomy Students are able to organize their work flow to prepare themselves before presentations and discussion. They can acquire appropriate	Autonomy
knowledge by making enquiries independently.	
Workload in Hours Independent Study Time 110, Study Time in Lecture 70	Workload in Hours
Credit points 6	Credit points
Examination Written exam	
nination duration and scale 60 min	Examination duration and scale
	Assignment for the Following
Curricula Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory	Curricula
Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory	
Environmental Engineering: Specialisation Water: Elective Compulsory	
International Management and Engineering: Specialisation II. Civil Engineering: Elective Compulsory	
Joint European Master in Environmental Studies - Cities and Sustainability: Specialisation Water: Elective Compulsory	
Water and Environmental Engineering: Specialisation Water: Compulsory	
Water and Environmental Engineering: Specialisation Environment: Compulsory	
Water and Environmental Engineering: Specialisation Cities: Elective Compulsory	



Course L0963: Geo-Information-Systems in Water Management and Hydraulic Engineering	
Тур	Problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Peter Fröhle
Language	DE/EN
Cycle	WiSe
Content	Theoretical basics of Geo-Information-Systems  Data models, geographical coordinates, geo-referencing, map-views Data mining and – analyses of geo-data Analysis techniques
Literature	None

Course L0226: Water Protection a	nd Wastewater Management
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	WiSe
	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 L0227: Water Protection and Wastewater Management		
Тур	ecitation Section (large)	
Hrs/wk		
CP	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Ralf Otterpohl	
Language	EN	
Cycle	WiSe	
	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.	



Module M0705: Groundwa	ater			
Courses				
Title		Тур	Hrs/wk	СР
Geohydraulic and Solute Transport (L05	539)	Lecture	2	2
Geohydraulic and Solute Transport (L05	540)	Recitation Section (small)	1	1
Simulation in Groundwater Hydrology (L	0541)	Lecture	1	1
Simulation in Groundwater Hydrology (L	0542)	Recitation Section (small)	2	2
Module Responsible	Prof. Wilfried Schneider			
Admission Requirements	None			
Recommended Previous	Ground water hydrology			
Knowledge	Hydromechanics			
	- Hydromoonamoo			
Educational Objectives	After taking part successfully, students have reached the fo	ollowing learning results		
Professional Competence				
Knowledge	The students are able to describe the fate of solutes in the subsurface along the path between soil and water body quantitatively and qualitatively.			
	They are able to do this with simulation models.		,	
Skills	The students are able to describe conceptually movement and storage of water in the unsaturated zone. They are able to analyse pF- function		to analyse pF- functions	
	and Ku functions. They can model transport of solutes in	the unsaturated and saturated zoned. They	are able to determine	ne dispersiities, sorption
	coefficients, decay rates and dissolution rates for organic and inorganic substances.			
Personal Competence				
Social Competence	The students can help to each other.			
Autonomy	none			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Examination	Written exam			
Examination duration and scale	60 min written exam and written papers			
Assignment for the Following	Civil Engineering: Specialisation Structural Engineering: E	Elective Compulsory		
Curricula	Civil Engineering: Specialisation Geotechnical Engineering	g: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Ele	ective Compulsory		
	Process Engineering: Specialisation Environmental Proce	ss Engineering: Elective Compulsory		
	Process Engineering: Specialisation Process Engineering	: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Wa	ter: Compulsory		
	Water and Environmental Engineering: Specialisation Env	rironment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Citi	es: Elective Compulsory		

Course L0539: Geohydraulic and S	Solute Transport
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Wilfried Schneider
Language	DE
Cycle	WiSe
Content	Pump test analysis, water content-water suction functions, unsaturated hydraulic conductivity function, Brooks-Corey relation, van Genuchten
	relation, solute transport in unsaturated zone, solute transport and reactions in groundwater
Literature	Todd; K. (2005): Groundwater Hydrology
	Fetter, C.W. (2001): Applied Hydrogeology
	Hölting & Coldewey (2005): Hydrogeologie
	Charbeneau, R.J. (2000): Groundwater Hydraulics and pollutant Transport

Course L0540: Geohydraulic and Solute Transport	
Тур	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Wilfried Schneider
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course



Course L0541: Simulation in Groundwater Hydrology		
Тур	Lecture	
Hrs/wk	1	
CP	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Prof. Wilfried Schneider	
Language	DE	
Cycle	WiSe	
Content	Basics and theoretical background of simulation models frequently used in science and practise for pumping test analysis, water movement in	
	vadose zone, solute transport in vadose zone, groundwater recharge, solute transport in groundwater	
Literature	Handbücher der verwendeten Slumationsmodelle werden bereitgestellt.	

Course L0542: Simulation in Groun	Course L0542: Simulation in Groundwater Hydrology	
Тур	Recitation Section (small)	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Wilfried Schneider	
Language	DE	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	



Module M0801: Water Res	ources and -Supply			
_				
Courses				
Title		Тур	Hrs/wk	CP
Chemistry of Drinking Water Treatment		Lecture	2	1
Chemistry of Drinking Water Treatment	(L0312)	Recitation Section (large)	1	2
Water Resource Management (L0402)		Lecture	2	2
Water Resource Management (L0403)		Recitation Section (small)	1	1
Module Responsible	Prof. Mathias Ernst			
Admission Requirements	None			
Recommended Previous	Knowledge of water management and the key processes involved in	water treatment.		
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following lea	rning results		
Professional Competence				
Knowledge	Students will be able to outline key areas of conflict in water manage	ment, as well as their mutual depe	endence for sustaina	able water supply. They
	will understand relevant economic, environmental and social factors	. Students will be able to explain	and outline the orga	anisational structures of
	water companies. They will be able to explain the available water trea	atment processes and the scope of	f their application.	
Skills	Students will be able to assess complex problems in drinking water p	roduction and establish solutions	involving water mar	nagement and technical
	measures. They will be able to assess the evaluation methods that ca		-	-
	selected treatment processes and apply generally accepted technica	rules and standards to these prod	cesses.	
Personal Competence				
Social Competence	Working in a diverse group of specialists, students will be able to de-	elop and document complex solu	itions for the manag	ement 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 Lecture 84			
Credit points	6			
Examination	Written exam			
Examination duration and scale	60 min (chemistry) + presentation			
Assignment for the Following	Civil Engineering: Specialisation Structural Engineering: Elective Cor	npulsory		
Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective	Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Elective Comp	pulsory		
	Energy and Environmental Engineering: Specialisation Energy and E	nvironmental Engineering: Electiv	e Compulsory	
	International Management and Engineering: Specialisation II. Energy	and Environmental Engineering:	Elective Compulsor	у
	Water and Environmental Engineering: Specialisation Water: Compu	sory		
	Water and Environmental Engineering: Specialisation Environment: E	Elective Compulsory		
	Water and Environmental Engineering: Specialisation Cities: Elective	Compulsory		
	- • •	-		

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



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

Course L0402: Water Resource M	anagement
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
	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	<ul> <li>Aktuelle UN World Water Development Reports</li> <li>Branchenbild der deutschen Wasserwirtschaft, VKU (2011)</li> <li>Aktuelle Artikel wissenschaftlicher Zeitschriften</li> <li>Ppt der Vorlesung</li> </ul>

Course L0403: Water Resource Management	
Тур	Recitation Section (small)
Hrs/wk	1
CP	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 M0513: System Aspects of Renewable Energies				
Courses				
Title		Тур	Hrs/wk	СР
	New Materials for Energy Production and Storage (L0021)	Lecture	2	2
Energy Trading (L0019)		Lecture	1	1
Energy Trading (L0020)		Recitation Section (small)	1	1
Deep Geothermal Energy (L0025)		Lecture	2	2
Module Responsible	Prof. Martin Kaltschmitt			
Admission Requirements	none			
Recommended Previous	Module: Technical Thermodynamics I			
Knowledge	Module: Technical Thermodynamics II			
Educational Objectives	After taking part successfully, students have reached the follow	ing learning results		
Professional Competence				
Knowledge	Students are able to describe the processes in energy trading	g and the design of energy markets a	nd can critically eval	uate them in relation
	current subject specific problems. Furthermore, they are able to	explain the basics of thermodynamics	of electrochemical e	nergy conversion in f
	cells and can establish and explain the relationship to diffe	rent types of fuel cells and their respe	ective structure. Stud	dents can compare t
	technology with other energy storage options. In addition, stud	ents can give an overview of the proce	dure and the energe	etic involvement of de
	geothermal energy.			
0.111				
Skills	Students can apply the learned knowledge of storage systems	= -		
	ensure a secure energy supply. In particular, they can plan a			
	storage systems in an energy-efficient way and can assess the		ems. In this context, s	students can assess t
	potential and limits of geothermal power plants and explain the	ir operating mode.		
	Furthermore, the students are able to explain the procedures a	nd strategies for marketing of energy a	nd apply it in the con	text of other modules
	renewable energy projects. In this context they can unassisted	y carry out analysis and evaluations of	energie markets and	energy trades.
Personal Competence				
Social Competence	Students are able to discuss issues in the thematic fields in the	renewable energy sector addressed w	ithin the module.	
		, , , , , , , , , , , , , , , , , , ,		
Autonomy	Students can independently exploit sources, acquire the partic	ular knowledge about the subject area	and transform it to ne	ew questions.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Examination	Written exam			
Examination duration and scale	3 hours written exam			
Assignment for the Following	Bioprocess Engineering: Specialisation A - General Bioproces	s Engineering: Elective Compulsory		
Curricula	Energy and Environmental Engineering: Specialisation Energy	and Environmental Engineering: Elect	ive Compulsory	
	International Management and Engineering: Specialisation II. I	Renewable Energy: Elective Compulsor	ry	
	International Management and Engineering: Specialisation II. I	Energy and Environmental Engineering	: Elective Compulsor	ту
	International Management and Engineering: Specialisation II. I	Process Engineering and Biotechnology	y: Elective Compulso	ry
	Renewable Energies: Core qualification: Compulsory			
	Process Engineering: Specialisation Environmental Process E	ngineering: Elective Compulsory		
	Process Engineering: Specialisation Process Engineering: Ele	ctive Compulsory		
	Water and Environmental Engineering: Specialisation Water: E	lective Compulsory		
	Water and Environmental Engineering: Specialisation Environ	ment: Elective Compulsory		
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Course L0021: Fuel Cells, Batterie	es, and Gas Storage: New Materials for Energy Production and Storage
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Michael Fröba
Language	DE
Cycle	SoSe
Content	1. Introduction to electrochemical energy conversion 2. Function and structure of electrolyte 3. Low-temperature fuel cell     Types  Thermodynamics of the PEM fuel cell  Cooling and humidification strategy 4. High-temperature fuel cell  The MCFC  The SOFC  Integration Strategies and partial reforming 5. Fuels  Supply of fuel  Reforming of natural gas and biogas  Reforming of liquid hydrocarbons 6. Energetic Integration and control of fuel cell systems
Literature	Hamann, C.; Vielstich, W.: Elektrochemie 3. Aufl.; Weinheim: Wiley - VCH, 2003

Course L0019: Energy Trading	
Тур	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Michael Sagorje
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 Trading	Course L0020: Energy Trading	
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Michael Sagorje	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	



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



Module M0703: Soil and G	roundwater Contamination			
Courses				
Title		Тур	Hrs/wk	СР
Contamination and Remediation (L0547)		Project Seminar	3	3
NAPL in Soil and Groundwater (L0545)		Lecture	1	1
NAPL in Soil and Groundwater (L0546)		Recitation Section (small)	2	2
Module Responsible	Prof. Wilfried Schneider			
Admission Requirements	None			
Recommended Previous Knowledge	<ul> <li>Ground water hydrology</li> <li>Geohydraulic and solute transport</li> <li>Hydromechanics</li> </ul>			
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge	The students are able to analyse contamination in They are faminliar with Monitored Natural Attenua .	soils and groundwater. They are able to create rem tion	ediation concepts fo	r LNAPL contamnations.
Skills	The students are able to analyse contaminations in soils and groundwater using special engineering methods. They can do transport modelling in the unsaturated zone, estimations of groundwater pollution and analyse the impacts of remediation measures. They can forecast die distribution, mobility and remediation of non aquaous phase liquids in soil and groundwater.			
Personal Competence				
Social Competence	The students are able to prepare complex contam	ination issues in teamwork and are able to find reme	ediation measures.	
Autonomy	None			
Workload in Hours	Independent Study Time 96, Study Time in Lecture	e 84		
Credit points	6			
Examination	Written exam			
Examination duration and scale	Klausur 60 min; Referat 15 min;			
Assignment for the Following	Water and Environmental Engineering: Specialisa	ation Water: Elective Compulsory		
Curricula	Water and Environmental Engineering: Specialisa			
	Water and Environmental Engineering: Specialisa	ation Cities: Elective Compulsory		

Course L0547: Contamination and Remediation		
Тур	Project Seminar	
Hrs/wk	3	
CP	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Prof. Wilfried Schneider	
Language	DE	
Cycle	SoSe	
Content	Processing of a complex soil and groundwater contamination site. Students perform analyses of data to detect the contamination and to analyse	
	the groundwater hazard and to develop a concept for remediation of the damage.	
Literature	entfällt	

Course L0545: NAPL in Soil and G	roundwater
Тур	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Wilfried Schneider
Language	DE
Cycle	SoSe
Content	concept of capillarity, multi phase distribution in poraus media, residual saturation, rellative permeability, infiltration of NAPL into the subsurface,
	vertical distribution of LNAPL, specific volume
Literature	Charbeneau, R.J. (2000): Groundwater Hydraulics and pollutant Transport



Course L0546: NAPL in Soil and Groundwater	
Тур	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Wilfried Schneider
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course



Module M0827: Modeling i	n Water Management			
Courses				
Title		Тур	Hrs/wk	CP
Applied Groundwater Modeling (L0543)		Lecture	1 1 1 3 WK	1
Applied Groundwater Modeling (L0544)		Recitation Section (small)	2	2
Modeling of Water Supply and Sewer Ne	twork (L0875)	Problem-based Learning	2	3
Module Responsible	Prof. Wilfried Schneider			
Admission Requirements	none			
Recommended Previous	Groundwater			
Knowledge				
	<ul> <li>groundwater hydraulics and transport of subsections.</li> </ul>	ostances		
	Pipe Systems			
	. Kasuladas an urban uratar infrastrusturas i		nana austama inaludi	na anasial atmostumas
	<ul> <li>Knowledge on urban water intrastructures, i</li> <li>Hydraulics of drinking water supply systems</li> </ul>	n particular drinking water systemsand urban drai	nage systems includi	ng special structures
	Basic knowledge on water management	s and sewer systems		
	- Dasic knowledge on water management			
Educational Objectives	After taking part successfully, students have reache	ed the following learning results		
Professional Competence				
Knowledge	The students are able to describe the modelling	of groundwater flow and transport as well as urt	oan water infrastructu	ires. They can carry ou
	systems analyses and can detect technical and c	conceptual weak points within the systems in case	se studies. Besides t	hey are able to analys
	interdependencies of hydraulic and toxic phenome	na in soil and water.		
Skills	The students are able to construct and apply scientific groundwater models indipendently. They can work on different scenarios and can compare			
	or assess different solutions for existing problems	by application of selected software products. The	e students are able	to use different softwar
	solutions (e.g. EPANET, EPA-SWMM).			
Personal Competence				
	Wird nicht vermittelt.			
Coolai Compotence				
Autonomy	Wird nicht vermittelt.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture	e 70		
Credit points	6			
Examination	Oral exam			
Examination duration and scale	20 min			
Assignment for the Following	Civil Engineering: Specialisation Structural Engineer	ering: Elective Compulsory		
Curricula	Civil Engineering: Specialisation Geotechnical Engine			
Su. Ioulu	Civil Engineering: Specialisation Coastal Engineer			
	Water and Environmental Engineering: Specialisati	, ,		
	Water and Environmental Engineering: Specialisati			
	3 - 1	. ,		

Course L0543: Applied Groundwat	Course L0543: Applied Groundwater Modeling		
Тур	Lecture		
Hrs/wk	1		
CP	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Lecturer	Prof. Wilfried Schneider		
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: Applied Groundwater Modeling	
Тур	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Wilfried Schneider
Language	DE/EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0875: Modeling of Water Supply and Sewer Network		
Тур	Problem-based Learning	
Hrs/wk	2	
CP	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: Geochem	ical Engineering			
Module Moost. Geochem	ical Engineering			
Courses				
Title		Тур	Hrs/wk	СР
Contaminated Sites and Landfilling (L090	06)	Lecture	2	2
Contaminated Sites and Landfilling (L090	07)	Recitation Section (large)	1	2
Geochemical Engineering (L0904)		Lecture	2	2
Module Responsible	Dr. Joachim Gerth			
Admission Requirements	none			
Recommended Previous	Module: General and Inorganic Chemistry,			
Knowledge	Module:Organic Chemistry,			
	Biology (Basic Knowledge)			
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge	With the completion of this module students as	cquire profound knowledge of biogeochemical pro	ocesses, the fate o	f pollutants in soil and
	groundwater, and techniques to deposit contami	nated waste material. They are able to describe in	principle the behav	iour 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 a	pply the acquired theoretical knowledge to model ca	uses of site pollution	and critically assess the
Onno	'	ble to draw comparisons on different remediation str	·	•
	be devised and treated.	ble to draw companions on allierent remediation of	atogres and teering	des. Meder projects our
	be devised and realed.			
Personal Competence				
Social Competence	Students can discuss technical and scientific task	s within a seminar subject specific and interdisciplina	ary .	
Autonomy	Students can independently exploit sources, again	uire the particular knowledge of the subject and apply	vit to now problems	
Autonomy	Students can independently exploit sources , acqu	dire the particular knowledge of the subject and apply	y it to new problems.	
Workload in Hours	Independent Study Time 110, Study Time in Lectu	re 70		
Credit points	6			
Examination	Written exam			
Examination duration and scale	2 hours			
Assignment for the Following	Energy and Environmental Engineering: Specialis	eation Environmental Engineering: Elective Compuls	ory	
Curricula	Environmental Engineering: Core qualification: Ele	ective Compulsory		
	Water and Environmental Engineering: Specialisa	ation Water: Elective Compulsory		
	Water and Environmental Engineering: Specialisa	ation Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialisa	ation Cities: Elective Compulsory		

Course L0906: Contaminated Sites	s and Landfilling
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Joachim Gerth, Dr. Marco Ritzkowski
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. Joachim Gerth, Dr. Marco Ritzkowski	
Language	EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

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



Module M0870: Management of Surface Water				
Courses				
Title		Тур	Hrs/wk	СР
Modelling of Flow in Rivers and Estuaries (L0810)		Lecture	3	4
Nature-Oriented Hydraulic Engineering /	Integrated Flood Protection (L0961)	Problem-based Learning	2	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous	Fundamentals of Hydromechanics, Hydraulics, Hydrology and Hydraulic Engineering; Hydraulic Engineering I and Hydraulic Engineering II			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge	Students are able to define in detail the basic processes that are related to the modelling of flows in hydraulic engineering. Besides, they can			
	describe the basic aspects of numerical modelling and acti	ual numerical models for the simulation of	of flows and waves. T	hey can also depict the
	concepts of nature oriented hydraulic engineering.			
Skille	Students are able to apply hydrodynamic-numerical models	e to practical hydraulic angineering tasks	Furthermore the stu	dents are able to set un
OKIIIS	flood-risk management concepts and are able to apply basic			derits are able to set up
	nood not management concepts and are able to apply basis	o consepts of remataration to practical pro-	oromo.	
Personal Competence				
Social Competence	The students are able to deploy their gained knowledge in applied problems of the practical nature-based hydraulic engineering. Additionally, they			
	will be able to work in team with engineers of other discipline	es.		
Autonomy	The students will be able to independently extend their know	vledge and apply it to new problems.		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Examination	Written exam			
Examination duration and scale	The duration of the examination is 150 min. The examination	n includes tasks with respect to the gene	ral understanding of t	he lecture contents and
	calculations tasks.			
Assignment for the Following	Environmental Engineering: Core qualification: Elective Cor	npulsory		
Curricula	Joint European Master in Environmental Studies - Cities and Sustainability: Core qualification: Compulsory			
	Water and Environmental Engineering: Specialisation Water	r: Compulsory		
	Water and Environmental Engineering: Specialisation Environmental	onment: Compulsory		
	Water and Environmental Engineering: Specialisation Cities	: Elective Compulsory		

Course L0810: Modelling of 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	Prof. Peter Fröhle		
Language	DE/EN		
Cycle	SoSe		
Content	Basics of numerial models / application of models		
	classification of models		
	model concept		
	modelling		
	- modeling		
	1D Working Equation		
	Mathematical description of physical processes		
	Equation of motions		
	o conservation of mass		
	conservation of momentum		
	Initial conditions and boundary conditions		
	Numerical Methods		
	Time step procedure		
	• Finite differences		
	• Finite volumes		
Literature	Vorlesungsskript		



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



Module M0871: Hydrologi	cal Systems			
Courses				
Title		Тур	Hrs/wk	CP
Applied Surface Hydrology (L0289)		Lecture	2	2
Applied Surface Hydrology (L1412)		Problem-based Learning	1	2
Interaction Water - Environment in Fluvia	al Areas (L0295)	Problem-based Learning	1	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	none			
Recommended Previous	Fundamentals of Hydromechanics and Hydraulic Engi	neering: Hydraulic Engineering I and Hydraulic E	Ingineering II	
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	ne following learning results		
Professional Competence				
Knowledge	The students are able to define the basic concepts of	of hydrology and water management. They are	able to describe a	nd quantify the relevant
	processes of the hydrological water cycle. Besides, t	he students know the main aspects of rainfall-re	un-off-models and	are able to theoretically
	derive established reservoir / storage models and a un	it-hydrograph.		
Skills	The students are able to use the basic hydrological co	oncepts and approaches and are able to theoret	ically derive establi	shed reservoir / storage
	models or a unit-hydrograph as the basis for rainfal	I-run-off-models. The student are able to explain	in the basic concep	pts of measurements of
	hydrological and hydrodynamic values in nature and are able to perform, analyze and statistically assess these measurements. Furthermore, they			
	are able to apply a hydrological model to basic hydrological	ogical problems.		
Personal Competence				
Social Competence				
eesia. eempetemee	able to work in team with engineers of other disciplines.			
Autonomy	·			
Autonomy	The students will be able to independently extend their	Trilowiedge and apply it to new problems		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	6		
Credit points	6			
Examination	Written exam			
Examination duration and scale	The duration of the examination is 90 min. The exami	nation includes tasks with respect to the genera	I understanding of	the lecture contents and
	calculations tasks.			
Assignment for the Following	Environmental Engineering: Core qualification: Electiv	e Compulsory		
Curricula	Joint European Master in Environmental Studies - Citie	es and Sustainability: Core qualification: Compuls	sory	
	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 L0289: Applied Surface Hy	ydrology	
Тур	Lecture	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Peter Fröhle, Sandra Hellmers	
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 Hy	Course L1412: Applied Surface Hydrology	
Тур	Problem-based Learning	
Hrs/wk	1	
CP	2	
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14	
Lecturer	Prof. Peter Fröhle	
Language	DE/EN	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

Course L0295: Interaction Water -	Environment in Fluvial Areas
Тур	Problem-based Learning
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Peter Fröhle, Sandra Hellmers
Language	DE/EN
Cycle	SoSe
	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: Wastewate	er Systems			
Courses				
Title		Тур	Hrs/wk	СР
Wastewater Systems - Collection, Treat	ment and Reuse (L0934)	Lecture	2	2
Wastewater Systems - Collection, Treat	ment and Reuse (L0943)	Recitation Section (large)	1	1
Advanced Wastewater Treatment (L035	7)	Lecture	2	2
Advanced Wastewater Treatment (L035	8)	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 treatment.		
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follow	ing learning results		
Professional Competence				
Knowledge	Students are able to outline key areas of the full range of treat	ment systems in waste water management	ent, as well as their	mutual dependence for
	sustainable water protection. They can describe relevant econo	omic, environmental and social factors.		
Skills	Students are able to pre-design and explain the available was	stewater treatment processes and the sc	ope of their applicat	tion in municipal and for
	some industrial treatment plants.			
Personal Competence				
Social Competence				
Autonomy	Students are in a position to work on a subject and to organize	their work flow independently. They can	also present on this	s subject.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Examination	Written exam			
Examination duration and scale	120 min			
Assignment for the Following	Civil Engineering: Specialisation Structural Engineering: Electi	ve Compulsory		
Curricula	Civil Engineering: Specialisation Geotechnical Engineering: El	ective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Elective	Compulsory		
	Bioprocess Engineering: Specialisation A - General Bioproces	s Engineering: Elective Compulsory		
	Energy and Environmental Engineering: Specialisation Environmental	nmental Engineering: Elective Compulso	ory	
	International Management and Engineering: Specialisation II. I	Energy and Environmental Engineering:	Elective Compulsor	у
	International Management and Engineering: Specialisation II. I	Process Engineering and Biotechnology	: Elective Compulso	ry
	Process Engineering: Specialisation Environmental Process E	ngineering: Elective Compulsory		
	Process Engineering: Specialisation Process Engineering: Ele	ctive Compulsory		
	Water and Environmental Engineering: Specialisation Water: C	Compulsory		
	Water and Environmental Engineering: Specialisation Environi	ment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Cities: C	ompulsory		

ns - Collection, Treatment and Reuse
Lecture
2
2
Independent Study Time 32, Study Time in Lecture 28
Prof. Ralf Otterpohl
EN
SoSe SoSe
•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
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
I



Course L0943: Wastewater System	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 Wastew	ater Treatment
Тур	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Joachim Behrendt
Language	DE
Cycle	SoSe
Content	Survey on advanced wastewater treatment
	reuse of reclaimed municipal wastewater
	Precipitation
	Flocculation
	Depth filtration
	Membrane Processes
	Activated carbon adsorption
	Ozonation
	"Advanced Oxidation Processes"
	Disinfection
Literature	Metcalf & Eddy, Wastewater Engineering: Treatment and Reuse, McGraw-Hill, Boston 2003
	Wassertechnologie, H.H. Hahn, Springer-Verlag, Berlin 1987
	Membranverfahren: Grundlagen der Modul- und Anlagenauslegung, T. Melin und R. Rautenbach, Springer-Verlag, Berlin 2007
	Trinkwasserdesinfektion: Grundlagen, Verfahren, Anlagen, Geräte, Mikrobiologie, Chlorung, Ozonung, UV-Bestrahlung, Membranfiltration, Qualitätssicherung, W. Roeske, Oldenbourg-Verlag, München 2006
	Organische Problemstoffe in Abwässern, H. Gulyas, GFEU, Hamburg 2003



Course L0358: Advanced Wastew	ater Treatment
Тур	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Joachim Behrendt
Language	DE
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 Eng	gineering - Water, Soil, Food and Er	nergy		
Courses				
Title		Тур	Hrs/wk	СР
Ecological Town Design - Water, Energy	, Soil and Food Nexus (L1229)	Seminar	2	2
Water & Wastewater Systems in a Globa	al Context (L0939)	Lecture	2	4
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge of the global situation with rising poverty, soil degradation, migration to cities, lack of water resources and sanitation			
Educational Objectives	After taking part successfully, students have read	ched the following learning results		
Professional Competence				
Knowledge	Students can describe the facets of the global	water situation. Students can judge the enormous	s potential of the impler	nentation of synergistic
	systems in Water, Soil, Food and Energy supply.			
Skills	Students are able to design ecological settlements for different geographic and socio-economic conditions for the main climates around the world.			
Personal Competence				
Social Competence				
Autonomy	Students are in a position to work on a subject a	nd to organize their work flow independently. They	can also present on this	subject.
Workload in Hours	Independent Study Time 124, Study Time in Lec	ture 56		
Credit points	6			
Examination	Project			
Examination duration and scale	During the course of the semester, the students	work towards mile stones. The work includes pres	sentations and papers. D	etailed information can
	be found at the beginning of the smester in the S	studIP course module handbook.		
Assignment for the Following	Bioprocess Engineering: Specialisation A - Gene	eral Bioprocess Engineering: Elective Compulsory		
Curricula	Chemical and Bioprocess Engineering: Speciali	sation General Process Engineering: Elective Com	npulsory	
	Environmental Engineering: Core qualification:	Elective Compulsory		
	Joint European Master in Environmental Studies	s - Cities and Sustainability: Core qualification: Con	npulsory	
	Process Engineering: Specialisation Environme	ntal Process Engineering: Elective Compulsory		
	Process Engineering: Specialisation Process En	gineering: Elective Compulsory		
	Water and Environmental Engineering: Specialis	• •		
	Water and Environmental Engineering: Specialis			
	Water and Environmental Engineering: Specialis	sation Cities: Elective Compulsory		

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



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



ourses				
itle		Тур	Hrs/wk	СР
rinicples of City Planning (L1066)		Problem-based Learning	2	3
reet Design (L1067)		Problem-based Learning	2	3
Module Responsible	Prof. Carsten Gertz			
Admission Requirements	None			
Recommended Previous	for "Principles of Urban Planning": none			
Knowledge	for "Designing Urban Streetscapes": some knowledge o	f transport planning e.g. through taking the u	ndergraduate class	Transport Planning
	Traffic Engineering"	. Lanoport planning, olg. Linough taking the di	ido.g.ddddio oldoo	"Tanoport Taning
Educational Objectives	After teling part consectible at alente base reached the	fellousing leavaing yearste		
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence	Chudanta ava abla ta			
Knowledge	Students are able to:			
	<ul> <li>use technical terms of urban planning.</li> </ul>			
	<ul> <li>describe the main determinants of urban develop</li> </ul>	oment.		
	<ul> <li>explain and compare different possibilities of how</li> </ul>	v urban development can be influenced.		
	<ul> <li>discuss requirements for public streetscapes.</li> </ul>			
	<ul> <li>explain the importance of street design.</li> </ul>			
Skilla	Students are able to:			
SKIIIS	Students are able to:			
	<ul> <li>read and analyze urban development concepts a</li> </ul>	and designs for streetscapes		
	<ul> <li>appraise such concepts in the context of competing</li> </ul>	ng requirements.		
	<ul> <li>design, justify and reflect their own solutions for our design.</li> </ul>	oncrete examples.		
Personal Competence	Studente era able to:			
Social Competence	Students are able to:			
	• discuss intermediate results with each other.			
	<ul> <li>constructively accept feedback on their own work</li> </ul>			
	<ul> <li>provide constructive feedback to others.</li> </ul>			
Autonomy	Students are able to:			
	independently complete a written report including	g drawings following a broadly pre-defined pro	cess.	
	assess the consequences of their proposed solu			
	<ul> <li>independently acquire knowledge and apply this</li> </ul>	to new issues or problem areas.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Examination	Project			
Examination duration and scale				
Assignment for the Following	Civil Engineering: Specialisation Structural Engineering	Elective Compulsory		
Curricula	Civil Engineering: Specialisation Geotechnical Engineer	ing: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: E			
	Logistics, Infrastructure and Mobility: Specialisation Infra			
	Water and Environmental Engineering: Specialisation W			
	Water and Environmental Engineering: Specialisation E	nvironment: Elective Compulsory		



Course L1066: Prinicples of City F	Planning
Тур	Problem-based Learning
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
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:
Literature	<ul> <li>legal framework,</li> <li>instruments and methods of planning,</li> <li>functional requirements,</li> <li>stakeholders and actors</li> <li>basic design requirements</li> <li>different planning levels and</li> <li>historical contexts.</li> </ul> The objective of the course is for students to acquire a basic understanding of urban development problems and approaches for solving them. They will also be able to comprehend the process of urban planning. The project work deals with a real life scenario and includes drawing up a development plan, an urban design concept as well as a building masterplan. Alberts Cord: Welcal, Julian (2000) Startislanuas: Eign illustricts Eignführung Brimus Verlag, Darmetedt
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.

Course L1067: Street Design	
	Drahlam haad Lawing
	Problem-based Learning
Hrs/wk	
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Carsten Gertz
Language	DE
Cycle	SoSe
Content	"Designing Urban Streetscapes" covers the various functional and aesthetic requirements for designing streetscape as the most important
	elements of public space. The class deals with:
	technical and design requirements,
	the effects of streetscapes on the behaviour of their users,      the effects of streetscapes on the behaviour of their users,      the effects of streetscapes on the behaviour of their users,      the effects of streetscapes on the behaviour of their users,      the effects of streetscapes on the behaviour of their users,      the effects of streetscapes on the behaviour of their users,      the effects of streetscapes on the behaviour of their users,      the effects of streetscapes on the behaviour of their users,      the effects of streetscapes on the behaviour of their users,      the effects of streetscapes on the behaviour of their users,      the effects of streetscapes on the behaviour of their users,      the effects of streetscapes on the behaviour of their users,      the effects of streetscapes on the behaviour of their users,      the effects of streetscapes on the behaviour of their users,      the effects of streetscapes on the behaviour of their users,      the effects of streetscapes on the behaviour of their users,      the effects of the effect
	possible measures relating to changes in traffic development.
	For their applied project, students will be required to redesign the streetscape of an actual case study.
Literature	Forschungsgesellschaft für Straßen- und Verkehrswesen (2011) Empfehlungen zur Straßenraumgestaltung innerhalb bebauter Gebiete - ESG.
	FGSV-Verlag. Köln (FGSV, 230).
	Forschungsgesellschaft für Straßen- und Verkehrswesen (2007) Richtlinien für die Anlage von Stadtstraßen – RASt 06. FGSV-Verlag. Köln
	(FGSV, 200).



Module M0663: Marine Ge	otechnics and Numerics			
Courses				
Γitle		Тур	Hrs/wk	СР
Marine Geotechnics (L0548)		Lecture	1	2
Marine Geotechnics (L0549)		Recitation Section (large)	1	1
Numerical Methods in Geotechnics (L03	75)	Lecture	3	3
Module Responsible	Prof. Jürgen Grabe			
Admission Requirements	none			
Recommended Previous	complete modules: Geotechnics I-II, Mathematic	atics I-III		
Knowledge	courses: Soil laboratory course			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the Following	Civil Engineering: Specialisation Geotechnic	cal Engineering: Compulsory		
Curricula	Civil Engineering: Specialisation Structural E	Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering	gineering: Compulsory		
	Theoretical Mechanical Engineering: Specia	lisation Maritime Technology: Elective Compulsory		
	Theoretical Mechanical Engineering: Technic	cal Complementary Course: Elective Compulsory		
	Water and Environmental Engineering: Spec	cialisation Cities: Elective Compulsory		
	Water and Environmental Engineering: Spec	cialisation Environment: Elective Compulsory		
	Water and Environmental Engineering: Spec	cialisation Water: Elective Compulsory		

Course L0548: Marine Geotechnic	s
Тур	Lecture
Hrs/wk	1
CP	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 Collif erosion Sea dikes Port structures Flood protection structures
Literature	<ul> <li>EAK (2002): Empfehlungen für Küstenschutzbauwerke</li> <li>EAU (2004): Empfehlungen des Arbeitsausschusses Uferbauwerke</li> <li>Poulos H.G. (1988): Marine Geotechnics. Unwin Hyman, London</li> <li>Wagner P. (1990): Meerestechnik: Eine Einführung für Bauingenieure. Ernst &amp; Sohn, Berlin</li> </ul>

Course L0549: Marine Geotechnics	
Тур	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course



Course L0375: Numerical Methods in Geotechnics		
Тур	Lecture	
Hrs/wk	3	
CP	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Dr. Hans Mathäus Hügel	
Language	DE	
Cycle	SoSe	
Content	Topics:	
	<ul> <li>numerical simulations</li> <li>numerical algorithms</li> <li>finite element method</li> <li>application of finite element method in geomechanics</li> <li>constitutive models for soils</li> <li>contact models for soil structure interaction</li> <li>selected applications</li> </ul>	
Literature	<ul> <li>Wriggers P. (2001): Nichtlineare Finite-Elemente-Methoden, Springer Verlag, Berlin</li> <li>Bathe Klaus-Jürgen (2002): Finite-Elemente-Methoden. Springer Verlag, Berlin</li> </ul>	



Module M0620: Special As	spects of Waste Resource Managem	ent		
Courses				
Title		Тур	Hrs/wk	СР
Advanced Topics in Waste Resource M	anagement (L1055)	Problem-based Learning	3	3
International Waste Management (L0317	)	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 successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge	The students are able to describe waste as a resource as well as advanced technologies for recycling and recovery of resources from waste in			
	detail. This covers collection, transport, treatment	and disposal in national and international conte	xts.	
Skilla	Students are able to color quitable processes f	or the treatment with respect to the national of	er cultural and dayalan	montal contact. They con
Skills	Its 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.			
	evaluate the ecological impact and the technical e	more or unierent technologies and management	ayatema.	
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 fro	ont of others and promote the scientific develo	pment of colleagues. Fu	urthermore, they can give
	and accept professional constructive criticisms.			
Autonomy	Students can independently gain additional know	ledge of the subject area and apply it in solving	the given course tasks a	and projects.
Workload in Hours	Independent Study Time 110, Study Time in Lectu	re 70		
Credit points	6			
Examination	Project			
Examination duration and scale	PowerPoint presentation (10-15 minutes)			
Assignment for the Following	Environmental Engineering: Specialisation Waste	and Energy: Elective Compulsory		
Curricula	Joint European Master in Environmental Studies -	Cities and Sustainability: Specialisation Energy	y: Elective Compulsory	
	Water and Environmental Engineering: Specialisa	ation Water: Elective Compulsory		
	Water and Environmental Engineering: Specialisa	ation Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialisa	ation Cities: Elective Compulsory		

Course L1055: Advanced Topics i	n Waste Resource Management
Тур	Problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Rüdiger Siechau
Language	EN
Cycle	WiSe
Content	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	Problem-based Learning	
Hrs/wk	2	
CP	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: Membrane	e Technology			
Courses				
Title		Тур	Hrs/wk	СР
Membrane Technology (L0399)		Lecture	2	3
Membrane Technology (L0400)		Recitation Section (small)	1	2
Membrane Technology (L0401)		Laboratory Course	1	1
Module Responsible	Prof. Mathias Ernst			
Admission Requirements	None			
Recommended Previous	Basic knowledge of water chemistry. Knowledge of the core pr	ocesses involved in water, gas and stea	am treatment	
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follow	ing learning results		
Professional Competence				
Knowledge	Students will be able to rank the technical applications of industrially important membrane processes. They will be able to explain the difference driving forces behind existing membrane separation processes. Students will be able to name materials used in membrane filtration and the advantages and disadvantages. Students will be able to explain the key differences in the use of membranes in water, other liquid media, gase and in liquid/gas mixtures.			
Skills	Students will be able to prepare mathematical equations for material transport in porous and solution-diffusion membranes and calculate ke parameters in the membrane separation process. They will be able to handle technical membrane processes using available boundary data an provide recommendations for the sequence of different treatment processes. Through their own experiments, students will be able to classify th separation efficiency, filtration characteristics and application of different membrane materials. Students will be able to characterise the formatio of the fouling layer in different waters and apply technical measures to control this.			
Personal Competence				
Social Competence				
Autonomy	Students will be in a position to solve homework on the topic solutions to technical questions.	of membrane technology independer	ntly. They will be cap	pable of finding creati
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Examination	Written exam			
Examination duration and scale	90 min			
Assignment for the Following	Bioprocess Engineering: Specialisation A - General Bioproces	s Engineering: Elective Compulsory		
Curricula	Bioprocess Engineering: Specialisation B - Industrial Bioproce	ss Engineering: Elective Compulsory		
	Chemical and Bioprocess Engineering: Specialisation Chemic	al Process Engineering: Elective Comp	ulsory	
	Chemical and Bioprocess Engineering: Specialisation Genera	Process Engineering: Elective Compu	Isory	
	Energy and Environmental Engineering: Specialisation Energy	and Environmental Engineering: Elect	ive Compulsory	
	Environmental Engineering: Specialisation Water: Elective Co	mpulsory		
	Joint European Master in Environmental Studies - Cities and S	ustainability: Specialisation Water: Elec	ctive Compulsory	
	Process Engineering: Specialisation Environmental Process E	ngineering: Elective Compulsory		
	Process Engineering: Specialisation Process Engineering: Ele	ctive Compulsory		
	Water and Environmental Engineering: Specialisation Water: E	lective Compulsory		
	Water and Environmental Engineering: Specialisation Environ	ment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Cities: E	lective Compulsory		



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

Course L0400: Membrane Techno	logy
Тур	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Course work	Students can voluntarily hand in solutions to exercises. They can gather extra points with the handed-in solutions. The students are given more
	detailed information at the beginning of the course.
Lecturer	Prof. Mathias Ernst
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L0401: Membrane Techno	Course L0401: Membrane Technology		
Тур	Laboratory Course		
Hrs/wk	1		
CP	1		
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14		
Course work	Compulsory report: Students hand in a report about the carried out experiments.		
Lecturer	Prof. Mathias Ernst		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		



Module M0822: Process M	Modeling in Water Technology			
Courses				
Title		Тур	Hrs/wk	СР
Process Modelling of Wastewater Treate	ment (L0522)	Problem-based Learning	2	3
Process Modeling in Drinking Water Tre	atment (L0314)	Problem-based Learning	2	3
Module Responsible	Dr. Klaus Johannsen			
Admission Requirements	none			
Recommended Previous	Knowledge of the most important processes in drinking water	and waste water treatment.		
Knowledge				
Educational Objectives	After taking part successfully, students have reached the follo	wing learning results		
Professional Competence				
Knowledge	Students are able to explain selected processes of drinking water and waste water treatment in detail. They are able to explain basics as well as possibilities and limitations of dynamic modeling.			
Skills	Students are able to use the most important features Modelica offers. They are able to transpose selected processes in drinking water and waste water treatment into a mathematical model in Modelica with respect to equilibrium, kinetics and mass balances. They are able to set up and apply models and assess their possibilities and limitations.			
Personal Competence				
Social Competence	Students are able to solve problems and document solution appropriate feedback and can work constructively with feedback		echnical background	. They are able to give
Autonomy	Students are able to define a problem, gain the required knowledge and set up a model.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Examination	Written exam			
Examination duration and scale	1,5 hours			
Assignment for the Following	Environmental Engineering: Specialisation Water: Elective Co	ompulsory		
Curricula	Joint European Master in Environmental Studies - Cities and	Sustainability: Specialisation Water: Elec	tive Compulsory	
	Water and Environmental Engineering: Specialisation Water:	Elective Compulsory		
	Water and Environmental Engineering: Specialisation Enviro	nment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Cities:	Elective Compulsory		



Тур	Problem-based Learning
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Joachim Behrendt
Language	DE/EN
Cycle	WiSe
Content	Mass and energy balances
	Tours and all an
	Tracer modelling
	Activated Sludge Model
	Wastewater Treatment Plant Modelling (continously and SBR)
	wastewater frequirent i faitt woderling (continuously and SDT)
	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 Model
	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



Course L0314: Process Modeling i	in Drinking Water Treatment
Тур	Problem-based Learning
Hrs/wk	2
CP	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 M0847: Analytical	Methods and Treatment Technologies for W	/astewaters		
Courses				
Title		Тур	Hrs/wk	СР
Low-Cost Procedures for Water and Wa	stewater Analysis (L0505)	Lecture	2	3
Physico-Chemical Water Treatment (L0-	482)	Lecture	2	3
Module Responsible	NN			
Admission Requirements	none			
Recommended Previous	Fundamental knowledge in chemistry and physics (knowledge	ge acquired at school)		
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following	owing learning results		
Professional Competence		<u> </u>		
Knowledge	The students know some non-biological processes for the tree	eatment of water and wastewater as	well as the fundamentals of	mass transfer which is
	essential for many treatment processes. They have knowled	ge about analytical procedures which	ch can be applied even with	out the availability of a
	laboratory and which are useful for evaluating the performa	nce of (waste)water treatment proce	esses and the assessment of	surface water quality
	in an economically feasible way.			
Skills	The students are able to select suitable processes for the	treatment of wastewaters with respe	ect to their characteristics. T	hey can evaluate the
	efforts and costs for analytical procedures for the characteriz	ation of waters/wastewaters and sele	ect economically feasible an	alytical procedures.
Personal Competence				
Social Competence	The students have the competence to plan and to perform	m wastewater analyses together w	ith colleagues in small gro	ups and to efficiently
	distribute the respective tasks within the group.			
Autonomy	The students are capable to make their own decisions with	respect to the selection of suitable	water/wastewater treatment	processes as well as
	economically feasible analytical procedures for water/waster	water characterization.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Examination	Oral exam			
Examination duration and scale	30 min			
Assignment for the Following	Bioprocess Engineering: Specialisation A - General Bioproce	ess Engineering: Elective Compulso	ry	
Curricula	Energy and Environmental Engineering: Specialisation Energy	gy and Environmental Engineering:	Elective Compulsory	
	Environmental Engineering: Specialisation Water: Elective C	Compulsory		
	Joint European Master in Environmental Studies - Cities and	Sustainability: Specialisation Water	: Elective Compulsory	
	Process Engineering: Specialisation Environmental Process	Engineering: Elective Compulsory		
	Process Engineering: Specialisation Process Engineering: E	Elective Compulsory		
	Water and Environmental Engineering: Specialisation Water	: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Environmental	onment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Cities	: Elective Compulsory		



Course L0505: Low-Cost Procedu	res for Water and Wastewater Analysis
	Lecture
Hrs/wk	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	NN
Language	
Cycle	
	2 Costing of wastewater and water analyses
	3 Parameters routinely measured in municipal wastewater effluents
	4 Surrogate parameters
	5 Field methods
	6 Basic laboratory instruments and equipment
	6.1 Balances
	6.2 Volumetric dosing instruments
	6.3 Photometer
	6.3.1 General
	6.3.2 Principle of photometry
	6.3.3 Elements of a photometer
	6.4 Deionised water supply
	6.5 Safety equipment
	7 Inorganic parameters
	7.1 Inorganic parameters by probes/electrodes
	7.1.1 Dissolved oxygen
	7.1.1.1 Polarographic measurement of dissolved oxygen
	7.1.1.2 Optical probe for measuring dissolved oxygen utilising luminescence quenching of oxygen
	7.1.1.3 Titrimetric determination of dissolved oxygen
	7.1.2 pH
	7.1.3 Alkalinity
	7.1.4 Electric conductivity/salinity
	7.2 Nitrogen and phosphorus compounds (nutrients)
	7.2.1 Colorimetric methods without expensive instruments
	7.2.2 Reflectometric methods
	7.2.3 Photometric methods
	8 Particles in water and wastewater
	9 Organic sum parameters
	9.1 Overview
	9.2 Chemical Oxygen Demand: Why to avoid COD analyses by the dichromate method?
	9.3 TOC cuvette tests
	9.4 Absorption of UV light (254 nm) as a surrogate parameter for COD
	9.5 Volatile Solids as surrogate for COD
	9.6 Biological oxygen demand
	10 Microbiological parameters determined in a low-cost way
	11 Toxicity toward activated sludge
Literature	Skript auf StudIP



Course L0482: Physico-Chemical	Water Treatment
Тур	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	NN
Language	EN
Cycle	WiSe
Content	- Stripping
	- Evaporation
	- Wastewater Incineration
	- Wet Air Oxidation
	- Ozonation
	- Advanced Oxidation Processes
Literature	Physical-Chemical Treatment of Water and Wastewater, A.P. Sincero, G.A. Sincero, CRC Press, Boca Raton 2003;
Literature	Handbook of Separation Techniques for Chemical Engineers, P.A. Schweitzer, ed., McGraw-Hill, New York 1988
	Perry's Chemical Engineers' Handbook, R.H. Perry, D.W. Green, J.O. Maloney, eds., McGraw-Hill, New York 1984
	Chemical Engineering, Vol. 2, J.M. Coulson, J.F. Richardson, Pergamon Press, Oxford 1991
	Ozone in Water Treatment, B. Langlais, D.A. Reckhow, D.R. Brink, eds., Lewis Publishers, Chelsea 1991
	Ozone in mater realiment, b. Langiais, b.r. recidiow, b.r. binni, eds., Lewis i ubilsticis, Ottelsca 1991



Module M0864: Practical (	Course in Water and Wastewater Techno	ology		
Courses				
Title		Тур	Hrs/wk	СР
Practical Course in Water and Wastewa	ter Technology I (L0503)	Laboratory Course	2	3
Practicle Course of Wastewater Techno	ology II (L0607)	Laboratory Course	3	3
Module Responsible	Dr. Dorothea Rechtenbach			
Admission Requirements	none			
Recommended Previous	Basic knowledge in chemistry and physics (knowledge	e acquired at school)		
Knowledge				
Educational Objectives	After taking part successfully, students have reached t	he following learning results		
Professional Competence				
Knowledge	The students know basic analytical procedures for e	evaluating the quality of water and wastewate	er. They have knowle	dge about fundamental
	process engineering features of important water and v	vastewater treatment technologies.		
Skills	The students are able to understand and to practically apply methodologies for wastewater analysis as well as descriptions of experiments and			
	experimental setups in wastewater technology.			
Personal Competence				
Social Competence				
Autonomy	The students are able to conduct experiments following	g written procedures without external assistant	ce.	
Workload in Hours	Independent Study Time 110, Study Time in Lecture 7	0		
Credit points	6			
Examination	Written elaboration			
Examination duration and scale	ca. 5 Stunden			
Assignment for the Following	Water and Environmental Engineering: Specialisation	Water: Elective Compulsory		
Curricula	Water and Environmental Engineering: Specialisation	Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation	Cities: Elective Compulsory		

Course L0503: Practical Course in	Course L0503: Practical Course in Water and Wastewater Technology I		
Тур	Laboratory Course		
Hrs/wk	2		
CP	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Dr. Dorothea Rechtenbach		
Language	DE/EN		
Cycle	WiSe		
Content	- Impact of pretreatment of wastewater samples on analytical results		
	- Analysis of nutrients in wastewater samples (different methods for nitrate analysis)		
	- Alkalinity		
	TOC, COD		
	- microscopic analysis of microorganisms relevant in wastewater treatment		
Literature	Skript auf StudIP		

Course L0607: Practicle Course of Wastewater Technology II		
Тур	Laboratory Course	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Dr. Joachim Behrendt	
Language	DE/EN	
Cycle	WiSe	
Content	Experiments:	
	Oxygen transfer	
	Oxygen Uptake rate	
	Sludge dewatering	
	Tracer	
	Flocculation	
Literature	Skript/Script	



Module M0902: Wastewate	er Treatment and Air Pollution Abate	ement			
Courses					
Title		Тур	Hrs/wk	CP	
Biological Wastewater Treatment (L0517	")	Lecture	2	3	
Air Pollution Abatement (L0203)		Lecture	2	3	
Module Responsible	Dr. Ernst-Ulrich Hartge				
Admission Requirements	None				
Recommended Previous	Basic knowledge of biology and chemistry				
Knowledge		and an artist to task a law.			
	basic knowledge of solids process engineering a	and separation technology			
Educational Objectives	After taking part successfully, students have reac	ched the following learning results			
Professional Competence					
Knowledge	After successful completion of the module studer	nts are able to			
	<ul> <li>name and explain biological processes f</li> </ul>	for waste water treatment,			
	<ul> <li>characterize waste water and sewage slu</li> </ul>	udge			
	<ul> <li>discuss legal regulations in the area of er</li> </ul>	missions and air quality			
	<ul> <li>classify off gas tretament processes and t</li> </ul>	to define their area of application			
Skills	Students are able to				
	choose and design processs steps for the biological waste water treatment				
	combine processes for cleaning of off-gas	ses depending on the pollutants contained in the	gases		
Personal Competence					
Social Competence					
Autonomy	Index and deat Objet. Time 404 Objet. Time in Least	t 50			
Workload in Hours	Independent Study Time 124, Study Time in Lect	ture 56			
Credit points	6				
Examination	Written exam				
Examination duration and scale	90 min	18: 5 : 5 : 6 : 6 : 6			
Assignment for the Following		eral Bioprocess Engineering: Elective Compulsor			
Curricula		sation General Process Engineering: Elective Con			
	Environmental Engineering: Specialisation Wast	lisation Environmental Engineering: Elective Com	ipuis01y		
		te and Energy. Elective Compulsory ecialisation II. Energy and Environmental Enginee	ering: Elective Compulsor	v	
		s - Cities and Sustainability: Specialisation Water:	-	J	
	Renewable Energies: Specialisation Bioenergy	, ,	2.0070 Oompaloory		
	Process Engineering: Specialisation Environment	, ,			
	Process Engineering: Specialisation Process En				
	Water and Environmental Engineering: Specialis				
	Water and Environmental Engineering: Specialis	sation Environment: Compulsory			
	Water and Environmental Engineering: Specialis	sation Cities: Compulsory			

Course L0517: Biological Wastewater Treatment		
Тур	Lecture	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Course work	No compulsory course work.	
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

 $\textbf{Lange}, \textbf{J\"{o}rg} \ (\textbf{Otterpohl}, \, \textbf{Ralf}; \, \textbf{Steger-Hartmann}, \, \textbf{Thomas}; )$ 

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

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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

Weimar: Universitätsverl, 2006

TUB\_HH\_Katalog

Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall

DWA-Regelwerk
Hennef: DWA, 2004
TUB\_HH\_Katalog

 $\textbf{Wiesmann}, \textbf{Udo} \ (\textbf{Choi}, \textbf{In Su}; \textbf{Dombrowski}, \textbf{Eva-Maria};)$ 

Fundamentals of biological wastewater treatment

 $ISBN: 3527312196 \ (Gb.) \ URL: http://deposit.ddb.de/cgi-bin/dokserv?id=2774611\&prov=M\&dok\_var=1\&dok\_ext=htm. The proves the provesting of the provesting of the provesting that the provesting of the provesti$ 

Weinheim: WILEY-VCH, 2007

TUB\_HH\_Katalog



Course L0203: Air Pollution Abatement			
Тур	Lecture		
Hrs/wk	2		
CP	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Dr. Ernst-Ulrich Hartge		
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 M0923: Integrated	d Transportation Planning		
Courses			
Title	Тур	Hrs/wk	СР
Integrated Transportation Planning (L10	068) Problem-based Learning	4	6
Module Responsible	Prof. Carsten Gertz		
Admission Requirements	s None		
Recommended Previous	s some knowledge of transport planning, e.g. through taking the undergraduate class "Transport Pla	nning and Traffic Engine	erin
Knowledge			
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
Knowledge	e Students are able to:		
	describe interdependencies between land-use/location choice and transportation/mobility to the control of	ohaviour	
	explain and evaluate the social, ecological and economic effects of transport and land-use		
	relate current issues in the area of integrated transport planning and formulate an opinion of the control		
	outo constitues and an area of magnated statistics partially and formation an opinion of		
Skills	s 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 stu	idies perspective and d	ocument the results
	accordance with scientific conventions.		
Personal Competence			
Social Competence	e Students are able to:		
	<ul> <li>provide feedback on topical contents and their teaching.</li> </ul>		
	constructively handle feedback on their own work.		
	produce results in group work and document these.		
Autonomy	y Students are able to:		
	<ul> <li>assess potential consequences of their future professional activities</li> <li>independently plan working on a pre-defined project topic, acquire the necessary knowledge</li> </ul>	ua and was annuanciate m	anna far ita avanutian
	• independently plan working on a pre-defined project topic, acquire the necessary knowledge	ge and use appropriate it	leans for its execution
Workload in Hours	s Independent Study Time 124, Study Time in Lecture 56		
Credit points			
Examination			
Examination duration and scale			
Assignment for the Following	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory		
Curricula	a Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory		
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure and Mobility: Elective Compulsor	у	
	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	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	
	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 Dev	elopment and Resources Oriented Sanitat	ion for different Climate Zon	es	
Courses				
Title		Тур	Hrs/wk	СР
Rural Development and Resources Orie	ented Sanitation for different Climate Zones (L0942)	Seminar	2	3
Rural Development and Resources Orie	ented 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 resource	ces and sanitation	
Knowledge				
Educational Objectives	After taking part successfully, students have reached the for	ollowing learning results		
Professional Competence				
Knowledge	Students can describe resources oriented wastewater systems mainly based on source control in detail. They can comment on technique designed for reuse of water, nutrients and soil conditioners.  Students are able to discuss a wide range of proven approaches in Rural Development from and for many regions of the world.			omment on techniques
				orld.
Skills	Students are able to design low-tech/low-cost sanitation, rural water supply, rainwater harvesting systems, measures for the rehabilitation of top soil quality combined with food and water security. Students can consult on the basics of soil building through "Holisitc Planned Grazing" as developed by Allan Savory.			
Personal Competence				
Social Competence				
Autonomy	Students are in a position to work on a subject and to orga	nize their work flow independently. The	ey can also present on this	subject.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Examination	Project			
Examination duration and scale	During the course of the semester, the students work tow be provided at the beginning of the smester.	ards mile stones. The work includes pr	resentations and papers. [	Detailed information will
Assignment for the Following	Bioprocess Engineering: Specialisation A - General Biopro	ocess Engineering: Elective Compulsor	ry	
Curricula	Chemical and Bioprocess Engineering: Specialisation Ge			
	Energy and Environmental Engineering: Specialisation Er			
	Environmental Engineering: Specialisation Water: Elective Compulsory			
	International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory			
	Joint European Master in Environmental Studies - Cities and Sustainability: Specialisation Water: Elective Compulsory			
	Process Engineering: Specialisation Environmental Proce	ss Engineering: Elective Compulsory		
	Process Engineering: Specialisation Process Engineering	: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Wa	ter: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Env	rironment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Citi	es: Elective Compulsory		

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



Course L0941: Rural Development and Resources Oriented Sanitation for different Climate Zones		
Тур	Lecture	
Hrs/wk	2	
CP	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Prof. Ralf Otterpohl	
Language	EN	
Cycle	WiSe	
Content	<ul> <li>Living Soil - THE key element of Rural Development</li> <li>Participatory Approaches</li> <li>Rainwater Harvesting</li> <li>Ecological Sanitation Principles and practical examples</li> <li>Permaculture Principles of Rural Development</li> <li>Performance and Resilience of Organic Small Farms</li> <li>Going Further: The TUHH Toolbox for Rural Development</li> <li>EMAS Technologies, Low cost drinking water supply</li> </ul>	
Literature	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 M0948: Study Wo	rk 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			
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		
Examination	Project (accord. to Subject Specific Regulations)		
Examination duration and scale			
Assignment for the Following Curricula	Water and Environmental Engineering: Specialisation Water: Compulsory		



## **Thesis**

Module M-002: Master The	esis		
Courses			
Title	Typ Hrs/w	k	СР
Module Responsible	Professoren der TUHH		
Admission Requirements	According to General Regulations §24 (1):		
	At least 78 credit points have to be achieved in study programme. The examinations board decides on excep	tions.	
Recommended Previous			
Knowledge			
Educational Objectives			
Professional Competence			
Knowledge	The students can use specialized knowledge (facts, theories, and methods) of their subject competently on s	pecialize	d issues.
	The students can explain in depth the relevant approaches and terminologies in one or more areas of the	eir subje	ect, describing curren
	developments and taking up a critical position on them.		
	The students can place a research task in their subject area in its context and describe and critically assess t	he state (	of research.
Skills	The students are able:		
	To select, apply and, if necessary, develop further methods that are suitable for solving the specialized problem.  To select, apply leaves they have provided and methods they have been a suitable for solving the specialized problem.  To select, apply and, if necessary, develop further methods that are suitable for solving the specialized problem.		
	<ul> <li>To apply knowledge they have acquired and methods they have learnt in the course of their studies to defined problems in a solution-oriented way.</li> </ul>	comple	x and/or incompletely
	To develop new scientific findings in their subject area and subject them to a critical assessment.		
Davagnal Compotence			
Personal Competence Social Competence			
30ciai Competence	Sudens can		
	Both in writing and orally outline a scientific issue for an expert audience accurately, understandably and in a		
	Deal with issues competently in an expert discussion and answer them in a manner that is appropriate to the their years accompate and visualists acquireless.	e addres	sees while upholding
	their own assessments and viewpoints convincingly.		
Autonomy	Students are able:		
	<ul> <li>To structure a project of their own in work packages and to work them off accordingly.</li> <li>To work their way in depth into a largely unknown subject and to access the information required for them to</li> </ul>	do so	
	To apply the techniques of scientific work comprehensively in research of their own.	do 50.	
	Independent Study Time 900, Study Time in Lecture 0		
Credit points			
Examination  Examination duration and scale			
Assignment for the Following			
Curricula			
	Chemical and Bioprocess Engineering: Thesis: Compulsory		
	Computer Science: Thesis: Compulsory		
	Electrical Engineering: Thesis: Compulsory		
	Energy and Environmental Engineering: Thesis: Compulsory Energy Systems: Thesis: Compulsory		
	Environmental Engineering: Thesis: Compulsory		
	Aircraft Systems Engineering: Thesis: Compulsory		
	Global Innovation Management: Thesis: Compulsory		
	Computational Science and Engineering: Thesis: Compulsory		
	Information and Communication Systems: 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		
	Materials Science: Thesis: Compulsory		
	Mechanical Engineering and Management: Thesis: Compulsory		
	Mechatronics: Thesis: Compulsory		
	Biomedical Engineering: Thesis: Compulsory  Microelectronics and Microeyetems: 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		
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Ship and Offshore Technology: Thesis: Compulsory
Theoretical Mechanical Engineering: Thesis: Compulsory
Process Engineering: Thesis: Compulsory
Water and Environmental Engineering: Thesis: Compulsory