

Module Manual

Master of Science (M.Sc.)

Water and Environmental Engineering Dual study program

Cohort: Winter Term 2024

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Program description

Content

Master of Science in 'Water and Environmental Engineering'

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

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

In addition to the foundational curriculum taught at TUHH, seminars on developing personal skills are integrated into the dual study programme, in the context of transfer between theory and practice. These seminars correspond to the modern professional requirements expected of an engineer, as well as promoting the link between the two places of learning.

The intensive dual courses at TUHH integrating practical experience consist of an academic-oriented and a practice-oriented element, which are completed at two places of learning. The academic-oriented element comprises study at TUHH. The practice-oriented element is coordinated with the study programme in terms of content and time, and consists of practical modules and phases spent in an affiliate company during periods when there are no lectures.

Core Qualification

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

Courses

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

Module M1759: Linkir	ng theory and practice (dual study program, Master's degree)		
Module Responsible	Dr. Henning Haschke		
Admission Requirements	None		
Recommended Previous Knowledge	 Successful completion of practical modules as part of the dual Bachelor's course Module "interlinking theory and practice as part of the dual Master's course" 		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence			
Knowledge	Dual students		
	can describe and classify selected classic and current theories, concepts and methods		
	related to project management and		
	change and transformation management		
	and apply them to specific situations, processes and plans in a personal, professional context.		
Skills	Dual students		
	 anticipate typical difficulties, positive and negative effects, as well as success and failure factors in the engineer sector, evaluate them and consider promising strategies and courses of action. develop specialised technical and conceptual skills to solve complex tasks and problems in their professional fiel activity/work. 		
Personal Competence			
Social Competence	Dual students		
	 can responsibly lead interdisciplinary teams within the framework of complex tasks and problems. engage in sector-specific and cross-sectoral discussions with experts, stakeholders and staff, representing t approaches, points of view and work results. 		
Autonomy	Dual students		
	define, reflect and evaluate goals and measures for complex application-oriented projects and change processes.		
	shape their professional area of responsibility independently and sustainably.		
	take responsibility for their actions and for the results of their work.		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84		
Credit points	6		
Course achievement	None		
Examination	Written elaboration		
Examination duration and	Studienbegleitende und semesterübergreifende Dokumentation: Die Leistungspunkte für das Modul werden durch die Anfertig		
scale	eines digitalen Lern- und Entwicklungsberichtes (E-Portfolio) erworben. Dabei handelt es sich um eine fortlaufende Dokumenta		
	und Reflexion der Lernerfahrungen und der Kompetenzentwicklung im Bereich der Personalen Kompetenz.		

Course L2890: Responsible Project Management in Engineering (for Dual Study Program)			
Тур	Seminar		
Hrs/wk	3		
СР	3		
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42		
Lecturer	Dr. Henning Haschke, Heiko Sieben		
Language	DE		
Cycle	WiSe/SoSe		
Content	 Theories and methods of project management Innovation management Agile project management Fundamentals of classic and agile methods Hybrid use of classic and agile methods Roles, perspectives and stakeholders throughout the project Initiating and coordinating complex engineering projects Principles of moderation, team management, team leadership, conflict management Communication structures: in-house, cross-company Public information policy Promoting commitment and empowerment Sharing experience with specialists and managers from the engineering sector Documenting and reflecting on learning experiences 		
Literature	Seminarapparat		

Course L2891: Responsible	Change and Transformation Management in Engineering (for Dual Study Program)		
Тур	Seminar		
Hrs/wk	3		
СР	3		
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42		
Lecturer	Dr. Henning Haschke, Heiko Sieben		
Language	DE		
Cycle	WiSe/SoSe		
Content	 Basic concepts, opportunities and limits of organisational change Models and methods of organisational design and development Strategic orientation and change, and their short-, medium- and long-term consequences for individuals, organisations and society as a whole Roles, perspectives and stakeholders in change processes Initiating and coordinating change measures in engineering Phase models of organisational change (Lewin, Kotter, etc.) Change-oriented information policy and dealing with resistance and uncertainty Promoting commitment and empowerment Successfully handling change and transformation: personally, as an employee, as a manager (personal, professional, organisational) Company-level and globally (systemic) Sharing experience with specialists and managers from the engineering sector Documenting and reflecting on learning experiences 		
Literature	Seminarapparat		

	ical module 1 (dual study program, Master's degree)
Courses	
Title	Typ Hrs/wk CP
Practical term 1 (dual study progra	
Module Responsible	
Admission Requirements Recommended Previous	
Knowledge	 Successful completion of a compatible dual B.Sc. at TU Hamburg or comparable practical work experience and competence
	in the area of interlinking theory and practice
	Course D from the module on interlinking theory and practice as part of the dual Master's course
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Dual students
	• combine their knowledge of facts, principles, theories and methods gained from previous study content with acqui
	practical knowledge - in particular their knowledge of practical professional procedures and approaches, in the current fi
	of activity in engineering.
	have a critical understanding of the practical applications of their engineering subject.
Skills	Dual students
	• apply technical theoretical knowledge to complex, interdisciplinary problems within the company, and evaluate
	 apply technical theoretical knowledge to complex, interdisciplinary problems within the company, and evaluate associated work processes and results, taking into account different possible courses of action.
	 implement the university's application recommendations with regard to their current tasks.
	develop solutions as well as procedures and approaches in their field of activity and area of responsibility.
Personal Competence	
Social Competence	
Social competence	
	• work responsibly in project teams within their working area and proactively deal with problems within their team.
	 represent complex engineering viewpoints, facts, problems and solution approaches in discussions with internal external stakeholders.
Autonomy	Dual students
	define goals for their own learning and working processes as engineers.
	reflect on learning and work processes in their area of responsibility.
	• reflect on the relevance of subject modules specialisations and specialisation for work as an engineer, and a
	implement the university's application recommendations and the associated challenges to positively transfer knowled
	between theory and practice.
Workload in Hours	Independent Study Time 300, Study Time in Lecture 0
Credit points	10
Course achievement	None
Examination	Written elaboration
	Documentation accompanying studies and across semesters: Module credit points are earned by completing a digital learning a
scale	development report (e-portfolio). This documents and reflects individual learning experiences and skills development relating interlinking theory and practice, as well as professional practice. In addition, the partner company provides proof to
	dual@TUHH Coordination Office that the dual student has completed the practical phase.
Accient for the	
-	Civil Engineering: Core Qualification: Compulsory Bioprocess Engineering: Core Qualification: Compulsory
	Chemical and Bioprocess Engineering: Core Qualification: Compulsory
	Computer Science: Core Qualification: Compulsory
	Data Science: Core Qualification: Compulsory
	Electrical Engineering: Core Qualification: Compulsory
	Energy Systems: Core Qualification: Compulsory
	Environmental Engineering: Core Qualification: Compulsory Aircraft Systems Engineering: Core Qualification: Compulsory
	Computer Science in Engineering: Core Qualification: Compulsory
	Information and Communication Systems: Core Qualification: Compulsory
	International Management and Engineering: Core Qualification: Compulsory
	Logistics, Infrastructure and Mobility: Core Qualification: Compulsory
	Aeronautics: Core Qualification: Compulsory
	Materials Science and Engineering: Core Qualification: Compulsory
	Materials Science: Core Qualification: Compulsory Mechanical Engineering and Management: Core Qualification: Compulsory
	Mechanical Engineering and Management: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory
	Biomedical Engineering: Core Qualification: Compulsory
	Microelectronics and Microsystems: Core Qualification: Compulsory
	Product Development, Materials and Production: Core Qualification: Compulsory
	Renewable Energies: Core Qualification: Compulsory
	[0]

Naval Architecture and Ocean Engineering: Core Qualification: Compulsory
Theoretical Mechanical Engineering: Core Qualification: Compulsory
Process Engineering: Core Qualification: Compulsory
Water and Environmental Engineering: Core Qualification: Compulsory

Course L2887: Practical term	1 (dual study program, Master's degree)
Тур	
Hrs/wk	0
СР	10
Workload in Hours	Independent Study Time 300, Study Time in Lecture 0
Lecturer	Dr. Henning Haschke
Language	DE
Cycle	WiSe/SoSe
Content	Company onboarding process
	 Assigning a professional field of activity as an engineer (B.Sc.) and associated fields of work Establishing responsibilities and authorisation of the dual student within the company as an engineer (B.Sc.) Working independently in a team and on selected projects - across departments and, if applicable, across companies Scheduling the current practical module with a clear correlation to work structures Scheduling the examination phase/subsequent study semester Operational knowledge and skills Company-specific: Responsibility as an engineer (B.Sc.) in their own area of work, coordinating team and project work, dealing with complex contexts and unsolved problems, developing and implementing innovative solutions Subject specialisation (corresponding to the chosen course [M.Sc.]) in the field of activity Systemic skills Implementing the university's application recommendations (theory-practice transfer) in corresponding work and task areas across the company
Literature	Sharing/reflecting on learning Creating an e-portfolio Importance of course contents (M.Sc.) when working as an engineer Importance of development and innovation when working as an engineer
Literature	 Studierendenhandbuch Betriebliche Dokumente Hochschulseitige Handlungsempfehlungen zum Theorie-Praxis-Transfer

Engineering					
Module M1974: Envir	onmental microbiology an	d analytics			
-					
Courses					
Fitle			Тур	Hrs/wk	СР
Environmental Analysis (L0354) Environmental microbiology (L322:	3)		Lecture Lecture	2	3 3
	Dr. Dorothea Rechtenbach		Lecture	L	5
Admission Requirements					
•		emistry and biology (knowle	edge acquired at so	hool)	
Knowledge	Fundamentals of inorganic/organic chemistry and biology (knowledge acquired at school).				
Educational Objectives	After taking part successfully, student	ts have reached the followin	g learning results		
Professional Competence			5 5		
Knowledge	On completion of this module, students will be able to describe the mechanisms of biological systems. They will know the main biological metabolic routes and can categorise their influence on global metabolic routes. They will be familiar with the basis analytical methods for investigating and assessing the quality of various environmental compartments.				
Skills	 On completion of this module, students will be able to categorise which metabolism will predominate under which environmental conditions. Students will be able to apply the theoretical principles they have learnt to exemplary sites and assess the resulting relationship from a technical and conceptual perspective. They will be able to draw comparisons on different investigation strategies and techniques. Model projects can be devised and treated. 				
Personal Competence					
Social Competence	The students are able to organize wor	rking processes within a tea	m in a targeted wa	y and based on the divison	of labour.
Autonomy	Students can independently exploit sources, acquire the particular knowledge of the subject and apply it to new problems.				
Workload in Hours	Independent Study Time 124, Study T	ime in Lecture 56			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	90 min				
scale					
Assignment for the	Civil Engineering: Specialisation Wate	r and Traffic: Elective Comp	oulsory		
Following Curricula	Water and Environmental Engineering	g: Core Qualification: Compu	ilsory		

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

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

Module M2004: Susta	inable Circular Economy			
Courses				
Fitle		Тур	Hrs/wk	СР
Circular Economy (L3264)	21.0)	Seminar	2	3
Environment and Sustainability (L0		Lecture	2	3
Module Responsible	Prof. Kerstin Kuchta			
Admission Requirements	None			
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students have reache	ed the following learning results		
Professional Competence				
Knowledge	Students are able to describe single techniques a	nd to give an overview for the f	ield of safety and risk a	assessment, Circu
	Economy as well as environmental and sustainable	engineering, in detail:		
	 basics in safety and reliability of technical fac 	ilities		
	 risk assessment and reliability analysis methods 			
	Circularity of material			
	 Identification and evaluation of material flows 	5		
	 energy production and supply 			
	 sustainable product design 			
Skills	Students are able apply interdisciplinary system-o	riented methods for Circularity ar	nd risk assessment as v	vell as sustainabi
	reporting. They can evaluate the effort and costs fo			
Personal Competence				
Social Competence				
Autonomy	Students can gain knowledge of the subject area t	from given sources and transform	it to new questions. Fu	rthermore, they o
	define targets for new application or research-orien			
	the potential social, economic and cultural impact.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture	2 56		
Credit points				
Course achievement				
Examination	Written elaboration			
Examination duration and	Elaboration and presentation (45 minutes in groups)		
scale				
Assignment for the	Civil Engineering: Core Qualification: Compulsory			
Following Curricula	Bioprocess Engineering: Specialisation C - Bioec	onomic Process Engineering, Fo	cus Management and	Controlling: Elect
	Compulsory			
	Chemical and Bioprocess Engineering: Specialisation	n General Process Engineering: Ele	ctive Compulsory	
	Chemical and Bioprocess Engineering: Specialisation	n Bioprocess Engineering: Elective	Compulsory	
	Chemical and Bioprocess Engineering: Specialisation	n Chemical Process Engineering: E	lective Compulsory	
	Chemical and Bioprocess Engineering: Specialisation	n Chemical and Bio process Engine	ering: Elective Compulso	ory
	Environmental Engineering: Specialisation Energy a	nd Resources: Elective Compulsory	/	
	Product Development, Materials and Production: Sp	ecialisation Product Development:	Elective Compulsory	
	Product Development, Materials and Production: Sp	ecialisation Production: Elective Co	mpulsory	
	Product Development, Materials and Production: Sp	ecialisation Materials: Elective Com	npulsory	

Course L3264: Circular Econo	ourse L3264: Circular Economy		
Тур	Seminar		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Lecturer	Dr. Marco Ritzkowski		
Language	EN		
Cycle	WiSe		
Content			
Literature			

Course L0319: Environment	and Sustainability
Тур	Lecture
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Kerstin Kuchta
Language	EN
Cycle	WiSe
Content	 This course presents actual methodologies and examples of environmental relevant, sustainable technologies, concepts and strategies in the field of energy supply, product design, water supply, waste water treatment or mobility. The following list shows examples: Production and use of biochar Energy production with algae Environmentally friendly product design Clean development mechanisms Democracy and energy Alternative mobility
Literature	Wird in der Veranstaltung bekannt gegeben.

Courses				
Title		Тур	Hrs/wk	СР
Practical term 2 (dual study progra			0	10
Module Responsible	-			
Admission Requirements Recommended Previous	None			
Knowledge	 Successful completion of practical modul 	e 1 as part of the dual Master's course		
	 course D from the module on interlinking 	theory and practice as part of the dual	Master's course	
Educational Objectives	After taking part successfully, students have rea	ached the following learning results		
Professional Competence				
Knowledge	Dual students			
	 combine their knowledge of facts, pr practical knowledge - in particular their k of activity in engineering. have a critical understanding of the pr 	cnowledge of practical professional pro	cedures and approaches	
Skills	Dual students			
	 apply technical theoretical knowledg associated work processes and results, ta implement the university's application develop (new) solutions as well as including in the case of frequently chang 	aking into account different possible co recommendations with regard to their procedures and approaches in their f	urses of action. current tasks.	
Personal Competence				
Social Competence	Dual students			
	 work responsibly in cross-departmen their team. represent complex engineering view. 			
	external stakeholders and develop these	further together.		
Autonomy	Dual students			
	 define goals for their own learning and reflect on learning and work processes reflect on the relevance of subject implement the university's application r between theory and practice. 	in their area of responsibility. modules specialisations and special		
Workload in Hours	Independent Study Time 300, Study Time in Leo	cture 0		
Credit points	10			
Course achievement	None			
Examination	Written elaboration			
Examination duration and scale	Documentation accompanying studies and acro development report (e-portfolio). This document interlinking theory and practice, as well as dual@TUHH Coordination Office that the dual st	nts and reflects individual learning exp professional practice. In addition, th	periences and skills dev e partner company pr	elopment relating
Assignment for the	Civil Engineering: Core Qualification: Compulsor	у		
Following Curricula	Bioprocess Engineering: Core Qualification: Con			
	Chemical and Bioprocess Engineering: Core Qua			
	Computer Science: Core Qualification: Compulse Data Science: Core Qualification: Compulsory	bi y		
	Electrical Engineering: Core Qualification: Comp	ulsory		
	Energy Systems: Core Qualification: Compulsor			
	Environmental Engineering: Core Qualification:			
	Aircraft Systems Engineering: Core Qualification			
	Computer Science in Engineering: Core Qualification Information and Communication Systems: Core			
	International Management and Engineering: Cole			
	Logistics, Infrastructure and Mobility: Core Qual	ification: Compulsory		
	Aeronautics: Core Qualification: Compulsory			
	Materials Science and Engineering: Core Qualific			
	Materials Science: Core Qualification: Compulso Mechanical Engineering and Management: Core	•		
	Mechatronics: Core Qualification: Compulsory	Company		
	Biomedical Engineering: Core Qualification: Con	npulsory		
	Microelectronics and Microsystems: Core Qualif			
	Product Development, Materials and Production	: Core Qualification: Compulsory		

Renewable Energies: Core Qualification: Compulsory
Naval Architecture and Ocean Engineering: Core Qualification: Compulsory
Theoretical Mechanical Engineering: Core Qualification: Compulsory
Process Engineering: Core Qualification: Compulsory
Water and Environmental Engineering: Core Qualification: Compulsory

Тур	
Hrs/wk	0
СР	10
Workload in Hours	Independent Study Time 300, Study Time in Lecture 0
Lecturer	Dr. Henning Haschke
Language	DE
Cycle	WiSe/SoSe
Content	Company onboarding process
	 Assigning a professional field of activity as an engineer (B.Sc.) and associated fields of work
	• Establishing responsibilities and authorisation of the dual student within the company as an engineer (B.Sc.)
	• Taking personal responsibility within a team and on selected projects - across departments and, if applicable, ac
	companies
	 Scheduling the current practical module with a clear correlation to work structures
	Scheduling the examination phase/subsequent study semester
	Operational knowledge and skills
	• Company-specific: Responsibility as an engineer (B.Sc.) in their own area of work, coordinating team and project v
	dealing with complex contexts and unsolved problems, developing and implementing innovative solutions
	Subject specialisation (corresponding to the chosen course [M.Sc.]) in the field of activity
	Systemic skills
	 Implementing the university's application recommendations (theory-practice transfer) in corresponding work and task a across the company
	Sharing/reflecting on learning
	Updating their e-portfolio
	 Importance of course contents (M.Sc.) when working as an engineer
	 Importance of development and innovation when working as an engineer
Literature	
	Studierendenhandbuch
	Betriebliche Dokumente
	Hochschulseitige Anwendungsempfehlungen zum Theorie-Praxis-Transfer

Courses				
2001363				
Fitle		Тур	Hrs/wk	СР
Practical term 3 (dual study progra			0	10
Module Responsible	-			
Admission Requirements Recommended Previous	None			
Kecommended Previous Knowledge	Successful completion of practical module	2 as part of the dual Master's course		
Knowledge	course E from the module on interlinking	theory and practice as part of the dual	Master's course	
Educational Objectives	After taking part successfully, students have rea	sched the following learning results		
-	After taking part successiony, students have rea	ched the following learning results		
Professional Competence	Dual students			
nutritica ge				
	combine their comprehensive and specified			dy contents with
	strategy-oriented practical knowledge gai			
	have a critical understanding of the p	practical applications of their enginee	ring subject, as well as	related fields wh
	implementing innovations.			
Skills	Dual students			
	apply specialised and conceptual skills	to solve complex, sometimes interdis	sciplinary problems with	in the company, a
	evaluate the associated work processes a	nd results, taking into account differer	nt possible courses of ac	tion.
	• implement the university's application	recommendations with regard to their	current tasks.	
	develop new solutions as well as proce	edures and approaches to implement	operational projects and	l assignments - ev
	when facing frequently changing requiren	nents and unpredictable changes (syst	emic skills).	
	can use academic methods to develo	p new ideas and procedures for oper	rational problems and is	ssues, and to ass
	these with regard to their usability.			
Personal Competence				
Social Competence	Dual students			
	 work responsibly in cross-department their team. 	al and interdisciplinary project teams	s and proactively deal v	with problems wit
	 can promote the professional developm 	nent of others in a targeted manner		
	represent complex and interdisciplinar		lems and solution appro	aches in discussi
	with internal and external stakeholders ar			
Autonomy	Dual students			
	reflect on learning and work processes	in their area of responsibility.		
	define goals for new application-orient		is while reflecting on po	tential effects on
	company and the public.			
	• reflect on the relevance of areas of	specialisation and research for work	k as an engineer, and	also implement
	university's application recommendations	s and the associated challenges to po	ositively transfer knowle	dge between the
	and practice.			
Workload in Hours	Independent Study Time 300, Study Time in Lec	ture 0		
Credit points	10			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Documentation accompanying studies and acros	ss semesters: Module credit points are	earned by completing a	a digital learning a
scale	development report (e-portfolio). This documen	its and reflects individual learning exp	periences and skills dev	elopment relating
	interlinking theory and practice, as well as p			ovides proof to
	dual@TUHH Coordination Office that the dual stu		se.	
Assignment for the	Civil Engineering: Core Qualification: Compulsory			
Following Curricula				
	Chemical and Bioprocess Engineering: Core Qua			
	Computer Science: Core Qualification: Compulso	и у		
	Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Comp	ulsory		
	Energy Systems: Core Qualification: Compulsory	•		
	,,,, core quameation. compulsory			
	Environmental Engineering: Core Qualification: (
	Environmental Engineering: Core Qualification: C Aircraft Systems Engineering: Core Qualification			
		: Compulsory		
	Aircraft Systems Engineering: Core Qualification	: Compulsory ation: Compulsory		
	Aircraft Systems Engineering: Core Qualification Computer Science in Engineering: Core Qualifica	: Compulsory ation: Compulsory Qualification: Compulsory		
	Aircraft Systems Engineering: Core Qualification Computer Science in Engineering: Core Qualifica Information and Communication Systems: Core (: Compulsory ation: Compulsory Qualification: Compulsory e Qualification: Compulsory		
	Aircraft Systems Engineering: Core Qualification Computer Science in Engineering: Core Qualifica Information and Communication Systems: Core (International Management and Engineering: Core	: Compulsory ation: Compulsory Qualification: Compulsory e Qualification: Compulsory		

Materials Science: Core Qualification: Compulsory
Mechanical Engineering and Management: Core Qualification: Compulsory
Mechatronics: Core Qualification: Compulsory
Biomedical Engineering: Core Qualification: Compulsory
Microelectronics and Microsystems: Core Qualification: Compulsory
Product Development, Materials and Production: Core Qualification: Compulsory
Renewable Energies: Core Qualification: Compulsory
Naval Architecture and Ocean Engineering: Core Qualification: Compulsory
Theoretical Mechanical Engineering: Core Qualification: Compulsory
Process Engineering: Core Qualification: Compulsory
Water and Environmental Engineering: Core Qualification: Compulsory

Course L2889: Practical term	n 3 (dual study program, Master's degree)
Тур	
Hrs/wk	0
СР	10
Workload in Hours	Independent Study Time 300, Study Time in Lecture 0
Lecturer	Dr. Henning Haschke
Language	DE
Cycle	WiSe/SoSe
Content	Company onboarding process
	 Assigning a future professional field of activity as an engineer (M.Sc.) and associated fields of work Extending responsibilities and authorisation of the dual student within the company up to the intended first assignment after completing their studies Working responsibly in a team; project responsibility within own area - as well as across divisions and companies if necessary Scheduling the final practical module with a clear correlation to work structures Internal agreement on a potential topic or innovation project for the Master's dissertation Planning the Master's dissertation within the company in cooperation with TU Hamburg Scheduling the examination phase/subsequent study semester
	Operational knowledge and skills
	 Company-specific: dealing with change, project and team development, responsibility as an engineer in their future field of work (M.Sc.), dealing with complex contexts, frequent and unpredictable changes, developing and implementing innovative solutions Specialising in one field of work (final dissertation) Systemic skills Implementing the university's application recommendations (theory-practice transfer) in corresponding work and task areas across the company
	Sharing/reflecting on learning
	 E-portfolio Relevance of study content and personal specialisation when working as an engineer Relevance of research and innovation when working as an engineer
Literature	 Studierendenhandbuch betriebliche Dokumente Hochschulseitige Anwendungsempfehlungen zum Theorie-Praxis-Transfer

Specialization Cities

Module M0923: Integ	rated Transportation Planning			
Courses				
Title		Тур	Hrs/wk	СР
Integrated Transportation Planning	(L1068)	Project-/problem-based Learning	4	6
Module Responsible	Prof. Carsten Gertz			
Admission Requirements				
Recommended Previous	some knowledge of transport planning, e.g. through taking	the undergraduate class "Transport P	lanning and Tra	affic Engineerin
Knowledge				
Educational Objectives	After taking part successfully, students have reached the fo	llowing learning results		
Professional Competence				
Knowledge	Students are able to:			
	 describe interdependencies between land-use/locatio explain and evaluate the social, ecological and econo relate current issues in the area of integrated transport 	omic effects of transport and land-use	policy measure	25.
Skills	Students are able to:			
	 quantify important parameters, which influence travel demand or are influenced by it. comprehensively examine a pre-defined or self-selected topic from a transportation studies perspective and document the results in accordance with scientific conventions. 			
Personal Competence Social Competence	 Students are able to: provide feedback on topical contents and their teach constructively handle feedback on their own work. produce results in group work and document these. 	ing.		
Autonomy	 Students are able to: assess potential consequences of their future profess independently plan working on a pre-defined project its execution. 		lge and use app	propriate means for
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and scale	written assignment with presentation during the semester			
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Ele	ctive Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering:			
	Civil Engineering: Specialisation Coastal Engineering: Election	ve Compulsory		
	Civil Engineering: Specialisation Water and Traffic: Compuls	sory		
	Logistics, Infrastructure and Mobility: Specialisation Infrastr	ucture and Mobility: Elective Compuls	ory	
	Water and Environmental Engineering: Specialisation Cities	: Compulsory		

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

	11				
Module M0827: Mode	ling in Water Management				
Courses					
Title Groundwater Modeling using Modfl	ow (L0543)	Typ Lecture	Hrs/wk	CP	
Groundwater Modeling using Modfl		Recitation Section (small)	2	2	
Modeling of Water Supply Network	(L0875)	Project-/problem-based Learning	2	3	
Module Responsible	Dr. Klaus Johannsen				
Admission Requirements	None				
Recommended Previous	Groundwater				
Knowledge	groundwater hydraulics and transport	of substances			
	Pipe Systems				
	 Knowledge on urban water infrastru special structures 	ictures, in particular drinking water systemsand	urban drainag	e systems including	
	 Hydraulics of drinking water supply sy 				
	 Basic knowledge on water manageme 	ent			
Educational Objectives	After taking part successfully, students have	e reached the following learning results			
Professional Competence					
Knowledge	The students are able to describe the modelling of groundwater flow and transport as well as urban water infrastructures. They carry out systems analyses and can detect technical and conceptual weak points within the systems in case studies. Besides the are able to analyse interdependencies of hydraulic and toxic phenomena in soil and water.				
Skills		ly scientific groundwater models indipendently. Thes for existing problems by application of selected s EPANET, EPA-SWMM).			
Personal Competence					
	Wird nicht vermittelt.				
Autonomy	Wird nicht vermittelt.				
Workload in Hours	Independent Study Time 110, Study Time in	Lecture 70			
Credit points	6				
Course achievement	None				
Examination	Oral exam				
Examination duration and	30 min				
scale					
Assignment for the Following Curricula	Civil Engineering: Specialisation Structural En Civil Engineering: Specialisation Geotechnica				
Following Curricula	5 5 1				
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory Civil Engineering: Specialisation Water and Traffic: Elective Compulsory				
	Civil Engineering: Specialisation Water and T				
	Water and Environmental Engineering: Specialisation				
	Water and Environmental Engineering: Speci				

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

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

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

Module M0828: Urbar	environmental Management			
Courses				
Title	Туј	p	Hrs/wk	СР
Noise Protection (L1109)		ture	2	2
Urban Infrastructures (L0874)	Proj	ject-/problem-based Learning	2	4
Module Responsible	Dr. Dorothea Rechtenbach			
Admission Requirements	None			
Recommended Previous	. Kasuladas as liikas slaasiss			
Knowledge	Knowledge on Urban planning			
	 Knowledge on measures for climate protection General knowledge of scientific writing/working 			
	General knowledge of scientific whiting/working			
Educational Objectives	After taking part successfully, students have reached the following le	earning results		
Professional Competence				
Knowledge	Students can describe urban development corridors as well as current	nt and future urban environn	nental probler	ns. They are able
	explain the causes of environmental problems (like noise).			
	Students can specify applications for various technical innovations a	and explain why these contrib	oute to the im	provement of urba
	life. They can, for example, derive and discuss measures for effective	e noise abatement.		
Skills	Students are able to develop specific solutions for correcting	existing or future environ	ment-related	problems of urb
SKIIS	development. They can define a range of conceptual and technical s	-		
	paths. To solve specific urban environmental problems they can se			
	context.			
Personal Competence				
	The students can work together in international groups.			
Autonomy	Students are able to organize their work flow to prepare themselve	c for procontations and cont	ributions to th	o discussions. The
Autonomy	can acquire appropriate knowledge by making enquiries independen			le discussions. The
		ary.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Written Report plus oral Presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elective Com	npulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective C	Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: Elective Compu	ulsory		
	Civil Engineering: Specialisation Water and Traffic: Elective Compulse	ory		
	Environmental Engineering: Core Qualification: Elective Compulsory			
	Joint European Master in Environmental Studies - Cities and Sustaina			
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure an	nd Mobility: Elective Compulse	ory	
	Water and Environmental Engineering: Specialisation Environment: E			
	Water and Environmental Engineering: Specialisation Cities: Compute	sory		

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

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

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

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

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

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

Course L0289: Applied Surface Hydrology		
Тур	Lecture	
Hrs/wk	2	
СР	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Peter Fröhle	
Language	DE/EN	
Cycle	SoSe	
	 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://kalypso.bjoernsen.de/ http://sourceforge.net/projects/kalypso/	

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

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

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

Course L0517: Biological Wastewater Treatment	
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Joachim Behrendt
Language	DE/EN
Cycle	SoSe
Content	Charaterisation of Wastewater
	Metobolism of Microorganisms
	Kinetic of mirobiotic processes
	Calculation of bioreactor for wastewater treatment
	Concepts of Wastewater treatment
	Design of WWTP
	Excursion to a WWTP
	Biofilms
	Biofim Reactors
	Anaerobic Wastewater and sldge treatment
	resources oriented sanitation technology
	Future challenges of wastewater treatment
Literature	Gujer, Willi
	Siedlungswasserwirtschaft : mit 84 Tabellen
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Engineering	
	ISBN: 3540343296 (Gb.) URL: http://www.gbv.de/dms/bs/toc/516261924.pdf URL: http://deposit.d-nb.de/cgi-bin/dokserv?
	id=2842122&prov=M&dok_var=1&dok_ext=htm
	Berlin [u.a.] : Springer, 2007
	TUB_HH_Katalog
	Henze, Mogens
	Wastewater treatment : biological and chemical processes
	ISBN: 3540422285 (Pp.)
	Berlin [u.a.] : Springer, 2002
	TUB_HH_Katalog
	Imhoff, Karl (Imhoff, Klaus R.;)
	Taschenbuch der Stadtentwässerung : mit 10 Tafeln
	ISBN: 3486263331 ((Gb.))
	München [u.a.] : Oldenbourg, 1999
	TUB_HH_Katalog
	Lange, Jörg (Otterpohl, Ralf; Steger-Hartmann, Thomas;)
	Abwasser : Handbuch zu einer zukunftsfähigen Wasserwirtschaft
	ISBN: 3980350215 (kart.) URL: http://www.gbv.de/du/services/agi/52567E5D44DA0809C12570220050BF25/00000700334
	Donaueschingen-Pfohren : Mall-Beton-Verl., 2000
	TUB_HH_Katalog
	Mudrack, Klaus (Kunst, Sabine;)
	Biologie der Abwasserreinigung : 18 Tabellen
	ISBN: 382741427X URL: http://www.gbv.de/du/services/agi/94B581161B6EC747C1256E3F005A8143/420000114903
	Heidelberg [u.a.] : Spektrum, Akad. Verl., 2003
	TUB_HH_Katalog
	Tchobanoglous, George (Metcalf & Eddy, Inc., ;)
	Wastewater engineering : treatment and reuse
	ISBN: 0070418780 (alk. paper) ISBN: 0071122508 (ISE (*pbk))
	Boston [u.a.] : McGraw-Hill, 2003
	TUB_HH_Katalog
	Henze, Mogens
	Activated sludge models ASM1, ASM2, ASM2d and ASM3
	ISBN: 1900222248
	London : IWA Publ., 2002
	TUB_HH_Katalog
	Kunz, Peter
	Umwelt-Bioverfahrenstechnik
	Vieweg, 1992
	Bauhaus-Universität., Arbeitsgruppe Weiterbildendes Studium Wasser und Umwelt (Deutsche Vereinigung für
	Wasserwirtschaft, Abwasser und Abfall, ;)
	Abwasserbehandlung : Gewässerbelastung, Bemessungsgrundlagen, Mechanische Verfahren, Biologische Verfahren, Reststoffe
	aus der Abwasserbehandlung, Kleinkläranlagen
	ISBN: 3860682725 URL: http://www.gbv.de/dms/weimar/toc/513989765_toc.pdf URL:
	http://www.gbv.de/dms/weimar/abs/513989765_abs.pdf
	Weimar : Universitätsverl, 2006
	TUB_HH_Katalog Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall
	DWA-Regelwerk
	Hennef : DWA, 2004
	TUB_HH_Katalog
	Wiesmann, Udo (Choi, In Su; Dombrowski, Eva-Maria;)
	Fundamentals of biological wastewater treatment
	ISBN: 3527312196 (Gb.) URL: http://deposit.ddb.de/cgi-bin/dokserv?id=2774611&prov=M&dok_var=1&dok_ext=htm
	Weinheim : WILEY-VCH, 2007
	TUB_HH_Katalog

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

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

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

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

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

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

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

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

2.1.9.1.001.1.9				
Module M1721: Wate	r and Environment: Theory and Application			
Courses		_		
Title		Гур	Hrs/wk	СР
Water and Environment (L2754) Water and Environment (L2753)		Project-/problem-based Learning .ecture	3 3	3 3
Module Responsible			5	5
Admission Requirements				
	Basic knowledge in water and environmental research, Hydrology			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following	learning results		
Professional Competence				
Knowledge	Common research tools and techniques together with the fundamental knowledge relevant to multi-scale and multi-phas challenges present in water and environmental research will be discussed in this module. Both theory and application will b considered.			
Skills	In addition to the fundamental knowledge, the students will be exposed to several analytical, experimental and numerical tool and techniques relevant to water and environmental research at different scales. This will provide the students with an exceller opportunity to improve their skills on multiple fronts which will be useful in their future career.			
Personal Competence				
Social Competence	Developing teamwork and problem solving skills through Research-Based Teaching approaches will be at the core of this module			
Autonomy	The students will be involved in writing individual reports and presentation. This will contribute to the students' ability an willingness to work independently and responsibly.			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	Report and Presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Coastal Engineering: Elective Com	pulsory		
Following Curricula	Civil Engineering: Specialisation Water and Traffic: Elective Compu	Ilsory		
	Environmental Engineering: Specialisation Environment and Clima	te: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Cities: Electi	ve Compulsory		
	Water and Environmental Engineering: Specialisation Water: Election	ive Compulsory		
	Water and Environmental Engineering: Specialisation Environment	: Compulsory		

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

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

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

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

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

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

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

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

Course L0011: Wind Turbine	Plants	
Тур	ture	
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	 Introduction, importance of offshore wind power generation, Specific requirements for offshore engineering Physical fundamentals for utilization of wind energy Design and operation of offshore wind turbines, presentation of different concepts of offshore wind turbines, representation of the individual system components and their system-technical relationships Foundation engineering, offshore site investigation, presentation of different concepts of offshore foundation structures, planning and fabrication of foundation structures Electrical infrastructure of an offshore wind farm, Inner Park cabling, offshore substation, grid connection Installation of offshore wind farms, installation techniques and auxiliary devices, construction logistics Development and planning of offshore wind farms Operation and optimization of offshore wind farms Day excursion
Literature	 Gasch, R.; Twele, J.: Windkraftanlagen - Grundlagen, Entwurf, Planung und Betrieb; Vieweg + Teubner, Stuttgart, 2007, 7. Auflage Molly, J. P.: Windenergie - Theorie, Anwendung, Messung; C. F. Müller, Heidel-berg, 1997, 3. Auflage Hau, E.: Windkraftanlagen; Springer, Berlin, Heidelberg, 2008, 4.Auflage Heier, S.: Windkraftanlagen - Systemauslegung, Integration und Regelung; Vieweg + Teubner, Stuttgart, 2009, 5. Auflage Jarass, L.; Obermair, G.M.; Voigt, W.: Windenergie: Zuverlässige Integration in die Energieversorgung; Springer, Berlin, Heidelberg, 2009, 2. Auflage

Module M2002: Wast	and Resource Manag	gement			
Courses					
Title			Тур	Hrs/wk	СР
Waste management (L3261)			Project-/problem-based Learning	3	3
International waste concepts (L325	9)		Lecture	2	2
International waste concepts (L326			Recitation Section (small)	1	1
Module Responsible	Prof. Kerstin Kuchta				
Admission Requirements	None				
Recommended Previous	Basics in process engineering				
Knowledge					
Educational Objectives	After taking part successfully, s	tudents have reached the follow	ing learning results		
Professional Competence					
Knowledge	The students are able to descri	ibe waste as a resource as well	as advanced technologies for re	cycling and r	ecovery of resource
	from waste in detail. This cover	s collection, transport, treatmen	t and disposal in national and inte	ernational con	texts.
Skills	Students are able to select suit:	able processes for the treatment	with respect to the national or cu	iltural and de	velopmental contex
SKIIIS			t of different technologies and ma		
	They can evaluate the ecologica		t of unreferit teenhologies and me	anagement sy	stems.
Personal Competence					
Social Competence	Students can work together as	s a team of 2-5 persons, partic	ipate in subject-specific and inte	erdisciplinary	discussions, devel
	cooperated solutions and defer	nd their own work results in from	nt of others and promote the scie	entific develo	oment of colleague
	Furthermore, they can give and	accept professional constructive	e criticisms.		
Autonomy	Students can independently da	ain additional knowledge of the	subject area and apply it in so	lving the giv	en course tasks ar
hatohomy	projects.	an additional knowledge of the		iving the giv	
	projects.				
Workload in Hours	Independent Study Time 96, Stu	udy Time in Lecture 84			
Credit points	6				
Course achievement	Compulsory Bonus Form	Description			
		elaboration			
Examination	Presentation				
Examination duration and	PowerPoint presentation (10-15	minutes)			
scale					
Assignment for the	Civil Engineering: Specialisation	Water and Traffic: Elective Com	npulsory		
Following Curricula	Chemical and Bioprocess Engine	eering: Specialisation General Pr	ocess Engineering: Elective Com	oulsory	
	Chemical and Bioprocess Engine	eering: Specialisation Bioprocess	Engineering: Elective Compulsor	гу	
	Chemical and Bioprocess Engine	eering: Specialisation Chemical I	Process Engineering: Elective Con	npulsory	
	Chemical and Bioprocess Engine	eering: Specialisation Chemical a	and Bio process Engineering: Elec	tive Compuls	ory
	Chemical and Bioprocess Engine	eering: Core Qualification: Electi	ve Compulsory		
	Environmental Engineering: Spe	ecialisation Energy and Resource	es: Elective Compulsory		
	International Management and	Engineering: Specialisation II. Re	enewable Energy: Elective Compu	lsory	
	Process Engineering: Specialisa	tion Environmental Process Engi	neering: Elective Compulsory		
	Water and Environmental Engin	eering: Specialisation Cities: Ele	ctive Compulsory		
	Water and Environmental Engin	eering: Specialisation Environme	ent: Elective Compulsory		

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Module M0581: Wate	r Protection			
Courses				
Title		Tun	Hrs/wk	СР
Water Protection and Wastewater I	Janagement (10226)	Typ Lecture	3	3
Water Protection and Wastewater I	5	Project Seminar	3	3
Module Responsible				
Admission Requirements				
Recommended Previous				
Knowledge	 Basic knowledge in water management 	t;		
	Good knowledge in urban drainage;			
	Good knowledge of wastewater treatment			
	 Good knowledge of pollutants (e.g. COI 	D, BOD, TS, N, P) and their properties;		
Educational Objectives	After taking part successfully, students have r	reached the following learning results		
Professional Competence				
Knowledge	The students can describe the basic principles	s of the regulatory framework related to the	e international and Eu	ropean water sect
	They can explain limnological processes, su			
	problems related to water protection, such a	as ecosystem service and wastewater trea	tment with a special	focus on innovati
	solutions, remediation measures as well as co	onceptual approaches.		
Skills	Students can accurately assess current probl	ems and situations in a country-specific or	local context. They o	can suggest concre
	actions to contribute to the planning of ton			
	administrative and legislative solutions to solv			
	5			
Personal Competence				
Social Competence	The students can work together in internation	al groups.		
Autonomv	Students are able to organize their work flow	to prepare presentations and discussions.	They can acquire ap	propriate knowled
	by making enquiries independently.			
Workload in Hours	Independent Study Time 96, Study Time in Le	cture 84		
Credit points	6			
Course achievement	None			
Examination	Presentation			
	Term paper plus presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Eng	gineering: Elective Compulsory		
•	Civil Engineering: Specialisation Geotechnical			
J	Civil Engineering: Specialisation Coastal Engin	• • • • •		
	Civil Engineering: Specialisation Water and Tr	•		
	Environmental Engineering: Specialisation Wa		Compulsory	
	International Management and Engineering: S			
	Water and Environmental Engineering: Specia	lisation Cities: Elective Compulsory		
	Water and Environmental Engineering: Specia	lisation Water: Elective Compulsory		
	Water and Environmental Engineering: Specia	lisation Environment: Compulsory		

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

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

	r Resources and -Supply			
Courses				
Title		Тур	Hrs/wk	СР
Chemistry of Drinking Water Treat	ment (L0311)	Lecture	2	1
Chemistry of Drinking Water Treatment (L0312)		Recitation Section (large)	1	2
Water Resource Management (L0402)		Lecture	2	2
Water Resource Management (L04	03)	Recitation Section (small)	1	1
Module Responsible	Prof. Mathias Ernst			
Admission Requirements	None			
Recommended Previous	Knowledge of water management and the k	key processes involved in water treatment.		
Knowledge				
Educational Objectives	After taking part successfully, students hav	e reached the following learning results		
Professional Competence				
Knowledge	Students will be able to outline key areas	of conflict in water management, as well as thei	r mutual depend	lence for sustaina
	water supply. They will understand releva	nt economic, environmental and social factors.	Students will be	able to explain a
	outline the organisational structures of wat	er companies. They will be able to explain the ava	ailable water trea	tment processes a
	the scope of their application.			
Skills		ex problems in drinking water production and		-
	management and technical measures. The	y will be able to assess the evaluation methods th	nat can be used f	for this. Students
	be able to carry out chemical calculations	s for selected treatment processes and apply ge	enerally accepted	l technical rules
	standards to these processes.			
Personal Competence				
Personal Competence Social Competence		students will be able to develop and document co	mplex solutions	for the managem
	Working in a diverse group of specialists, s	students will be able to develop and document co		
	Working in a diverse group of specialists, s and treatment of drinking water. They will	I be able to take an appropriate professional pos	sition, for examp	le representing u
	Working in a diverse group of specialists, s and treatment of drinking water. They will		sition, for examp	le representing u
Social Competence	Working in a diverse group of specialists, s and treatment of drinking water. They will interests. They will be able to develop joint	I be able to take an appropriate professional pos	sition, for examp	le representing u
Social Competence	Working in a diverse group of specialists, s and treatment of drinking water. They will interests. They will be able to develop joint Students will be in a position to work on a s	I be able to take an appropriate professional pos- solutions in teams of diverse experts and present ubject independently and present on this subject.	sition, for examp	le representing u
Social Competence Autonomy	Working in a diverse group of specialists, s and treatment of drinking water. They will interests. They will be able to develop joint Students will be in a position to work on a s Independent Study Time 96, Study Time in	I be able to take an appropriate professional pos- solutions in teams of diverse experts and present ubject independently and present on this subject.	sition, for examp	le representing u
Social Competence Autonomy Workload in Hours	Working in a diverse group of specialists, s and treatment of drinking water. They will interests. They will be able to develop joint Students will be in a position to work on a s Independent Study Time 96, Study Time in 6	I be able to take an appropriate professional pos- solutions in teams of diverse experts and present ubject independently and present on this subject.	sition, for examp	le representing u
Social Competence Autonomy Workload in Hours Credit points	Working in a diverse group of specialists, s and treatment of drinking water. They will interests. They will be able to develop joint Students will be in a position to work on a s Independent Study Time 96, Study Time in 6	I be able to take an appropriate professional pos- solutions in teams of diverse experts and present ubject independently and present on this subject.	sition, for examp	le representing u
Social Competence Autonomy Workload in Hours Credit points Course achievement	Working in a diverse group of specialists, s and treatment of drinking water. They will interests. They will be able to develop joint Students will be in a position to work on a s Independent Study Time 96, Study Time in 6 None Written exam	I be able to take an appropriate professional pos- solutions in teams of diverse experts and present ubject independently and present on this subject.	sition, for examp	le representing u
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination	Working in a diverse group of specialists, s and treatment of drinking water. They will interests. They will be able to develop joint Students will be in a position to work on a s Independent Study Time 96, Study Time in 6 None Written exam	I be able to take an appropriate professional pos- solutions in teams of diverse experts and present ubject independently and present on this subject.	sition, for examp	le representing u
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale	Working in a diverse group of specialists, s and treatment of drinking water. They will interests. They will be able to develop joint Students will be in a position to work on a s Independent Study Time 96, Study Time in 6 None Written exam 60 min (chemistry) + presentation	I be able to take an appropriate professional possional possion in teams of diverse experts and present ubject independently and present on this subject. Lecture 84	sition, for examp	le representing u
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and	Working in a diverse group of specialists, s and treatment of drinking water. They will interests. They will be able to develop joint Students will be in a position to work on a s Independent Study Time 96, Study Time in 6 None Written exam 60 min (chemistry) + presentation Civil Engineering: Specialisation Structural I	I be able to take an appropriate professional possionations in teams of diverse experts and present ubject independently and present on this subject. Lecture 84	sition, for examp	le representing u
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Working in a diverse group of specialists, s and treatment of drinking water. They will interests. They will be able to develop joint Students will be in a position to work on a s Independent Study Time 96, Study Time in 6 None Written exam 60 min (chemistry) + presentation Civil Engineering: Specialisation Structural I Civil Engineering: Specialisation Geotechnic	I be able to take an appropriate professional pos solutions in teams of diverse experts and present ubject independently and present on this subject. Lecture 84 Engineering: Elective Compulsory cal Engineering: Elective Compulsory	sition, for examp	le representing u
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Working in a diverse group of specialists, s and treatment of drinking water. They will interests. They will be able to develop joint Students will be in a position to work on a s Independent Study Time 96, Study Time in 6 None Written exam 60 min (chemistry) + presentation Civil Engineering: Specialisation Structural I Civil Engineering: Specialisation Geotechnic Civil Engineering: Specialisation Water and	I be able to take an appropriate professional pos solutions in teams of diverse experts and present ubject independently and present on this subject. Lecture 84 Engineering: Elective Compulsory cal Engineering: Elective Compulsory Traffic: Compulsory	sition, for examp	le representing u
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Working in a diverse group of specialists, s and treatment of drinking water. They will interests. They will be able to develop joint Students will be in a position to work on a s Independent Study Time 96, Study Time in 6 None Written exam 60 min (chemistry) + presentation Civil Engineering: Specialisation Structural I Civil Engineering: Specialisation Geotechnic Civil Engineering: Specialisation Water and Civil Engineering: Specialisation Coastal Engineeri	I be able to take an appropriate professional pos solutions in teams of diverse experts and present ubject independently and present on this subject. Lecture 84 Engineering: Elective Compulsory cal Engineering: Elective Compulsory Traffic: Compulsory gineering: Elective Compulsory	sition, for examp these solutions t	le representing u
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Working in a diverse group of specialists, s and treatment of drinking water. They will interests. They will be able to develop joint Students will be in a position to work on a s Independent Study Time 96, Study Time in 6 None Written exam 60 min (chemistry) + presentation Civil Engineering: Specialisation Structural I Civil Engineering: Specialisation Geotechnic Civil Engineering: Specialisation Water and Civil Engineering: Specialisation Coastal Eng Chemical and Bioprocess Engineering: Tech	I be able to take an appropriate professional pos solutions in teams of diverse experts and present ubject independently and present on this subject. Lecture 84 Engineering: Elective Compulsory cal Engineering: Elective Compulsory Traffic: Compulsory gineering: Elective Compulsory unical Complementary Course: Elective Compulsory	sition, for examp these solutions t	le representing u o others.
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Working in a diverse group of specialists, s and treatment of drinking water. They will interests. They will be able to develop joint Students will be in a position to work on a s Independent Study Time 96, Study Time in 6 None Written exam 60 min (chemistry) + presentation Civil Engineering: Specialisation Structural I Civil Engineering: Specialisation Geotechnic Civil Engineering: Specialisation Water and Civil Engineering: Specialisation Water and Civil Engineering: Specialisation Coastal Eng Chemical and Bioprocess Engineering: Tech International Management and Engineering	I be able to take an appropriate professional pos solutions in teams of diverse experts and present ubject independently and present on this subject. Lecture 84 Engineering: Elective Compulsory cal Engineering: Elective Compulsory Traffic: Compulsory gineering: Elective Compulsory inical Complementary Course: Elective Compulsory : Specialisation II. Energy and Environmental Engin	sition, for examp these solutions t	le representing u o others.
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Working in a diverse group of specialists, s and treatment of drinking water. They will interests. They will be able to develop joint Students will be in a position to work on a s Independent Study Time 96, Study Time in 6 None Written exam 60 min (chemistry) + presentation Civil Engineering: Specialisation Structural I Civil Engineering: Specialisation Geotechnic Civil Engineering: Specialisation Water and Civil Engineering: Specialisation Coastal Eng Chemical and Bioprocess Engineering: Tech International Management and Engineering Process Engineering: Specialisation Environ	I be able to take an appropriate professional possionations in teams of diverse experts and present ubject independently and present on this subject. Lecture 84 Engineering: Elective Compulsory cal Engineering: Elective Compulsory Traffic: Compulsory gineering: Elective Compulsory inical Complementary Course: Elective Compulsory : Specialisation II. Energy and Environmental Engin mental Process Engineering: Elective Compulsory	sition, for examp these solutions t	le representing u o others.
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Working in a diverse group of specialists, s and treatment of drinking water. They will interests. They will be able to develop joint Students will be in a position to work on a s Independent Study Time 96, Study Time in 6 None Written exam 60 min (chemistry) + presentation Civil Engineering: Specialisation Structural I Civil Engineering: Specialisation Geotechnic Civil Engineering: Specialisation Water and Civil Engineering: Specialisation Coastal Eng Chemical and Bioprocess Engineering: Tech International Management and Engineering Process Engineering: Specialisation Process	I be able to take an appropriate professional possionations in teams of diverse experts and present ubject independently and present on this subject. Lecture 84 Engineering: Elective Compulsory cal Engineering: Elective Compulsory Traffic: Compulsory gineering: Elective Compulsory inical Complementary Course: Elective Compulsory : Specialisation II. Energy and Environmental Engin mental Process Engineering: Elective Compulsory : Engineering: Elective Compulsory : Engineering: Elective Compulsory : Engineering: Elective Compulsory : Specialisation II. Energy and Environmental Engin mental Process Engineering: Elective Compulsory : Engine	sition, for examp these solutions t	le representing u o others.
Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	Working in a diverse group of specialists, s and treatment of drinking water. They will interests. They will be able to develop joint Students will be in a position to work on a s Independent Study Time 96, Study Time in 6 None Written exam 60 min (chemistry) + presentation Civil Engineering: Specialisation Structural I Civil Engineering: Specialisation Geotechnic Civil Engineering: Specialisation Geotechnic Civil Engineering: Specialisation Coastal Eng Chemical and Bioprocess Engineering: Tech International Management and Engineering Process Engineering: Specialisation Process Water and Environmental Engineering: Specialisation Process	I be able to take an appropriate professional possionations in teams of diverse experts and present ubject independently and present on this subject. Lecture 84 Engineering: Elective Compulsory cal Engineering: Elective Compulsory Traffic: Compulsory gineering: Elective Compulsory inical Complementary Course: Elective Compulsory : Specialisation II. Energy and Environmental Engin mental Process Engineering: Elective Compulsory : Engineering: Elective Compulsory : Engineering: Elective Compulsory : Engineering: Elective Compulsory : Specialisation II. Energy and Environmental Engin mental Process Engineering: Elective Compulsory : Engine	sition, for examp these solutions t	le representing u o others.

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

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

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

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

Module M0822: Proce	ess Modeling in Water Technolo	рду			
Courses					
Title		Тур		Hrs/wk	СР
Process Modelling of Wastewater T	reatment (L0522)	Project-/prob	lem-based Learning	2	3
Process Modeling in Drinking Water	r Treatment (L0314)	Project-/prob	lem-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 wate	er treatment.		
Knowledge					
Educational Objectives	After taking part successfully, students have	reached the following learning re	esults		
Professional Competence					
Knowledge	Students are able to explain selected proce basics as well as possibilities and limitations		e water treatment i	n detail. The	y are able to explair
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 doo able to give appropriate feedback and can w				ackground. They are
Autonomy	Students are able to define a problem, gain t	he required knowledge and set u	ıp a model.		
Workload in Hours	Independent Study Time 124, Study Time in	Lecture 56			
Credit points	6				
Course achievement	None				
Examination					
Examination duration and	30 min				
scale					
Assignment for the	Civil Engineering: Specialisation Water and T	raffic: Elective Compulsory			
-	Chemical and Bioprocess Engineering: Techr		ctive Compulsory		
-	Environmental Engineering: Specialisation W			lsory	
	Process Engineering: Specialisation Environn			-	
	Process Engineering: Specialisation Process I	Engineering: Elective Compulsory	/		
	Water and Environmental Engineering: Speci	alisation Water: Elective Compul	sory		
	Water and Environmental Engineering: Speci	alisation Environment: Elective C	Compulsory		
	Water and Environmental Engineering: Speci	alisation Cities: Elective Compuls	sory		

Course L0522: Process Mode	lling of Wastewater Treatment
Тур	Project-/problem-based Learning
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Joachim Behrendt
Language	DE/EN
Cycle	WiSe
Content	Mass and energy balances
	Tracer modelling
	Activated Sludge Model
	Wastewater Treatment Plant Modelling (continously and SBR)
	Sludge Treatment (ADM, aerobic autothermal)
	Biofilm Modelling
Literature	Henze, Mogens (Seminar on Activated Sludge Modelling, ; Kollekolle Seminar on Activated Sludge Modelling, ;)
	Activated sludge modelling : processes in theory and practice ; selected proceedings of the 5th Kollekolle Seminar on Activated
	Sludge Modelling, held in Kollekolle, Denmark, 10 - 12 September 2001
	ISBN: 1843394146
	[London] : IWA Publ., 2002
	TUB_HH_Katalog
	Henze, Mogens
	Activated sludge models ASM1, ASM2, ASM2d and ASM3
	ISBN: 1900222248
	London : IWA Publ., 2002
	TUB_HH_Katalog
	Henze, Mogens
	Wastewater treatment : biological and chemical processes
	ISBN: 3540422285 (Pp.)
	Berlin [u.a.] : Springer, 2002
	TUB_HH_Katalog
	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
	Usen: 352/312196 (Gb.) ORL: http://deposit.adb.de/cgi-bin/dokserv/id=2774611&prov=M&dok_var=1&dok_ext=htm Weinheim : WILEY-VCH, 2007
	TUB HH Katalog

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

Module M0802: Memi	orane Technology			
Courses				
Title		Тур	Hrs/wk	СР
Membrane Technology (L0399)		Lecture	2	3
Membrane Technology (L0400)		Recitation Section (small)	1	2
Membrane Technology (L0401)	Dect Melline Freed	Practical Course	1	1
Module Responsible				
Admission Requirements				
	Basic knowledge of water chemistry. Knowledge of	f the core processes involved in water, gas	and steam treatr	nent
Knowledge	After taking part successfully, students have reach	and the following learning results		
	After taking part successfully, students have reach	led the following learning results		
Professional Competence				
Knowledge	Students will be able to rank the technical applica			
	the different driving forces behind existing mem membrane filtration and their advantages and dis			
	membranes in water, other liquid media, gases an		and the key and	
	······, -···, -····, -····, -····, -····, -····, -····, -····, -····, -····, -····, -····, -····, -····, -····,			
Skills	Students will be able to prepare mathematical ec	quations for material transport in porous a	nd solution-diffu	sion membranes a
	calculate key parameters in the membrane separ			
	available boundary data and provide recommend			
	experiments, students will be able to classify t			
	membrane materials. Students will be able to char	racterise the formation of the fouling layer i	in different water	s and apply techn
	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 ab	le to make decision
	within their group on laboratory experiments to be	e undertaken jointly and present these to ot	hers.	
Autonomy	Students will be in a position to solve homework	on the tonic of membrane technology in	dopondoptly. The	w will be capable
Autonomy	finding creative solutions to technical questions.	ton the topic of membrane technology in	dependenciy. The	
Workload in Hours	Independent Study Time 124, Study Time in Lectur	re 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic:	: Elective Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation A - General			
	Bioprocess Engineering: Specialisation B - Industria			
	Chemical and Bioprocess Engineering: Specialisati			
	Chemical and Bioprocess Engineering: Specialisati	• •		
	Chemical and Bioprocess Engineering: Technical C Environmental Engineering: Specialisation Water C		-	
	Process Engineering: Specialisation Water C		iipuisoi y	
	Process Engineering: Specialisation Process Engine	5 1 5		
		Process Engineering. Elective Compulsory		
	5 5 1	5 5 1 5		
	Water and Environmental Engineering: Specialisat Water and Environmental Engineering: Specialisat	ion Water: Elective Compulsory		

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

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

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

Module M0949: Rural	Development and Resources Oriented	Sanitation for diffe	erent Climate Zon	es
Courses				
Title		Тур	Hrs/wk	СР
Rural Development and Resources	Oriented Sanitation for different Climate Zones (L0942)	Seminar	2	3
Rural Development and Resources	Oriented Sanitation for different Climate Zones (L0941)	Lecture	2	3
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
Recommended Previous	Basic knowledge of the global situation with rising pover	ty, soil degradation, lack of w	ater resources and sanita	tion
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
Knowledge	Students can describe resources oriented wastewater s	systems mainly based on so	urce control in detail. The	ey can comment on
	techniques designed for reuse of water, nutrients and so	il conditioners.		
	Students are able to discuss a wide range of proven app	roaches in Rural Developmen	t from and for many regio	ons of the world.
Skills	Students are able to design low-tech/low-cost sanitati	on rural water supply rain	water harvesting systems	s measures for the
JKIIIS	rehabilitation of top soil quality combined with food and			
	"Holisitc Planned Grazing" as developed by Allan Savory			···· ·································
Personal Competence				
Social Competence	The students are able to develop a specific topic in a tea	m and to work out milestone	s according to a given pla	n.
Autonomy	Students are in a position to work on a subject and to	o organize their work flow in	ndependently. They can a	also present on this
	subject.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	During the course of the semester, the students work to	owards mile stones. The worl	< includes presentations a	and papers. Detailed
scale	information will be provided at the beginning of the sme	ster.		
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Election	ve Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation A - General Biopro	ocess Engineering: Elective C	ompulsory	
	Chemical and Bioprocess Engineering: Specialisation Ger	neral Process Engineering: El	ective Compulsory	
	Environmental Engineering: Specialisation Environment	and Climate: Elective Compu	sory	
	Environmental Engineering: Specialisation Water Quality			
	International Management and Engineering: Specialisation	•••		Compulsory
	Process Engineering: Specialisation Environmental Proce	• •	pulsory	
	Process Engineering: Specialisation Process Engineering			
	Water and Environmental Engineering: Specialisation Wa			
	Water and Environmental Engineering: Specialisation En		ы у	
	Water and Environmental Engineering: Specialisation Cit	ies. Elective compulsory		

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

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

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

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

Module M1720: Emeri	ging Trends in Environmental Eng	uneering		
Module M1720. Eller	Jing Trends in Environmental Eng	Jineering		
Courses				
Title		Тур	Hrs/wk	СР
Environmental Research Trends (L2	752)	Seminar	2	2
Microplastics in Environment (L275)))	Lecture	2	2
Scientific Communication and Meth	ods (L2751)	Lecture	1	2
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
Recommended Previous	Basic knowledge on water, soil and environmenta	al research.		
Knowledge				
Educational Objectives	After taking part successfully, students have read	ched the following learning results		
Professional Competence				
Knowledge	The students will be exposed to up-to-date resea	arch topics focused on soil, water and	I climate related challen	iges with a particula
	focus on the effects of microplastics in environ	ment. Data analysis, data measureme	ent, curation and prese	ntation will be othe
	skills that the students will develop in this modul	e.		
Skills	Students' research skills will be improved in this	s module. How to prepare and delive	r an effective presentat	tion how to write a
Skills	Students' research skills will be improved in this abstract, research paper and proposal will be di the students will be exposed to current research	scussed in this module. Moreover, thr		
Skills Personal Competence	abstract, research paper and proposal will be di	scussed in this module. Moreover, thr		
Personal Competence	abstract, research paper and proposal will be di	scussed in this module. Moreover, thr trends in environmental engineering.	rough Research-Based L	earning approaches
Personal Competence Social Competence	abstract, research paper and proposal will be di the students will be exposed to current research	scussed in this module. Moreover, thr trends in environmental engineering. through Research-Based Teaching ap	rough Research-Based L proaches will be at the c	earning approaches
Personal Competence Social Competence	abstract, research paper and proposal will be di the students will be exposed to current research Developing teamwork and problem solving skills	scussed in this module. Moreover, thr trends in environmental engineering. through Research-Based Teaching ap dual reports and presentation. This	rough Research-Based L proaches will be at the c	earning approaches
Personal Competence Social Competence Autonomy	abstract, research paper and proposal will be di the students will be exposed to current research Developing teamwork and problem solving skills The students will be involved in writing indivi-	scussed in this module. Moreover, thr trends in environmental engineering. through Research-Based Teaching ap dual reports and presentation. This ly.	rough Research-Based L proaches will be at the c	earning approaches
Personal Competence Social Competence Autonomy	abstract, research paper and proposal will be di the students will be exposed to current research Developing teamwork and problem solving skills The students will be involved in writing indivi willingness to work independently and responsib Independent Study Time 110, Study Time in Lect	scussed in this module. Moreover, thr trends in environmental engineering. through Research-Based Teaching ap dual reports and presentation. This ly.	rough Research-Based L proaches will be at the c	earning approaches
Personal Competence Social Competence Autonomy Workload in Hours	abstract, research paper and proposal will be di the students will be exposed to current research Developing teamwork and problem solving skills The students will be involved in writing indivi- willingness to work independently and responsib Independent Study Time 110, Study Time in Lect 6	scussed in this module. Moreover, thr trends in environmental engineering. through Research-Based Teaching ap dual reports and presentation. This ly.	rough Research-Based L proaches will be at the c	earning approaches
Personal Competence Social Competence Autonomy Workload in Hours Credit points Course achievement	abstract, research paper and proposal will be di the students will be exposed to current research Developing teamwork and problem solving skills The students will be involved in writing indivi- willingness to work independently and responsib Independent Study Time 110, Study Time in Lect 6	scussed in this module. Moreover, thr trends in environmental engineering. through Research-Based Teaching ap dual reports and presentation. This ly.	rough Research-Based L proaches will be at the c	earning approaches
Personal Competence Social Competence Autonomy Workload in Hours Credit points Course achievement Examination	abstract, research paper and proposal will be di the students will be exposed to current research Developing teamwork and problem solving skills The students will be involved in writing indivi willingness to work independently and responsib Independent Study Time 110, Study Time in Lect 6 None	scussed in this module. Moreover, thr trends in environmental engineering. through Research-Based Teaching ap dual reports and presentation. This ly.	rough Research-Based L proaches will be at the c	earning approaches
Personal Competence Social Competence Autonomy Workload in Hours Credit points Course achievement Examination	abstract, research paper and proposal will be di the students will be exposed to current research Developing teamwork and problem solving skills The students will be involved in writing indivi willingness to work independently and responsib Independent Study Time 110, Study Time in Lect 6 None Subject theoretical and practical work	scussed in this module. Moreover, thr trends in environmental engineering. through Research-Based Teaching ap dual reports and presentation. This ly.	rough Research-Based L proaches will be at the c	earning approaches
Personal Competence Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination and scale	abstract, research paper and proposal will be di the students will be exposed to current research Developing teamwork and problem solving skills The students will be involved in writing indivi willingness to work independently and responsib Independent Study Time 110, Study Time in Lect 6 None Subject theoretical and practical work	scussed in this module. Moreover, thr trends in environmental engineering. through Research-Based Teaching ap dual reports and presentation. This ly.	rough Research-Based L proaches will be at the c	earning approaches
Personal Competence Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	abstract, research paper and proposal will be di the students will be exposed to current research Developing teamwork and problem solving skills The students will be involved in writing indivi- willingness to work independently and responsib Independent Study Time 110, Study Time in Lect 6 None Subject theoretical and practical work Report and Presentation	scussed in this module. Moreover, thr trends in environmental engineering. through Research-Based Teaching ap dual reports and presentation. This ly. ture 70 c: Elective Compulsory	rough Research-Based L proaches will be at the c will contribute to the s	earning approaches
Personal Competence Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	abstract, research paper and proposal will be di the students will be exposed to current research Developing teamwork and problem solving skills The students will be involved in writing indivi willingness to work independently and responsib Independent Study Time 110, Study Time in Lect 6 None Subject theoretical and practical work Report and Presentation Civil Engineering: Specialisation Water and Traffi	scussed in this module. Moreover, thr trends in environmental engineering. through Research-Based Teaching ap dual reports and presentation. This ly. ture 70 c: Elective Compulsory mment and Climate: Elective Compuls	rough Research-Based L proaches will be at the c will contribute to the s	earning approaches
Personal Competence Social Competence Autonomy Workload in Hours Credit points Course achievement Examination Examination duration and scale Assignment for the	abstract, research paper and proposal will be di the students will be exposed to current research Developing teamwork and problem solving skills The students will be involved in writing indivi willingness to work independently and responsib Independent Study Time 110, Study Time in Lect 6 None Subject theoretical and practical work Report and Presentation Civil Engineering: Specialisation Water and Traffi Environmental Engineering: Specialisation Enviro	scussed in this module. Moreover, thr trends in environmental engineering. through Research-Based Teaching ap dual reports and presentation. This ly. ture 70 c: Elective Compulsory mment and Climate: Elective Compuls ation Cities: Elective Compulsory	rough Research-Based L proaches will be at the c will contribute to the s	earning approaches

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

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

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

Courses	
Title	Typ Hrs/wk CP
Adaptation to climate change in hy	draulic engineering (L2291) Project-/problem-based Learning 4 6
Module Responsible	Prof. Peter Fröhle
Admission Requirements	None
Recommended Previous Knowledge	 Hydrology, Hydraulic Engineering Hydromechanic, Hydraulics Fundamentals of Coastal Engineering, Coastal- and Flood Protection Hydrological Systems
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence Knowledge Skills	 Climate protection and climate adaptation Insights into climate change and its regional characteristics - fundamentals, climate modelling / climate models Impacts of climate change on the components of the regional hydrological cycle Fundamentals of analysis of climate data Consequences of the impact of the climate change Measures for climate adaptation Assessment, prioritization and communication of adaptation measures Fundamentals of the analysis of hydrometeorological and hydrological data Critical thinking: analysis of processes and relations, assessment of needs for action Creative thinking: development of adaptation strategies and adaptation measures Practical thinking: inclusion of restrictions, application of calculation approaches, methods, numerical models, planni methods Consideration of complex tasks
Personal Competence Social Competence Autonomy	 Working in heterogenous groups Working with different scientific / non-scientific disciplines Self reflection Application oriented use of knowledge and skills
	Autonomous work on complex tasks
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written elaboration
Examination duration and scale	Preparation of a written report and a presentation of a complex task.
Assignment for the	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory
	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory
	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory Water and Environmental Engineering: Specialisation Cities: Elective Compulsory
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory Water and Environmental Engineering: Specialisation Environment: Elective Compulsory
	Water and Environmental Engineering: Specialisation Water: Elective Compulsory

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

Courses				
Гitle		Тур	Hrs/wk	СР
	Protection in a Changing Climate (SeaPiaC) (L2926)	Project-/problem-based Learning	4	6
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous	Hydraulic Engineering			
Knowledge	Hydromechanics, Hydraulics			
	Fundamentals of Coastal Engineering, Coastal- and	Flood Protection		
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge				
	Climate and Climate Change			
	General Impacts of Climate Change on Wind Regim Concequences of Climate Change for Coastal Press			
	 Consequences of Climate Change for Coastal Proce Coastal Protection in Taiwan and Germany 	5565		
	 Fundamentals of Climate Adaptation 			
	Nature-based Solutions (NBS) for Coastal Protection	1		
Skills				
	Critical thinking: analysis of processes and relations			
	Creative thinking: development of adaptation strategies and adaptation measures			
	 Practical thinking: inclusion of restrictions, applic 	ation of calculation approaches, meth	iods, numerica	l models, plannin
	methods			
	 Consideration of complex tasks 			
Personal Competence				
Social Competence	Working in heterogenous groups			
	Working in international groups			
	Working with different scientific / non-scientific disc	iplines		
	Self reflection			
Autonomy				
Autonomy	 Application oriented use of knowledge and skills 			
	Autonomous work on complex tasks			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement				
	Written elaboration			
	Preparation of a written report on a complex task with a	presentation and subsequent discussion	on. The work o	n the complex tas
	happens in the course of the lecture.			
•	Civil Engineering: Specialisation Coastal Engineering: Elec			
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering			
	Civil Engineering: Specialisation Structural Engineering: El Civil Engineering: Specialisation Water and Traffic: Electiv			
	Environmental Engineering: Specialisation water and Tranic: Electiv			
	Water and Environmental Engineering: Specialisation Environment al			
	Water and Environmental Engineering: Specialisation Envi	ronment: Elective Compulsory		

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

Courses						
Title			Тур		Hrs/wk	СР
Waste and Environmental Chemist	-		Practical Course		2	2
Biological Waste Treatment (L0318)		Project-/problem	-based Learning	3	4
Module Responsible	Prof. Kerstin Kuchta					
Admission Requirements	None					
Recommended Previous	chemical and biologica	al basics				
Knowledge						
Educational Objectives	After taking part succe	essfully, students have	reached the following learning resu	lts		
Professional Competence						
Knowledge	design and layout of a	anaerobic and aerobic v	ning the planning of biological waste vaste treatment plants in detail, des and explain different methods for wa	scribe different te		
Skills	control measurements	s. The students can re	tion of design and layout of plants. cherché and evaluate literature and f reflecting and evaluating findings	date connected	-	
Personal Competence						
Social Competence	Students can participa	ate in subject-specific	and interdisciplinary discussions, de	evelop cooperate	ed solutions a	nd defend their d
	work results in front accept professional co		e the scientific development in fro	nt of colleagues.	Furthermore	, they can give a
Autonomy	Students can independently tap knowledge from literature, business or test reports and transform it to the course projects. They are capable, in consultation with supervisors as well as in the interim presentation, to assess their learning level and define furthe steps on this basis. Furthermore, they can define targets for new application-or research-oriented duties in accordance with the potential social, economic and cultural impact.					
Workload in Hours	Independent Study Tir	me 110. Study Time in	Lecture 70			
Credit points		ne 110, Study fille in				
Course achievement		Form	Description			
course acmevement	Yes None	Subject theoretical				
		practical work				
Examination	Presentation					
Examination duration and	Elaboration and Prese	ntation (15-25 minutes	in groups)			
scale						
Assignment for the	Civil Engineering: Spe	cialisation Coastal Engi	neering: Elective Compulsory			
Following Curricula	Civil Engineering: Spe	cialisation Geotechnica	l Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory					
	Civil Engineering: Spe	cialisation Water and T	raffic: Elective Compulsory			
	Bioprocess Engineerin	g: Specialisation A - Ge	eneral Bioprocess Engineering: Elect	ive Compulsory		
	Chemical and Bioprocess Engineering: Specialisation General Process Engineering: Elective Compulsory					
	Chemical and Bioproce	ess Engineering: Specia	alisation Bioprocess Engineering: Ele	ective Compulsor	У	
	Chemical and Bioproce	ess Engineering: Specia	alisation Chemical Process Engineer	ing: Elective Con	npulsory	
	Chemical and Bioproce	ess Engineering: Specia	alisation Chemical and Bio process E	ingineering: Elec	tive Compulso	ory
	Environmental Engine	ering: Core Qualificatio	n: Compulsory			
	-		Specialisation II. Renewable Energy		lsory	
			nental Process Engineering: Elective			
	Water and Environment	ntal Engineering: Speci	alisation Cities: Elective Compulsory	/		
			alisation Environment: Elective Com			

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

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

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

Module M2006: Wast	e Treatment and Recycling				
Courses					
Title	Тур		Hrs/wk	СР	
Planning of waste treatment plants	(L3267) Proje	ject-/problem-based Learning	3	3	
Recycling technologies and therma		ture	2	2	
Recycling technologies and therma	I waste treatment (L3266) Reci	itation Section (small)	1	1	
Module Responsible	Prof. Kerstin Kuchta				
Admission Requirements	None				
Recommended Previous	Basics of thermo dynamics				
Knowledge	Basics of fluid dynamics				
	fluid dynamics chemistry				
	• huld dynamics chemistry				
Educational Objectives	After taking part successfully, students have reached the following le	arning results			
Professional Competence					
Knowledge	The students can name, describe current issue and problems in the	field of waste treatment (m	echanical, che	emical and thern	
	and contemplate them in the context of their field.				
	The industrial application of unit operations as part of process engine			aste technologi	
	Compostion, particle sizes, transportation and dosing of wastes are de	escribed as important unit of	perations .		
	Students will be able to design and design waste treatment technolo	ogy equipment.			
Chille	The students are able to called suitable processes for the treatment	of wastes or row material w	th respect to	their characteric	
SKIIIS	The students are able to select suitable processes for the treatment of wastes or raw material with respect to their characteristic and the process aims. They can evaluate the efforts and costs for processes and select economically feasible treatment concepts				
	and the process aims. They can evaluate the errorts and costs for pro		ally leasible tr	earment concep	
Personal Competence					
Social Competence	Students can				
	 respectfully work together as a team and discuss technical task 				
	 participate in subject-specific and interdisciplinary discussions, 	,			
	develop cooperated solutions				
	 promote the scientific development and accept professional control 	onstructive criticism.			
Autonomy	Students can independently tap knowledge of the subject area	and transform it to new	questions. Th	ey are capable,	
	consultation with supervisors, to assess their learning level and def	fine further steps on this ba	sis. Furthermo	re, they can def	
	targets for new application-or research-oriented duties in accordance	with the potential social, ec	onomic and cu	ultural impact.	
	Independent Study Time 96, Study Time in Lecture 84				
Credit points					
Course achievement					
	Written exam				
Examination duration and	120 min				
scale					
-	Civil Engineering: Specialisation Water and Traffic: Elective Compulso				
Following Curricula	Bioprocess Engineering: Specialisation A - General Bioprocess Engine				
	Chemical and Bioprocess Engineering: Specialisation General Process		-		
	Chemical and Bioprocess Engineering: Specialisation Bioprocess Engi	5 1 .	, ,		
	Chemical and Bioprocess Engineering: Specialisation Chemical Process				
	Chemical and Bioprocess Engineering: Specialisation Chemical and Bi	1 5 5	tive Compulso	ry	
	Environmental Engineering: Specialisation Energy and Resources: Ele				
	International Management and Engineering: Specialisation II. Renewa	55	sory		
	Renewable Energies: Specialisation Bioenergy Systems: Elective Com				
	Process Engineering: Specialisation Chemical Process Engineering: El				
	Process Engineering: Specialisation Process Engineering: Elective Cor				
	Process Engineering: Specialisation Environmental Process Engineering	• • •			
	Water and Environmental Engineering: Specialisation Environment: C				
	Water and Environmental Engineering: Specialisation Cities: Elective	Compulsory			

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

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

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

Specialization Environment

Module M0581: Wate	* Drotostion			
Module M0561: Wate	refotection			
Courses				
Title		Тур	Hrs/wk	СР
Water Protection and Wastewater I	-	Lecture	3	3
Water Protection and Wastewater I	-	Project Seminar	3	3
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
Recommended Previous	 Basic knowledge in water management; 			
Knowledge	 Good knowledge in urban drainage; 			
	 Good knowledge of wastewater treatment 	nt techniques;		
	 Good knowledge of pollutants (e.g. COD, 	BOD, TS, N, P) and their properties;		
Educational Objectives	After taking part successfully, students have re	ached the following learning results		
Professional Competence				
Knowledge	The students can describe the basic principles	of the regulatory framework related to the	international and Eu	ropean water sector.
	They can explain limnological processes, sub-	stance cycles and water morphology in	detail. They are able	e to assess complex
	problems related to water protection, such as		tment with a special	focus on innovative
	solutions, remediation measures as well as con	ceptual approaches.		
Skills	Students can accurately assess current problem	ms and situations in a country-specific or	local context. They c	an suggest concrete
	actions to contribute to the planning of tomo	prrow's urban water cycle. Furthermore,	they can suggest ap	opropriate technical,
	administrative and legislative solutions to solve	these problems.		
Personal Competence				
Social Competence	The students can work together in international groups.			
Autonomy	Students are able to organize their work flow t	to prepare presentations and discussions.	They can acquire ap	propriate knowledge
	by making enquiries independently.			
	Independent Study Time 96, Study Time in Lect	ture 84		
Credit points Course achievement				
Examination				
Examination duration and				
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engi	neering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical E	ngineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engine			
	Civil Engineering: Specialisation Water and Traf			
	Environmental Engineering: Specialisation Wate	. ,	1	
	International Management and Engineering: Sp		ompulsory	
	Water and Environmental Engineering: Speciali Water and Environmental Engineering: Speciali			
	Water and Environmental Engineering: Speciali			
		· · · · · · · · · · · · · · · · · · ·		

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

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

Module M2006: Wast	e Treatment and Recycling			
Courses				
Title	Тур		Hrs/wk	СР
Planning of waste treatment plants	(L3267) Project	t-/problem-based Learning	3	3
Recycling technologies and therma	al waste treatment (L3265) Lecture	e	2	2
Recycling technologies and therma	al waste treatment (L3266) Recitat	tion Section (small)	1	1
Module Responsible	Prof. Kerstin Kuchta			
Admission Requirements	None			
Recommended Previous				
Knowledge	Basics of thermo dynamicsBasics of fluid dynamics			
	 fluid dynamics chemistry 			
Educational Objectives	After taking part successfully, students have reached the following learn	ning results		
Professional Competence				
Knowledge	The students can name, describe current issue and problems in the field	eld of waste treatment (m	echanical, che	mical and thern
	and contemplate them in the context of their field.			
	The industrial application of unit operations as part of process engineer	ing is explained by actual	examples of w	aste technologi
	Compostion, particle sizes, transportation and dosing of wastes are desi			uste teennologi
	composition, particle sizes, transportation and dosing of wastes are des		serucions .	
	Students will be able to design and design waste treatment technology	equipment.		
Skills	The students are able to select suitable processes for the treatment of	wastes or raw material wi	th respect to t	heir characteris
Skiis	Skills The students are able to select suitable processes for the treatment of wastes or raw material with respect and the process aims. They can evaluate the efforts and costs for processes and select economically feasible			
			,	
Personal Competence				
Social Competence	Students can			
	 respectfully work together as a team and discuss technical tasks 			
	 participate in subject-specific and interdisciplinary discussions, 			
	 develop cooperated solutions 			
	 promote the scientific development and accept professional con 	structive criticism.		
	t i i i i i i i i i i i i i i i i i i i			
Autonomy	Students can independently tap knowledge of the subject area a			
	consultation with supervisors, to assess their learning level and define			
	targets for new application-or research-oriented duties in accordance w	ith the potential social, ec	onomic and cu	Itural impact.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory	,		
Following Curricula	Bioprocess Engineering: Specialisation A - General Bioprocess Engineer	ing: Elective Compulsory		
	Chemical and Bioprocess Engineering: Specialisation General Process E	ngineering: Elective Comp	ulsory	
	Chemical and Bioprocess Engineering: Specialisation Bioprocess Engine	ering: Elective Compulsor	ý	
	Chemical and Bioprocess Engineering: Specialisation Chemical Process			
	Chemical and Bioprocess Engineering: Specialisation Chemical and Bio	process Engineering: Elect	ive Compulsor	У
	Environmental Engineering: Specialisation Energy and Resources: Elect			
	International Management and Engineering: Specialisation II. Renewable	5,5	sory	
	Renewable Energies: Specialisation Bioenergy Systems: Elective Compu	•		
	Process Engineering: Specialisation Chemical Process Engineering: Elec	1 2		
	Process Engineering: Specialisation Process Engineering: Elective Comp			
	Process Engineering: Specialisation Environmental Process Engineering.			
	Water and Environmental Engineering: Specialisation Environment: Con			
	Water and Environmental Engineering: Specialisation Cities: Elective Co	ompulsory		

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

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

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

Lingineering				
Module M0513: Syste	m Aspects of Renewable Energies			
Courses				
Title		Тур	Hrs/wk	СР
Fuel Cells, Batteries, and Gas Storage: New Materials for Energy Production and Storage (L0021)		Lecture	2	2
Energy Trading (L0019) Energy Trading (L0020)		Lecture Recitation Section (small)	1	1
Deep Geothermal Energy (L0025)		Lecture	2	2
	Prof. Martin Kaltschmitt			
Admission Requirements				
-	Module: Technical Thermodynamics I			
Knowledge				
	Module: Technical Thermodynamics II			
Educational Objectives	After taking part successfully, students have reached the fo	lowing learning results		
Professional Competence				
-	Students are able to describe the processes in energy tradir	a and the design of energy mark	ets and can critic	allv evaluate them in
	relation to current subject specific problems. Furtherm			
	electrochemical energy conversion in fuel cells and can es			-
	their respective structure. Students can compare this techn			
	an overview of the procedure and the energetic involvemen			-
Skills	Students can apply the learned knowledge of storage system	ns for excessive energy to explain	n for various ener	gy systems different
	approaches to ensure a secure energy supply. In particular, they can plan and calculate domestic, commercial and industrial			
	heating equipment using energy storage systems in an en	heating equipment using energy storage systems in an energy-efficient way and can assess them in relation to complex power		
	systems. In this context, students can assess the potentia	al and limits of geothermal powe	er plants and exp	plain their operating
	mode.			
	Furthermore, the students are able to explain the procedure	Furthermore, the students are able to evolution the procedures and strategies for marketing of energy and early it is the evolution of		
	Furthermore, the students are able to explain the procedures and strategies for marketing of energy and apply it in the context of			
	other modules on renewable energy projects. In this context they can unassistedly carry out analysis and evaluations of energie markets and energy trades.			
Personal Competence				
Social Competence	Students are able to discuss issues in the thematic fields in	the renewable energy sector add	ressed within the	module.
Autonomv	Students can independently exploit sources , acquire the	particular knowledge about the	subiect area and	transform it to new
	Students can independently exploit sources , acquire the particular knowledge about the subject area and transform it to new questions.			
	Independent Study Time 96, Study Time in Lecture 84			
Credit points				
Course achievement				
	Written exam			
Examination duration and	3 hours written exam			
scale	Diepreses Engineering, Enginitientien A., Constal Di	a Engineering, Elective Computer		
-	Bioprocess Engineering: Specialisation A - General Bioproce		лу	
Following Curricula	Aircraft Systems Engineering: Core Qualification: Elective Co International Management and Engineering: Specialisation I		nnulsony	
	International Management and Engineering: Specialisation I International Management and Engineering: Specialisation I	••		Compulsory
	International Management and Engineering: Specialisation I International Management and Engineering: Specialisation I			
	Aeronautics: Core Qualification: Elective Compulsory	Envirenting and blotect	mology. Elective	compuisory
	Renewable Energies: Core Qualification: Compulsory			
	Theoretical Mechanical Engineering: Specialisation Energy S	vstems: Elective Compulsory		
	Process Engineering: Specialisation Environmental Process E			
	Process Engineering: Specialisation Process Engineering: Ele	• • •		
	Water and Environmental Engineering: Specialisation Water			
	Water and Environmental Engineering: Specialisation Water Water and Environmental Engineering: Specialisation Enviro			
	trace, and Environmental Engineering. Specialisation Enviro			

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

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

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

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

	11			
Module M0827: Mode	ling in Water Management			
Courses				
Title Groundwater Modeling using Modfle	ow (L0543)	Typ Lecture	Hrs/wk	CP
Groundwater Modeling using Modfle		Recitation Section (small)	2	2
Modeling of Water Supply Network	(L0875)	Project-/problem-based Learning	g 2	3
Module Responsible	Dr. Klaus Johannsen			
Admission Requirements	None			
Recommended Previous	Groundwater			
Knowledge	groundwater hydraulics and transport of	substances		
	Pipe Systems			
	 Knowledge on urban water infrastructures 	rres, in particular drinking water systemsand	urban drainag	e systems including
	Hydraulics of drinking water supply syste	ms and sewer systems		
	Basic knowledge on water management			
Educational Objectives	After taking part successfully, students have re	ached the following learning results		
Professional Competence				
Knowledge	The students are able to describe the modelling of groundwater flow and transport as well as urban water infrastructures. They ca carry out systems analyses and can detect technical and conceptual weak points within the systems in case studies. Besides the are able to analyse interdependencies of hydraulic and toxic phenomena in soil and water.			
Skills	The students are able to construct and apply scientific groundwater models indipendently. They can work on different scenarios and can compare or assess different solutions for existing problems by application of selected software products. The students are able to use different software solutions (e.g. EPANET, EPA-SWMM).			
Personal Competence				
Social Competence	Wird nicht vermittelt.			
Autonomy	Wird nicht vermittelt.			
Workload in Hours	Independent Study Time 110, Study Time in Le	cture 70		
Credit points	6			
Course achievement	None			
	Oral exam			
Examination				
Examination duration and				
Examination duration and scale	30 min			
Examination duration and scale Assignment for the	30 min Civil Engineering: Specialisation Structural Engi	•		
Examination duration and scale	30 min Civil Engineering: Specialisation Structural Engi Civil Engineering: Specialisation Geotechnical E	ngineering: Elective Compulsory		
Examination duration and scale Assignment for the	30 min Civil Engineering: Specialisation Structural Engi Civil Engineering: Specialisation Geotechnical E Civil Engineering: Specialisation Coastal Engine	ngineering: Elective Compulsory ering: Elective Compulsory		
Examination duration and scale Assignment for the	30 min Civil Engineering: Specialisation Structural Engi Civil Engineering: Specialisation Geotechnical E Civil Engineering: Specialisation Coastal Engine Civil Engineering: Specialisation Water and Traf	ngineering: Elective Compulsory ering: Elective Compulsory fic: Elective Compulsory		
Examination duration and scale Assignment for the	30 min Civil Engineering: Specialisation Structural Engi Civil Engineering: Specialisation Geotechnical E Civil Engineering: Specialisation Coastal Engine Civil Engineering: Specialisation Water and Traf Civil Engineering: Specialisation Computational	ngineering: Elective Compulsory ering: Elective Compulsory fic: Elective Compulsory Engineering: Elective Compulsory		
Examination duration and scale Assignment for the	30 min Civil Engineering: Specialisation Structural Engi Civil Engineering: Specialisation Geotechnical E Civil Engineering: Specialisation Coastal Engine Civil Engineering: Specialisation Water and Traf	ngineering: Elective Compulsory ering: Elective Compulsory fic: Elective Compulsory Engineering: Elective Compulsory sation Environment: Elective Compulsory		

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

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

Course L0875: Modeling of Water Supply Network		
Тур	Project-/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	
Cycle	SoSe	
Content		
Literature	Mutschmann/Stimmelmayr: Taschenbuch der Wasserversorgung, 16. Auflage. Springer Vieweg - Verlag. Wiesbaden 2014.	

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

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

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

Module M0828: Urbar	Environmental Management			
Courses				
Title	Тур		Hrs/wk	СР
Noise Protection (L1109)	Lecture		2	2
Urban Infrastructures (L0874)		t-/problem-based Learning	2	4
Module Responsible	Dr. Dorothea Rechtenbach			
Admission Requirements	None			
Recommended Previous	Knowledge on Urban planning			
Knowledge	Knowledge on measures for climate protection			
	General knowledge of scientific writing/working			
	After taking part successfully, students have reached the following learn	ning results		
Professional Competence				
Knowledge	Students can describe urban development corridors as well as current a	and future urban environn	nental problen	ns. They are able t
	explain the causes of environmental problems (like noise).			
	Students can specify applications for various technical innovations and		oute to the im	provement of urba
	life. They can, for example, derive and discuss measures for effective no	oise abatement.		
Skills	Students are able to develop specific solutions for correcting exi	isting or future environr	ment-related	problems of urba
	development. They can define a range of conceptual and technical solutions for environmental problems for different developm			Ferent developmer
	paths. To solve specific urban environmental problems they can select	t technical innovations ar	nd integrate t	hem into the urba
	context.			
Personal Competence				
Social Competence	The students can work together in international groups.			
Autonomy	Students are able to organize their work flow to prepare themselves for	or presentations and cont	ributions to th	e discussions. The
	can acquire appropriate knowledge by making enquiries independently.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Written Report plus oral Presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elective Compu	ilsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Com	npulsory		
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulso	ory		
	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory	1		
	Environmental Engineering: Core Qualification: Elective Compulsory			
	Joint European Master in Environmental Studies - Cities and Sustainability			
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure and ${\tt M}$		ory	
	Water and Environmental Engineering: Specialisation Environment: Elec			
	Water and Environmental Engineering: Specialisation Cities: Compulsory	У		

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

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

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

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

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

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

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

Engineering	
	ISBN: 3540343296 (Gb.) URL: http://www.gbv.de/dms/bs/toc/516261924.pdf URL: http://deposit.d-nb.de/cgi-bin/dokserv?
	id=2842122&prov=M&dok_var=1&dok_ext=htm
	Berlin [u.a.] : Springer, 2007
	TUB_HH_Katalog
	Henze, Mogens
	Wastewater treatment : biological and chemical processes
	ISBN: 3540422285 (Pp.)
	Berlin [u.a.] : Springer, 2002
	TUB_HH_Katalog
	Imhoff, Karl (Imhoff, Klaus R.;)
	Taschenbuch der Stadtentwässerung : mit 10 Tafeln
	ISBN: 3486263331 ((Gb.))
	München [u.a.] : Oldenbourg, 1999
	TUB_HH_Katalog
	Lange, Jörg (Otterpohl, Ralf; Steger-Hartmann, Thomas;)
	Abwasser : Handbuch zu einer zukunftsfähigen Wasserwirtschaft
	ISBN: 3980350215 (kart.) URL: http://www.gbv.de/du/services/agi/52567E5D44DA0809C12570220050BF25/000000700334
	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 Reubeus Universität Arbeitermunne Weiterhildendes Studium Wesser und Umwelt (Deutsche Versinigung für
	Bauhaus-Universität., Arbeitsgruppe Weiterbildendes Studium Wasser und Umwelt (Deutsche Vereinigung für
	Wasserwirtschaft, Abwasser und Abfall, ;)
	Abwasserbehandlung : Gewässerbelastung, Bemessungsgrundlagen, Mechanische Verfahren, Biologische Verfahren, Reststoffe
	aus der Abwasserbehandlung, Kleinkläranlagen
	ISBN: 3860682725 URL: http://www.gbv.de/dms/weimar/toc/513989765_toc.pdf URL:
	http://www.gbv.de/dms/weimar/abs/513989765_abs.pdf
	Weimar : Universitätsverl, 2006
	TUB_HH_Katalog
	Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall
	DWA-Regelwerk
	Hennef : DWA, 2004
	TUB_HH_Katalog
	Wiesmann, Udo (Choi, In Su; Dombrowski, Eva-Maria;)
	Fundamentals of biological wastewater treatment
	ISBN: 3527312196 (Gb.) URL: http://deposit.ddb.de/cgi-bin/dokserv?id=2774611&prov=M&dok_var=1&dok_ext=htm
	Weinheim : WILEY-VCH, 2007
	TUB_HH_Katalog

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

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

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

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

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

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

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

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

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

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

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

Engineering"				
Module M1724: Smar	t Monitoring			
Courses				
Title		Тур	Hrs/wk	СР
Smart Monitoring (L2762)		Integrated Lecture	2	2
Smart Monitoring (L2763)		Recitation Section (small)	2	4
Module Responsible	Prof. Kay Smarsly			
Admission Requirements	None			
Recommended Previous Knowledge	Basic knowledge or interest in object-oriented modeling, pro research and teaching areas, such as Internet of Things, Inc skills of scientific working, are required. Basic knowledge in so	dustry 4.0 and cyber-physical sy	stems, as well a	
Educational Objections				
	After taking part successfully, students have reached the follo	owing learning results		
Professional Competence	The students will become familiar with the principles and			
Skills	environment. In addition, the students will learn to design an analysis techniques, modern software design concepts, and e also part of this module, which will be conducted throughout students will design smart monitoring systems that integrate Specific focus will be put on the application of machine lear real-world (built or natural) systems, such as bridges or slope every group will be documented in a paper. All students of th system in the annual "Smart Monitoring" competition. The wr will be taught in English. Limited enrollment. The students will gain insights into operating state-of-the-art processes relevant to engineering, such as environmental, devising monitoring strategies of physical processes as part implement the strategies in smart wireless sensor nodes, usi be able to document the findings of their projects in short rep	mbedded computing methodolo t the semester and will contribu- a number of "intelligent" sensor ming techniques. The smart mo- s, or on scaled lab structures fo is module will "automatically" p itten papers and oral examination smart sensor systems, used fo structural, or comfort monitor c of group projects, tailored to ng embedded computing and p	gies. Besides lect ute to the grade. rs to be implemen onitoring systems r validation purpo articipate with th ons form the final r monitoring a wi ing. The student their knowledge l	ures, project wor In small groups, ited by the stude will be mounted ses. The outcom eir smart monito grades. The mod de range of phys s will be capable backgrounds, and
Personal Competence Social Competence	The students will be able to work in groups, share parts of th achieving the common project goals.	ne work for their projects, and d	evelop communio	cation skills, towa
Autonomy	The students will be able to gain a solid basis on approaching and solving problems in engineering, as well as on documentin results, through their involvement in their monitoring group projects.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
	10 pages of work with 15-minute oral presentation			
scale				
	Civil Engineering: Specialisation Water and Traffic: Elective Co	ompulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Ele			
j	Civil Engineering: Specialisation Coastal Engineering: Elective			
	Civil Engineering: Specialisation Structural Engineering: Electi			
	Computer Science: Specialisation II: Intelligence Engineering:			
	Environmental Engineering: Specialisation Energy and Resour	1 5		
	Environmental Engineering: Specialisation Environment and C	limate: Elective Compulsory		
	Environmental Engineering: Specialisation Environment and C Environmental Engineering: Specialisation Water Quality and		npulsory	
		Water Engineering: Elective Cor	npulsory	
	Environmental Engineering: Specialisation Water Quality and	Water Engineering: Elective Cor	npulsory	
	Environmental Engineering: Specialisation Water Quality and Mechatronics: Technical Complementary Course: Elective Con	Water Engineering: Elective Cor npulsory		
	Environmental Engineering: Specialisation Water Quality and Mechatronics: Technical Complementary Course: Elective Com Mechatronics: Core Qualification: Elective Compulsory	Water Engineering: Elective Cor npulsory nd Computer Science: Elective (
	Environmental Engineering: Specialisation Water Quality and Mechatronics: Technical Complementary Course: Elective Con Mechatronics: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Robotics a	Water Engineering: Elective Cor npulsory Ind Computer Science: Elective (Elective Compulsory		

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

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

Module M0858: Coast	al Hydraulic Engineering I				
Courses					
Title			Тур	Hrs/wk	СР
Basics of Coastal Engineering (L08	07)		Lecture	3	4
Basics of Coastal Engineering (L14	13)	I	Project-/problem-based Learning	1	2
Module Responsible	Prof. Peter Fröhle				
Admission Requirements	None				
Recommended Previous	Basics of hydraulic engineering, hydrology a	and hydromechanics			
Knowledge					
Educational Objectives	After taking part successfully, students have	e reached the following	g learning results		
Professional Competence					
Knowledge	The students are able to define and explain the basic concepts of coastal engineering and port engineering. They are able to apply the concepts to selected practical problems of coastal engineering. Students can define and determine the basics for design and dimensioning of coastal engineering constructions.				
Skills	The students are capable to apply basic design approaches to selected and pre-defined design tasks in coastal engineering.				
Personal Competence					
Social Competence	The students are able to deploy their gaine	ed knowledge in applie	ed problems such as the desig	n of coastal p	protection structure
	Additionaly, they will be able to work in tear	m with engineers of ot	her disciplines, for instance des	igning of coas	stal breakwaters.
Autonomy	The students will be able to independently extend their knowledge and applyit to new problems.				
Workload in Hours	Independent Study Time 124, Study Time in	n Lecture 56			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	The duration of the examination is 2 hours. The examination includes tasks with respect to the general understanding of the				
scale	lecture contents and calculations tasks.				
Assignment for the	Civil Engineering: Specialisation Coastal Eng	gineering: Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnic	cal Engineering: Compu	ilsory		
	Civil Engineering: Specialisation Structural E	Engineering: Elective C	ompulsory		
	Environmental Engineering: Specialisation E	Environment and Clima	te: Elective Compulsory		
	Environmental Engineering: Specialisation V	Water Quality and Wate	er Engineering: Elective Compu	lsory	
	International Management and Engineering:	: Specialisation II. Civil	Engineering: Elective Compuls	ory	
	Water and Environmental Engineering: Spec	cialisation Environmen	t: Elective Compulsory		
	Water and Environmental Engineering: Spec	cialisation Water: Elect	ive Compulsory		

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

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

Module M1878: Susta	inable energy from wind and water			
Courses				
Title Offshore Geotechnical Engineering Hydro Power Use (L0013) Wind Turbine Plants (L0011)		Typ Lecture Lecture Lecture	Hrs/wk 1 1 2	CP 1 1 3
Wind Energy Use - Focus Offshore (Lecture	1	1
	Dr. Marvin Scherzinger			
Admission Requirements				
Kecommended Previous Knowledge	Module: Technical Thermodynamics I, Module: Technical Thermodynamics II,			
	Module: Fundamentals of Fluid Mechanics			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
<i>know</i> edge	By ending this module students can explain in detail knowledge of wind turbines with a particular focus of wind energy use in offshore conditions and can critical comment these aspects in consideration of current developments. Furthermore, they are able to describe fundamentally the use of water power to generate electricity. The students reproduce and explain the basic procedure in the implementation of renewable energy projects in countries outside Europe. Through active discussions of various topics within the seminar of the module, students improve their understanding and the			
Skills	application of the theoretical background and are thus able to transfer what they have learned in practice. S 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 multidisciplinary within a se	minar.	
Autonomy	Students can independently exploit sources in the olecture and to acquire the particular knowledge about		ecture material to clear	r the contents of t
Workload in Hours	Independent Study Time 110, Study Time in Lecture	70		
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and	180 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering	ng: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engine	ering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering:	Elective Compulsory		
	International Management and Engineering: Specialis	ation II. Energy and Environmenta	al Engineering: Elective	Compulsory
	International Management and Engineering: Specialis	ation II. Renewable Energy: Electi	ive Compulsory	
	Product Development, Materials and Production: Spec	cialisation Product Development: I	Elective Compulsory	
	Product Development, Materials and Production: Spec	cialisation Production: Elective Co	mpulsory	
	Product Development, Materials and Production: Spec	cialisation Materials: Elective Com	pulsory	
	Renewable Energies: Core Qualification: Compulsory			
	Theoretical Mechanical Engineering: Specialisation Er		•	
	Process Engineering: Specialisation Environmental Pr		ulsory	
	Water and Environmental Engineering: Specialisation			
	Water and Environmental Engineering: Specialisation		ſy	
	Water and Environmental Engineering: Specialisation	Water: Elective Compulsory		

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

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

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

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

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

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

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

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

Module M2002: Wast	and Resource Manag	jement			
Courses					
Title			Тур	Hrs/wk	СР
Waste management (L3261)			Project-/problem-based Learning	3	3
International waste concepts (L325))		Lecture	2	2
International waste concepts (L326)		Recitation Section (small)	1	1
Module Responsible	Prof. Kerstin Kuchta				
Admission Requirements	None				
Recommended Previous	Basics in process engineering				
Knowledge					
Educational Objectives	After taking part successfully, st	tudents have reached the	e following learning results		
Professional Competence					
Knowledge	The students are able to descri	be waste as a resource	as well as advanced technologies for re	cycling and r	ecovery of resource
	from waste in detail. This covers	s collection, transport, tr	eatment and disposal in national and inte	ernational con	itexts.
<i>CL 11</i>				1	
SKIIIS			atment with respect to the national or c		
	They can evaluate the ecologica	al impact and the technic	al effort of different technologies and ma	anagement sy	/stems.
Personal Competence					
Social Competence	Students can work together as	a team of 2-5 persons	, participate in subject-specific and inte	erdisciplinary	discussions, devel
	Students can work together as a team of 2-5 persons, participate in subject-specific and interdisciplinary discussions, develop cooperated solutions and defend their own work results in front of others and promote the scientific development of colleagues				
	Furthermore, they can give and	accept professional con	structive criticisms.		
Autonomy	Students can independently gain additional knowledge of the subject area and apply it in solving the given course tasks and				
	projects.				
Workload in Hours	Independent Study Time 96, Stu	udy Time in Lecture 84			
Credit points	6				
Course achievement	Compulsory Bonus Form	Descr	iption		
	Yes 20 % Written e	elaboration			
Examination	Presentation				
Examination duration and	PowerPoint presentation (10-15	minutes)			
scale					
Assignment for the	Civil Engineering: Specialisation	Water and Traffic: Elect	ive Compulsory		
Following Curricula	Chemical and Bioprocess Engine	eering: Specialisation Ge	neral Process Engineering: Elective Com	oulsory	
	Chemical and Bioprocess Engine	eering: Specialisation Bio	process Engineering: Elective Compulso	ry	
	Chemical and Bioprocess Engine	eering: Specialisation Ch	emical Process Engineering: Elective Cor	npulsory	
	Chemical and Bioprocess Engine	eering: Specialisation Ch	emical and Bio process Engineering: Elec	tive Compuls	ory
	Chemical and Bioprocess Engine	eering: Core Qualificatior	a: Elective Compulsory		
	Environmental Engineering: Spe	cialisation Energy and R	esources: Elective Compulsory		
	International Management and I	Engineering: Specialisati	on II. Renewable Energy: Elective Compu	Ilsory	
			ess Engineering: Elective Compulsory		
	Water and Environmental Engin	eering: Specialisation Cit	ies: Elective Compulsory		
	Water and Environmental Engin	eering: Specialisation En	vironment: Elective Compulsory		

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

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

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

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

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

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

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

Module M1123: Selec	ted Topics in Environmental En	gineering		
Courses				
		-	11	
Title		Тур	Hrs/wk	СР
Environmental Aquatic Chemistry (Lecture	2	3
Solid Matter Process Technology for		Lecture	2	3
Sustainable landfill design and oper	ation (L3270)	Integrated Lecture Lecture	3	3
Sludge Treatment (L0520) Special topics of the Environmental	ongineering 1CD (L2280)	Lecture	2	3
Special topics of the Environmental			2	2
Special topics of the Environmental			2	3
Thermal Biomass Utilization (L1767		Lecture	2	2
Thermal Biomass Utilization (L2386		Practical Course	1	1
Module Responsible	Prof. Mathias Ernst			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
,	Depends on choice of courses			
Credit points				
Assignment for the	Environmental Engineering: Core Qualification: Elective Compulsory			
•	Water and Environmental Engineering: Specialisation Cities: Elective Compulsory			
3	Water and Environmental Engineering: Specia	1 ,		
	Water and Environmental Engineering: Specia			
	water and environmental engineering: specia			

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

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

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

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

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

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

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

Course L1767: Thermal Biom	ass Utilization	
Тур	Lecture	
Hrs/wk	2	
CP	2	
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Examination Form	Klausur	
Examination duration and	50 min	
scale		
Lecturer	Prof. Martin Kaltschmitt	
Language	DE	
Cycle	WiSe	
Content	 Goal of this course is it to discuss the physical, chemical, and biological as well as the technical, economic, and environmental basics of all options to provide energy from biomass from a German and international point of view. Additionally different system approaches to use biomass for energy, aspects to integrate bioenergy within the energy system, technical and economic development potentials, and the current and expected future use within the energy system are presented. The course is structured as follows: Biomass as an energy carrier within the energy system; use of biomass in Germany and world-wide, overview on the content of the course Photosynthesis, composition of organic matter, plant production, energy crops, residues, organic waste Biomass provision chains for woody and herbaceous biomass, harvesting and provision, transport, storage, drying Thermo-chemical conversion Basics of thermo-chemical conversion Direct thermo-chemical conversion through combustion: combustion technologies for small and large scale units, 	
	 electricity generation technologies, flue gas treatment technologies, ashes and their use Gasification: Gasification technologies, producer gas cleaning technologies, options to use the cleaned producer gas for the provision of heat, electricity and/or fuels Fast and slow pyrolysis: Technologies for the provision of bio-oil and/or for the provision of charcoal, oil cleaning technologies, options to use the pyrolysis oil and charcoal as an energy carrier as well as a raw material Physical-chemical conversion of biomass containing oils and/or fats: Basics, oil seeds and oil fruits, vegetable oil production production of a biofuel with standardized characteristics (trans-esterification, hydrogenation, co-processing in existing refineries), options to use this fuel, options to use the residues (i.e. meal, glycerine) Bio-chemical conversion of biomass Basics of bio-chemical conversion Biogas: Process technologies for plants using agricultural feedstock, sewage sludge (sewage gas), organic waste fraction (landfill gas), technologies for the provision of bio methane, use of the digested slurry Ethanol production: Process technologies for feedstock containing sugar, starch or celluloses, use of ethanol as a fuel use of the stillage 	
Literature	Kaltschmitt, M.; Hartmann, H. (Hrsg.): Energie aus Biomasse; Springer, Berlin, Heidelberg, 2009, 2. Auflage	

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

Module M0801: Wate	r Resources and -Supply			
Courses				
Title		Тур	Hrs/wk	СР
Chemistry of Drinking Water Treatment (L0311)		Lecture	2	1
Chemistry of Drinking Water Treatment (L0312)		Recitation Section (large)	1	2
Water Resource Management (L0402)		Lecture	2	2
Water Resource Management (L04	03)	Recitation Section (small)	1	1
Module Responsible	Prof. Mathias Ernst			
Admission Requirements	None			
Recommended Previous	Knowledge of water management and the	e key processes involved in water treatment.		
Knowledge				
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results		
Professional Competence				
Knowledge	Students will be able to outline key area	s of conflict in water management, as well as th	eir mutual depend	lence for sustaina
	water supply. They will understand relev	ant economic, environmental and social factors	. Students will be	able to explain a
	outline the organisational structures of wa	ater companies. They will be able to explain the a	vailable water trea	tment processes a
	the scope of their application.			
Skills		lex problems in drinking water production an		-
	management and technical measures. Th	ey will be able to assess the evaluation methods	that can be used	for this. Students
	be able to carry out chemical calculation	ns for selected treatment processes and apply	generally accepted	technical rules
	standards to these processes.			
Personal Competence				
	Working in a diverse group of specialists, students will be able to develop and document complex solutions for the management			
	and treatment of drinking water. They will be able to take an appropriate professional position, for example representing use			
		nt solutions in teams of diverse experts and preser		
Autonomy	Students will be in a position to work on a	subject independently and present on this subject	t.	
Workload in Hours	Independent Study Time 96, Study Time in	n Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 min (chemistry) + presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structura	l Engineering: Elective Compulsory		
Following Curricula				
	Civil Engineering: Specialisation Water and			
	Civil Engineering: Specialisation Coastal E			
		chnical Complementary Course: Elective Compuls	orv	
		ng: Specialisation II. Energy and Environmental En		Compulsory
		onmental Process Engineering: Elective Compulsor		compuisory
	Process Engineering: Specialisation Process		3	
	Water and Environmental Engineering: Sp			
		ecialisation Environment: Elective Compulsory		
	Water and Environmental Engineering: Sp			

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

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

Course L0402: Water Resour	ce Management
Тур	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	 Aktuelle UN World Water Development Reports Branchenbild der deutschen Wasserwirtschaft, VKU (2011) Aktuelle Artikel wissenschaftlicher Zeitschriften Ppt der Vorlesung

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

Module M0822: Proce	ss Modeling in Water Technolo	ду		
Courses				
Title		Тур	Hrs/wk	СР
Process Modelling of Wastewater T	reatment (L0522)	Project-/problem-based Learning	2	3
Process Modeling in Drinking Water		Project-/problem-based Learning	2	3
Module Responsible	Dr. Klaus Johannsen			
Admission Requirements	None			
Recommended Previous	Knowledge of the most important processes in	n drinking water and waste water treatment.		
Knowledge				
Educational Objectives	After taking part successfully, students have i	eached the following learning results		
Professional Competence				
Knowledge	Students are able to explain selected proces basics as well as possibilities and limitations of	ses of drinking water and waste water treatment i	n detail. The	y are able to explair
Skills		features Modelica offers. They are able to transponematical model in Modelica with respect to equilib assess their possibilities and limitations.		
Personal Competence Social Competence		ument solutions in a group with members of different rk constructively with feedback concerning their wo		oackground. They are
Autonomy	Students are able to define a problem, gain th	e required knowledge and set up a model.		
Workload in Hours	Independent Study Time 124, Study Time in L	ecture 56		
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and				
scale				
Assignment for the	Civil Engineering: Specialisation Water and Tr	affic: Elective Compulsory		
•		cal Complementary Course: Elective Compulsory		
-	Environmental Engineering: Specialisation Wa	ter Quality and Water Engineering: Elective Compu	lsory	
	Process Engineering: Specialisation Environm	ental Process Engineering: Elective Compulsory		
	Process Engineering: Specialisation Process E	ngineering: Elective Compulsory		
	Water and Environmental Engineering: Specia	lisation Water: Elective Compulsory		
	Water and Environmental Engineering: Specia	lisation Environment: Elective Compulsory		
	Water and Environmental Engineering: Specia	lisation Cities: Elective Compulsory		

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

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

Module M0802: Meml	orane Technology			
Courses				
Title		Тур	Hrs/wk	СР
Membrane Technology (L0399)		Lecture	2	3
Membrane Technology (L0400)		Recitation Section (small)	1	2
Membrane Technology (L0401)		Practical Course	1	1
Module Responsible	Prof. Mathias Ernst			
Admission Requirements	None			
Recommended Previous	Basic knowledge of water chemistry. Knowledge of the	he core processes involved in water, gas	and steam treatr	nent
Knowledge				
Educational Objectives	After taking part successfully, students have reached	d the following learning results		
Professional Competence				
Knowledge	Students will be able to rank the technical application	ons of industrially important membrane p	rocesses. They v	vill be able to expla
	the different driving forces behind existing membr	ane separation processes. Students wil	l be able to nar	ne materials used
	membrane filtration and their advantages and disa	dvantages. Students will be able to exp	ain the key diffe	erences in the use
	membranes in water, other liquid media, gases and i	in liquid/gas mixtures.		
Skille	Students will be able to propare mathematical equi	ations for material transport in persus a	nd colution diffu	sion mombrance a
JKIIIS	Students will be able to prepare mathematical equa calculate key parameters in the membrane separati			
	available boundary data and provide recommenda			
			•	-
	periments, students will be able to classify the separation efficiency, filtration characteristics and application of different; embrane materials. Students will be able to characterise the formation of the fouling layer in different waters and apply technical			
	measures to control this.	terise the formation of the found dyer i		s and apply teening
Personal Competence				
Social Competence	Students will be able to work in diverse teams on ta	asks in the field of membrane technology	. They will be ab	le to make decisio
	within their group on laboratory experiments to be u	ndertaken jointly and present these to ot	hers.	
Autonomy	Students will be in a position to solve homework o	in the tonic of membrane technology in	dependently. The	w will be canable
Autonomy	finding creative solutions to technical questions.	in the topic of memorane teenhology in	acpendenciy. The	y will be capable
Workload in Hours	Independent Study Time 124, Study Time in Lecture	56		
Credit points	6			
Course achievement				
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic: E	lective Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation A - General Bi	ioprocess Engineering: Elective Compulso	ory	
	Bioprocess Engineering: Specialisation B - Industrial			
	Chemical and Bioprocess Engineering: Specialisation			
	Chemical and Bioprocess Engineering: Specialisation	• •		
	Chemical and Bioprocess Engineering: Technical Con			
	Environmental Engineering: Specialisation Water Qua		npulsory	
	Process Engineering: Specialisation Process Engineer	•		
	Process Engineering: Specialisation Environmental Process Engineering: Specialisation Environmen			
	Water and Environmental Engineering: Specialisation			
	Water and Environmental Engineering: Specialisation			
	Water and Environmental Engineering: Specialisation	n Cities: Elective Compulsory		

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

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

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

Module M0949: Rural	Development and Resources Oriented	Sanitation for diffe	erent Climate Zon	es
Courses				
Title		Тур	Hrs/wk	СР
Rural Development and Resources	Oriented Sanitation for different Climate Zones (L0942)	Seminar	2	3
Rural Development and Resources	Oriented Sanitation for different Climate Zones (L0941)	Lecture	2	3
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
Recommended Previous	Basic knowledge of the global situation with rising pover	ty, soil degradation, lack of w	ater resources and sanita	tion
Knowledge				
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	Students can describe resources oriented wastewater	systems mainly based on so	urce control in detail. The	ey can comment on
	techniques designed for reuse of water, nutrients and so	oil conditioners.		
	Students are able to discuss a wide range of proven app	roaches in Rural Developmen	t from and for many regio	ons of the world.
	5 1 11	·	, ,	
Skills	Students are able to design low-tech/low-cost sanitat			
	rehabilitation of top soil quality combined with food and		consult on the basics of s	soli bullaing through
	"Holisitc Planned Grazing" as developed by Allan Savory			
Personal Competence				
Social Competence	The students are able to develop a specific topic in a tea	am and to work out milestone	s according to a given pla	n.
Autonomy	Students are in a position to work on a subject and t	o organize their work flow in	dependently. They can	lea present on this
Autonomy	subject.	o organize their work now in	idependentity. They can a	iso present on this
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	During the course of the semester, the students work t	owards mile stones. The work	< includes presentations a	and papers. Detailed
scale	information will be provided at the beginning of the sme	ster.		
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elect	ive Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation A - General Biopr	ocess Engineering: Elective C	ompulsory	
	Chemical and Bioprocess Engineering: Specialisation Ge			
	Environmental Engineering: Specialisation Environment			
	Environmental Engineering: Specialisation Water Quality	• •		
	International Management and Engineering: Specialisati			Compulsory
	Process Engineering: Specialisation Environmental Proce	• •	puisory	
	Process Engineering: Specialisation Process Engineering Water and Environmental Engineering: Specialisation W			
	Water and Environmental Engineering: Specialisation W Water and Environmental Engineering: Specialisation Er		orv	
	Water and Environmental Engineering: Specialisation Ei Water and Environmental Engineering: Specialisation Ci			

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

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

Courses			
Title Adaptation to climate change in hy	draulic engineering (L2291) Typ Project-/problem-base	Hrs/wk	CP 6
Module Responsible	Prof. Peter Fröhle		
Admission Requirements	None		
Recommended Previous Knowledge	 Hydrology, Hydraulic Engineering Hydromechanic, Hydraulics Fundamentals of Coastal Engineering, Coastal- and Flood Protection Hydrological Systems 		
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence Knowledge Skills	 Climate protection and climate adaptation Insights into climate change and its regional characteristics - fundamentals, climate change on the components of the regional hydrological cycle Fundamentals of analysis of climate data Consequences of the impact of the climate change Measures for climate adaptation Assessment, prioritization and communication of adaptation measures Fundamentals of the analysis of processes and relations, assessment of needs for a Cretative thinking: development of adaptation strategies and adaptation measures Practical thinking: inclusion of restrictions, application of calculation approamethods Consideration of complex tasks 	e action irres	
Personal Competence Social Competence Autonomy	 Working in heterogenous groups Working with different scientific / non-scientific disciplines Self reflection 		
Autonomy	 Application oriented use of knowledge and skills 		
	Autonomous work on complex tasks		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56		
Credit points	6		
Course achievement	None		
Examination	Written elaboration		
Examination duration and scale	Preparation of a written report and a presentation of a complex task.		
Assignment for the	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Cities: Elective Compulsory	201	
	Water and Environmental Engineering: Specialisation Environment: Elective Compulso Water and Environmental Engineering: Specialisation Water: Elective Compulsory	u y	

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

Module M1720: Emerg	ging Trends in Environment	al Engineering		
Courses				
Title		Тур	Hrs/wk	СР
Environmental Research Trends (L2	752)	Seminar	2	2
Microplastics in Environment (L275))	Lecture	2	2
Scientific Communication and Meth	ods (L2751)	Lecture	1	2
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
Recommended Previous	Basic knowledge on water, soil and envir	ronmental research.		
Knowledge				
Educational Objectives	After taking part successfully, students h	nave reached the following learning results		
Professional Competence				
Knowledge	The students will be exposed to up-to-date research topics focused on soil, water and climate related challenges with a partic focus on the effects of microplastics in environment. Data analysis, data measurement, curation and presentation will be o skills that the students will develop in this module.			•
Skills	Students' research skills will be improved in this module. How to prepare and deliver an effective presentation, how to write abstract, research paper and proposal will be discussed in this module. Moreover, through Research-Based Learning approach the students will be exposed to current research trends in environmental engineering.			
Personal Competence				
Social Competence	Developing teamwork and problem solving	ng skills through Research-Based Teaching approa	ches will be at the	core of this module.
Autonomy	The students will be involved in writing individual reports and presentation. This will contribute to the students' ability a willingness to work independently and responsibly.			students' ability and
Workload in Hours	Independent Study Time 110, Study Time	e in Lecture 70		
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	Report and Presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Water a	nd Traffic: Elective Compulsory		
-		on Environment and Climate: Elective Compulsory		
-	• • •	pecialisation Cities: Elective Compulsory		
	• •	pecialisation Environment: Elective Compulsory		
	Water and Environmental Engineering: S			

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

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

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

Courses										
ītle							Тур		Hrs/wk	СР
ustainable Nature-based Coastal F	1			(SeaPiaC)	(L2926)		Project-/problem-base	ed Learning	4	6
Module Responsible		Peter Fröhle								
Admission Requirements	None									
Recommended Previous	•	Hydraulic	Ingineering							
Knowledge			nanics, Hydi							
	•	Fundamer	tals of Coas	tal Engine	eering, Coast	tal- and Flood	Protection			
Educational Objectives	After	taking part	successfully	, students	s have reach	ed the follow	ing learning results			
Professional Competence										
Knowledge										
			d Climate C		14/					
						Regime and	water Cycle			
			tection in T		ge for Coasta d Cormony	al Processes				
			tals of Clima		-					
					or Coastal Pr	otection				
Skills										
SKIIS		Critical thi	nking: analy	sis of pro	cesses and r	elations, asse	essment of needs for a	action		
	•	Creative t	inking: dev	elopment	of adaptatio	on strategies	and adaptation measu	ires		
	•		hinking: inc	clusion of	restrictions	, application	of calculation approa	ches, meth	hods, numeric	al models, planni
		methods								
	•	Considera	ion of comp	olex tasks						
Personal Competence										
Social Competence		Mr. 1	1							
			heterogeno							
			internation			ific discipline	c			
		Self reflect		scientific	/ Holl-Scient	inc discipline	5			
Autonomy		Applicatio	oriented u	se of knov	wledge and s	skills				
			us work on a							
Workload in Hours	Indep	endent Stu	ly Time 124	L Study Ti	ime in Lectu	re 56				
Credit points			.,	,,						
Course achievement	None									
Examination	Writte	en elaborati	on							
Examination duration and	Prepa	ration of a	written repo	ort on a c	omplex task	with a prese	ntation and subseque	ent discussi	on. The work	on the complex ta
scale	happe	ens in the c	ourse of the	lecture.						
5		5 5			5	ng: Elective C	, ,			
Following Curricula			•		-	-	tive Compulsory			
		5 5			5	ering: Elective				
						Elective Com				
							nate: Elective Compu	lsory		
	Water	r and Enviro	nmental En	gineering	: specialisati	ion Cities: Ele	ctive Compulsory			
					C		ent: Elective Compuls			

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

3 3				
Module M0859: Coast	al Hydraulic Engineering II			
Courses				
Title		Тур	Hrs/wk	СР
Coastal- and Flood Protection (L080	(8)	Lecture	2	3
Coastal- and Flood Protection (L14)	5)	Project-/problem-based Learning	1	1
Maintenance and Defence of Flood	Protection Structures (L1411)	Lecture	2	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous	Coastal Engineering I			
Knowledge				
Educational Objectives	After taking part successfully, students have	e reached the following learning results		
Professional Competence				
Knowledge	The students have the capability to define	and explain in detail the important aspects of erosid	on protection	and flood protection
	and are able to apply the aspects to prac	ctical coastal protection problems. They are able to	design and	dimension importan
	coastal protection measures from the function	ional and from the constructional point of view.		
Skills	The students are able to select design an	proaches for the functional and constructional desic	in of erosion	and flood protectio
	measures and apply these approaches to p	-	,	p
		5		
Personal Competence				
Social Competence		ned knowledge in applied problems such as the fund		
	coastal and flood protection structures. Add	litionaly, they will be able to work in team with engine	eers of other o	disciplines.
Autonomy	The students will be able to independently e	extend their knowledge and apply it to new problems		
Workload in Hours	Independent Study Time 110, Study Time ir	n Lecture 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	The duration of the examination is 130 m	in. The examination includes tasks with respect to	the general	understanding of th
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Coastal Eng	gineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnic	al Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Structural E	Engineering: Elective Compulsory		
	Environmental Engineering: Specialisation E	Environment and Climate: Elective Compulsory		
	Environmental Engineering: Specialisation V	Nater Quality and Water Engineering: Elective Compu	llsory	
	Water and Environmental Engineering: Spec	cialisation Environment: Elective Compulsory		
	Water and Environmental Engineering: Spec	cialisation Water: Elective Compulsory		

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

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

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

Module M2003: Biolo	gical Waste Treatment			
Courses				
		-	11	
Title	n; (1.0228)	Typ Practical Course	Hrs/wk 2	CP 2
Waste and Environmental Chemist Biological Waste Treatment (L0318	-	Project-/problem-based Learning	2	2
Module Responsible			-	
Admission Requirements				
	chemical and biological basics			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge	The module aims possess knowledge concerning the plan design and layout of anaerobic and aerobic waste treatmen plants for biological waste treatment plants and explain d	ent plants in detail, describe different t		
Skills	The students are able to discuss the compilation of design control measurements. The students can recherché and and plan additional tests. They are capable of reflecting a	evaluate literature and date connected	-	
Personal Competence				
	Students can participate in subject-specific and interdisc	iplinary discussions, develop cooperat	ed solutions a	nd defend their d
	work results in front of others and promote the scientif accept professional constructive criticism.			
Autonomy	Students can independently tap knowledge from literatur are capable, in consultation with supervisors as well as in steps on this basis. Furthermore, they can define targets potential social, economic and cultural impact.	the interim presentation, to assess the	eir learning lev	el and define fur
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	. , ,			
Course achievement		tion		
	Yes None Subject theoretical and			
	practical work			
Examination	Presentation			
Examination duration and	Elaboration and Presentation (15-25 minutes in groups)			
scale				
Assignment for the	Civil Engineering: Specialisation Coastal Engineering: Elec	tive Compulsory		
Following Curricula				
	Civil Engineering: Specialisation Structural Engineering: E			
	Civil Engineering: Specialisation Water and Traffic: Electiv	e Compulsory		
	Bioprocess Engineering: Specialisation A - General Biopro		nulcon	
	Chemical and Bioprocess Engineering: Specialisation Gen	eral Process Engineering: Elective Com		
	Chemical and Bioprocess Engineering: Specialisation Gen Chemical and Bioprocess Engineering: Specialisation Biop	eral Process Engineering: Elective Com rocess Engineering: Elective Compulso	ry	
	Chemical and Bioprocess Engineering: Specialisation Gen Chemical and Bioprocess Engineering: Specialisation Biop Chemical and Bioprocess Engineering: Specialisation Chemical	eral Process Engineering: Elective Com rocess Engineering: Elective Compulso mical Process Engineering: Elective Cor	ry npulsory	זיע
	Chemical and Bioprocess Engineering: Specialisation Gen Chemical and Bioprocess Engineering: Specialisation Biop Chemical and Bioprocess Engineering: Specialisation Cher Chemical and Bioprocess Engineering: Specialisation Cher	eral Process Engineering: Elective Com rocess Engineering: Elective Compulso mical Process Engineering: Elective Cor mical and Bio process Engineering: Elec	ry npulsory	огу
	Chemical and Bioprocess Engineering: Specialisation Gen Chemical and Bioprocess Engineering: Specialisation Biop Chemical and Bioprocess Engineering: Specialisation Cher Chemical and Bioprocess Engineering: Specialisation Cher Environmental Engineering: Core Qualification: Compulso	eral Process Engineering: Elective Comp rocess Engineering: Elective Compulso mical Process Engineering: Elective Cor mical and Bio process Engineering: Elec ry	ry npulsory ctive Compulso	эгу
	Chemical and Bioprocess Engineering: Specialisation Gen Chemical and Bioprocess Engineering: Specialisation Biop Chemical and Bioprocess Engineering: Specialisation Cher Chemical and Bioprocess Engineering: Specialisation Cher	eral Process Engineering: Elective Comp rocess Engineering: Elective Compulso mical Process Engineering: Elective Cor mical and Bio process Engineering: Elec ry n II. Renewable Energy: Elective Compu	ry npulsory ctive Compulso	ory
	Chemical and Bioprocess Engineering: Specialisation Gen Chemical and Bioprocess Engineering: Specialisation Biop Chemical and Bioprocess Engineering: Specialisation Cher Chemical and Bioprocess Engineering: Specialisation Cher Environmental Engineering: Core Qualification: Compulso International Management and Engineering: Specialisation	eral Process Engineering: Elective Compu- rocess Engineering: Elective Compulso mical Process Engineering: Elective Cor- mical and Bio process Engineering: Elec- ry n II. Renewable Energy: Elective Compu- s Engineering: Elective Compulsory	ry npulsory ctive Compulso	ory

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

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

Irface Processes				
	Tv	'p	Hrs/wk	СР
L2731)		•	3	3
28) Lecture 2 2				2
<i>)</i>)	Re	citation Section (large)	1	1
Prof. Nima Shokri				
None				
Basic Mathematics, Hydrology				
After taking part successfully, students ha	ive reached the following l	earning results		
Upon completion of this module, the stu	udents will understand th	e mechanisms controllin	g solute transpor	t in soil and natura
porous media and will be able to work wit	h the equations that gove	rn the fate and transport	of solutes in poro	us media. Analytica
numerical and experimental tools and tech	hniques will be used in this	s module.		
·				
In addition to the physical insights, the students will be exposed to analytical, experimental and numerical tools and techniques i				
this module. This provides them with an e	excellent opportunity to im	prove their skills on mult	iple fronts which	will be useful in the
future career.				
Teamwork & problem solving				
The students will be involved in writing individual reports and presentation. This will contribute to the students' ability and				
willingness to work independently and responsibly.				
Independent Study Time 96, Study Time in Lecture 84				
6				
None				
Subject theoretical and practical work				
Report				
Civil Engineering: Specialisation Structura	l Engineering: Elective Cor	npulsory		
Civil Engineering: Specialisation Geotechn	ical Engineering: Elective	Compulsory		
Civil Engineering: Specialisation Coastal E	ngineering: Elective Comp	ulsory		
Civil Engineering: Specialisation Water and	d Traffic: Elective Compuls	sory		
Civil Engineering: Specialisation Computat	tional Engineering: Electiv	e Compulsory		
			у	
			-	
		ing: Elective Compulsory	,	
	-			
	 Prof. Nima Shokri None Basic Mathematics, Hydrology After taking part successfully, students had Upon completion of this module, the stuporous media and will be able to work witt numerical and experimental tools and tect In addition to the physical insights, the st this module. This provides them with an effuture career. Teamwork & problem solving The students will be involved in writing willingness to work independently and rest Independent Study Time 96, Study Time i None Subject theoretical and practical work Report Civil Engineering: Specialisation Structura and Civil Engineering: Specialisation Coastal E Civil Engineering: Specialisation Computa Chemical and Bioprocess Engineering: Tect Environmental Engineering: Specialisation Procest Water and Environmental Engineering: Sp 	Image: Specialisation Structural Engineering: Elective Computational Engineering: Specialisation Computational Engineering: Elective Computational Engineering: Specialisation Computational Engineering: Elective Computational Engineering: Specialisation Process Engineering: Elective Computer Process Engineering: Specialisation Process Engineering	L2731) Typ L2731) Recitation Section (small) (a) Lecture (b) Recitation Section (large) Prof. Nima Shokri Recitation Section (large) None Recitation Section (large) Basic Mathematics, Hydrology After taking part successfully, students have reached the following learning results Upon completion of this module, the students will understand the mechanisms controllin porous media and will be able to work with the equations that govern the fate and transport numerical and experimental tools and techniques will be used in this module. In addition to the physical insights, the students will be exposed to analytical, experimental this module. This provides them with an excellent opportunity to improve their skills on mult future career. Teamwork & problem solving The students will be involved in writing individual reports and presentation. This will convillingness to work independently and responsibly. Independent Study Time 96, Study Time in Lecture 84 6 6 Subject theoretical and practical work. Report Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory Civil Engineering: Specialisation Computational Engineering: Elective Compulsory Civil Engineering: Specialisation Computational Engineering: Elective Compulsory	Typ Hrs/wk L2731) Recitation Section (small) 3 b) Lecture 2 p) Recitation Section (large) 1 Prof. Nima Shokri None

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

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

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

Courses				
Гitle	Тур		Hrs/wk	СР
Module Responsible	Dozenten des SD B			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following lea	rning results		
Professional Competence				
Knowledge	The students are able to demonstrate their detailed knowledge in the exemplify the state of technology and application and discuss critically science and society. The students can develop solving strategies and approaches for fun	/ in the context of actual	l problems and g	general conditions
	Environmental Engineering. They may apply theory based procedu 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 They can explain how these methods or approaches relate to solution to be adjusted. General findings and further developments may essent	s in the field of work and		
Personal Competence				
Social Competence	The students are able to condense the relevance and the structure o the presentation and discussion in front of a bigger group. They can le colleagues.			
Autonomy	The students are capable of independently planning and documenting the work steps and procedures while considering the g deadlines. This includes the ability to accurately procure the newest scientific information. Furthermore, they can obtain feed from experts with regard to the progress of the work, and to accomplish results on the state of the art in science and technolog		can obtain feedbac	
Workload in Hours	Independent Study Time 360, Study Time in Lecture 0			
Credit points	12			
Course achievement	None			
Examination	Study work			
Examination duration and				
scale				
Assignment for the	Water and Environmental Engineering: Specialisation Environment: Co	mpulsory		
Following Curricula				

Specialization Water

nt (L0311) nt (L0312)) rof. Mathias Ernst lone nowledge of water management and the k fter taking part successfully, students hav		ion (small) tment.	Hrs/wk 2 1 2 1	CP 1 2 2 1
nt (L0312)) rof. Mathias Ernst lone nowledge of water management and the H fter taking part successfully, students hav	Lecture Recitation Sect Lecture Recitation Sect	ion (small) tment.	2 1 2	1 2 2
nt (L0312)) rof. Mathias Ernst lone nowledge of water management and the H fter taking part successfully, students hav	Recitation Sect Lecture Recitation Sect sey processes involved in water trea	ion (small) tment.	1 2	2
) rof. Mathias Ernst lone nowledge of water management and the k fter taking part successfully, students hav	Lecture Recitation Sect Recitation Sect	ion (small) tment.	2	2
) rof. Mathias Ernst lone nowledge of water management and the k fter taking part successfully, students hav	Recitation Sect	tment.		
rof. Mathias Ernst lone nowledge of water management and the k fter taking part successfully, students hav	ey processes involved in water trea	tment.	1	1
ione nowledge of water management and the H fter taking part successfully, students hav				
nowledge of water management and the l fter taking part successfully, students hav				
fter taking part successfully, students hav				
	e reached the following learning res	ults		
	e reached the following learning res	ults		
tudente will be able to active lies				
tudopte will be able to cutline lies and				
Students will be able to outline key areas of conflict in water management, as well as their mutual dependence for sustaina water supply. They will understand relevant economic, environmental and social factors. Students will be able to explain a outline the organisational structures of water companies. They will be able to explain the available water treatment processes a the scope of their application.				
Students will be able to assess complex problems in drinking water production and establish solutions involving w management and technical measures. They will be able to assess the evaluation methods that can be used for this. Students be able to carry out chemical calculations for selected treatment processes and apply generally accepted technical rules standards to these processes.				
Working in a diverse group of specialists, students will be able to develop and document complex solutions for the managem and treatment of drinking water. They will be able to take an appropriate professional position, for example representing u				
nterests. They will be able to develop joint	solutions in teams of diverse expert	s and present the	ese solutions to	o others.
tudents will be in a position to work on a s	ubject independently and present or	n this subject.		
ndependent Study Time 96, Study Time in	Lecture 84			
lone				
/ritten exam				
ivil Engineering: Specialisation Structural	Engineering: Elective Compulsory			
		/		
		ve Compulsory		
			erina: Elective	Compulsory
		-	,	
	• •	c compaisory		
		mulcon		
	utline the organisational structures of wat he scope of their application. tudents will be able to assess comple- hanagement and technical measures. The e able to carry out chemical calculations tandards to these processes. Vorking in a diverse group of specialists, s nd treatment of drinking water. They will therests. They will be able to develop joint tudents will be in a position to work on a s independent Study Time 96, Study Time in vitten exam 0 min (chemistry) + presentation ivil Engineering: Specialisation Structural I ivil Engineering: Specialisation Geotechnic ivil Engineering: Specialisation Coastal En- hemical and Bioprocess Engineering: Tech ternational Management and Engineering rocess Engineering: Specialisation Process Vater and Environmental Engineering: Spe Vater and Environmental Engineering: Spe Vater and Environmental Engineering: Spe	utiline the organisational structures of water companies. They will be able to ene scope of their application. tudents will be able to assess complex problems in drinking water pro- hanagement and technical measures. They will be able to assess the evaluati e able to carry out chemical calculations for selected treatment processes tandards to these processes. Working in a diverse group of specialists, students will be able to develop and nd treatment of drinking water. They will be able to take an appropriate pr therests. They will be able to develop joint solutions in teams of diverse expert tudents will be in a position to work on a subject independently and present of heependent Study Time 96, Study Time in Lecture 84 written exam 0 min (chemistry) + presentation ivil Engineering: Specialisation Structural Engineering: Elective Compulsory ivil Engineering: Specialisation Coastal Engineering: Elective Compulsory ivil Engineering: Specialisation Coastal Engineering: Elective Compulsory ivil Engineering: Specialisation Engineering: Elective Compulsory ivil Engineering: Specialisation Engineering: Elective Compulsory ivil Engineering: Specialisation Rest and Traffic: Compulsory ivil Engineering: Specialisation Coastal Engineering: Elective Compulsory ivil Engineering: Specialisation Rest and Traffic: Compulsory ivil Engineering: Specialisation Coastal Engineering: Elective Compulsory ivil Engineering: Specialisation Forcess Engineering: Elective Compulsory ivernational Management and Engineering: Specialisation II. Energy and Enviror rocess Engineering: Specialisation Process Engineering: Elective Compulsory ivater and Environmental Engineering: Specialisation Water: Compulsory ivater and Environmental Engineering: Specialisation Environment: Elective Compulsory ivater and Environmental Engineering: Specialisation Environment: Elective Compulsory ivater and Environmental Engineering: Specialisation Environment: Elective Compulsory ivater and Environmental Engineering: Specialisation E	utiline the organisational structures of water companies. They will be able to explain the available scope of their application. tudents will be able to assess complex problems in drinking water production and end anagement and technical measures. They will be able to assess the evaluation methods that e able to carry out chemical calculations for selected treatment processes and apply gene tandards to these processes. Working in a diverse group of specialists, students will be able to develop and document com nd treatment of drinking water. They will be able to take an appropriate professional position terests. They will be able to develop joint solutions in teams of diverse experts and present the tudents will be in a position to work on a subject independently and present on this subject. Independent Study Time 96, Study Time in Lecture 84 Independent Study Time Specialisation Structural Engineering: Elective Compulsory ivil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory ivil Engineering: Specialisation Coastal Engineering: Elective Compulsory ivil Engineering: Specialisation Coastal Engineering: Elective Compulsory ivil Engineering: Specialisation Coastal Engineering: Elective Compulsory ivil Engineering: Specialisation Forcess Engineering: Elective Compulsory iternational Management and Engineering: Specialisation II. Energy and Environmental Engine rocess Engineering: Specialisation Process Engineering: Elective Compulsory iternational Management and Engineering: Specialisation II. Energy and Environmental Engine rocess Engineering: Specialisation Process Engineering: Elective Compulsory iternational Management and Engineering: Specialisation II. Energy and Environmental Engine rocess Engineering: Specialisation Process Engineering: Elective Compulsory	utiline the organisational structures of water companies. They will be able to explain the available water treat he scope of their application. tudents will be able to assess complex problems in drinking water production and establish solution anagement and technical measures. They will be able to assess the evaluation methods that can be used for e able to carry out chemical calculations for selected treatment processes and apply generally accepted tandards to these processes. Working in a diverse group of specialists, students will be able to develop and document complex solutions for nd treatment of drinking water. They will be able to take an appropriate professional position, for example therests. They will be able to develop joint solutions in teams of diverse experts and present these solutions to tudents will be in a position to work on a subject independently and present on this subject. Independent Study Time 96, Study Time in Lecture 84 Written exam 0 min (chemistry) + presentation ivil Engineering: Specialisation Structural Engineering: Elective Compulsory ivil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory ivil Engineering: Specialisation Coastal Engineering: Elective Compulsory ivil Engineering: Specialisation Coastal Engineering: Elective Compulsory hemical and Bioprocess Engineering: Technical Complementary Course: Elective Compulsory thernational Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Forpulsory thernational Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory / Ater and Environmental Engineering: Specialisation Environmental Engineering: Elective Compulsory / Ater and Environmental Engineering: Specialisation Mater: Compulsory / Ater and Environmental Engineering: Specialisation Environment: Elective Compulsory

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

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

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

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

Module M2033: Subsu	Irface Processes			
Courses				
Title		Тур	Hrs/wk	СР
Modeling of Subsurface Processes (L2731)	Recitation Section (small)	3	3
Subsurface Solute Transport (L272)	3)	Lecture	2	2
Subsurface Solute Transport (L2729	9)	Recitation Section (large)	1	1
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
Recommended Previous	Basic Mathematics, Hydrology			
Knowledge				
Educational Objectives	After taking part successfully, students ha	ve reached the following learning results		
Professional Competence				
Knowledge	Upon completion of this module, the stu	Idents will understand the mechanisms contro	lling solute transpo	ort in soil and natura
	porous media and will be able to work wit	h the equations that govern the fate and transp	ort of solutes in por	ous media. Analytica
	numerical and experimental tools and tec	hniques will be used in this module.		
Skills		udents will be exposed to analytical, experimen		
		excellent opportunity to improve their skills on n	nultiple fronts which	will be useful in the
	future career.			
Personal Competence				
Social Competence	Teamwork & problem solving			
Autonomy	The students will be involved in writing individual reports and presentation. This will contribute to the students' ability and			
	willingness to work independently and res	ponsibly.		
Workload in Hours	Independent Study Time 96, Study Time i	n Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	Report			
scale				
Assignment for the	Civil Engineering: Specialisation Structura	I Engineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechr	ical Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal E	ngineering: Elective Compulsory		
	Civil Engineering: Specialisation Water an	d Traffic: Elective Compulsory		
	Civil Engineering: Specialisation Computa	tional Engineering: Elective Compulsory		
	Chemical and Bioprocess Engineering: Teo	chnical Complementary Course: Elective Compu	lsory	
	Environmental Engineering: Core Qualifica	ation: Compulsory		
	Process Engineering: Specialisation Enviro	nmental Process Engineering: Elective Compuls	ory	
	Process Engineering: Specialisation Proces	ss Engineering: Elective Compulsory		
	Water and Environmental Engineering: Sp	ecialisation Water: Compulsory		
	Water and Environmental Engineering: Sp	ecialisation Environment: Elective Compulsory		

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

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

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

Engineering				
Module M0513: Syste	m Aspects of Renewable Energies			
Courses				
Courses		_		
Title	no. New Meterials for Engres Draduction and Charage (10021)	Тур	Hrs/wk 2	CP 2
Energy Trading (L0019)	ge: New Materials for Energy Production and Storage (L0021)	Lecture Lecture	2	2
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	Madula: Taskaisel Theorematics II			
	Module: Technical Thermodynamics II			
Educational Objectives	After taking part successfully, students have reached the for	ollowing learning results		
Professional Competence				
Knowledge	Students are able to describe the processes in energy tradi	ng and the design of energy marl	ets and can critic	ally evaluate them in
	relation to current subject specific problems. Furthern	nore, they are able to explain	n the basics of	thermodynamics of
	electrochemical energy conversion in fuel cells and can es	stablish and explain the relations	hip to different ty	pes of fuel cells and
	their respective structure. Students can compare this tech	nology with other energy storage	options. In additio	on, students can give
	an overview of the procedure and the energetic involvement	nt of deep geothermal energy.		
Skills	Students can apply the learned knowledge of storage syste	ms for excessive energy to expla	in for various ener	gy systems different
	approaches to ensure a secure energy supply. In particu	lar, they can plan and calculate	domestic, comm	ercial and industrial
	heating equipment using energy storage systems in an e	nergy-efficient way and can asse	ss them in relation	n to complex power
	systems. In this context, students can assess the potent	ial and limits of geothermal pow	er plants and ex	plain their operating
	mode.			
	Furthermore, the students are able to explain the procedur	es and strategies for marketing o	of energy and app	v it in the context of
	Furthermore, the students are able to explain the procedures and strategies for marketing of energy and apply it in the context of other modules on renewable energy projects. In this context they can unassistedly carry out analysis and evaluations of energie			
	markets and energy trades.			
Personal Competence				
Social Competence	Students are able to discuss issues in the thematic fields in	the renewable energy sector add	iressed within the	module.
Autonomy	Students can independently exploit sources , acquire the	particular knowledge about the	subject area and	transform it to new
	questions.		,	
	Independent Study Time 96, Study Time in Lecture 84			
Credit points				
Course achievement				
	Written exam			
Examination duration and scale	3 nours written exam			
	Bioprocess Engineering: Specialisation A - General Bioproce	ass Engineering: Elective Compute	ony	
•	Aircraft Systems Engineering: Core Qualification: Elective C		ory	
ronowing curricula	International Management and Engineering: Specialisation		mpulson	
	International Management and Engineering: Specialisation	•••		Compulsory
	International Management and Engineering: Specialisation			
	Aeronautics: Core Qualification: Elective Compulsory	In Trocess Engineering and Bloter		compulsory
	Renewable Energies: Core Qualification: Compulsory			
	Theoretical Mechanical Engineering: Specialisation Energy	Systems: Elective Compulsory		
	Process Engineering: Specialisation Environmental Process		1	
	Process Engineering: Specialisation Process Engineering: El			
	Water and Environmental Engineering: Specialisation Wate			
	Water and Environmental Engineering: Specialisation Water Water and Environmental Engineering: Specialisation Enviro			
	water and Environmental Engineering. Specialisation Enviro	onnene. Elective compuisory		

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

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

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

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

5 5				
Module M0870: Mana	gement of Surface Water			
Courses				
Title		Тур	Hrs/wk	СР
Modelling of Flow in Rivers and Estu		Lecture	3 earning 2	4
	ring / Integrated Flood Protection (L0961)	Project-/problem-based L	earning z	Z
Module Responsible				
Admission Requirements				
	Fundamentals of Hydromechanics, Hydraulics, Hy	drology and Hydraulic Engineering	; Hydraulic Engineer	ing I and Hydraulic
	Engineering II			
Educational Objectives	After taking part successfully, students have reache	ed the following learning results		
Professional Competence				
Knowledge	Students are able to define in detail the basic pr	ocesses that are related to the mo	delling of flows in hy	draulic engineering
	Besides, they can describe the basic aspects of nu	-	cal models for the sin	nulation of flows and
	waves. They can also depict the concepts of nature	oriented hydraulic engineering.		
Skills	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		-	
Personal Competence				
Social Competence	The students are able to deploy their gained know	ledge in applied problems of the pra-	ctical nature-based h	ydraulic engineering
	Additionaly, they will be able to work in team with e	•		
Autonomy	The students will be able to independently extend t	heir knowledge and apply it to new p	roblems.	
Workload in Hours	Independent Study Time 110, Study Time in Lecture	e 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	The duration of the examination is 150 min. The	examination includes tasks with res	pect to the general u	understanding of the
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Water and Traffic: (Compulsory		
Following Curricula	Environmental Engineering: Core Qualification: Elec	tive Compulsory		
	Joint European Master in Environmental Studies - Ci	ties and Sustainability: Core Qualifica	tion: Compulsory	
	Water and Environmental Engineering: Specialisation	n Water: Compulsory		
	Water and Environmental Engineering: Specialisation	n Environment: Compulsory		
	Water and Environmental Engineering: Specialisatic	n Cities: Elective Compulsory		

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

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

Lingineering					
Module M0874: Waste	ewater Systems				
Courses					
Title		Тур		Hrs/wk	СР
Biological Wastewater Treatment (I	L0517)	Lecture		2	2
Biological Wastewater Treatment (L3122)	Recitation Sec	ction (large)	1	1
Advanced Wastewater Treatment (L0357)	Lecture		2	2
Advanced Wastewater Treatment (L0358)	Recitation Sec	ction (large)	1	1
Module Responsible	Dr. Joachim Behrendt				
Admission Requirements	None				
Recommended Previous	Knowledge of wastewater management an	d the key processes involved in was	stewater treatmer	nt.	
Knowledge					
Educational Objectives	After taking part successfully, students have	ve reached the following learning re	sults		
Professional Competence					
Knowledge	Students are able to outline key areas of t	he full range of treatment systems	in waste water m	anagement, as	well as their mutua
	dependence for sustainable water protection	on. They can describe relevant ecor	nomic, environme	ntal and social	factors.
e					
Skills	Students are able to pre-design and expla		nent processes a	nd the scope o	f their application
	municipal and for some industrial treatmer	nt plants.			
Personal Competence					
	Social skills are not targeted in this module.				
	5				
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 96, Study Time in	Lecture 84			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	120 min				
scale					
Assignment for the	Civil Engineering: Specialisation Structural	Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Geotechni		ry		
	Civil Engineering: Specialisation Coastal En	gineering: Elective Compulsory			
	Civil Engineering: Specialisation Water and				
	Bioprocess Engineering: Specialisation A -		ective Compulsory	/	
	Environmental Engineering: Specialisation				
	International Management and Engineering				Compulsorv
	International Management and Engineering				
	Process Engineering: Specialisation Enviror		Ū.	J	. ,
	Process Engineering: Specialisation Process				
	Water and Environmental Engineering: Spe				
	Water and Environmental Engineering: Spe		ompulsorv		
	Water and Environmental Engineering: Spe		J		
		compulsory			

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

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

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

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

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

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

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

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

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

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

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

Module M0858: Coast	al Hydraulic Engineering I				
Courses					
Title			Тур	Hrs/wk	СР
Basics of Coastal Engineering (L08)	07)		Lecture	3	4
Basics of Coastal Engineering (L14			Project-/problem-based Learning		2
Module Responsible	Prof. Peter Fröhle				
Admission Requirements	None				
Recommended Previous	Basics of hydraulic engineering, hydrology a	nd hydromechanics			
Knowledge					
Educational Objectives	After taking part successfully, students have	reached the followir	ng learning results		
Professional Competence					
Knowledge	The students are able to define and explain	the basic concepts o	f coastal engineering and port e	ngineering. Th	ney are able to appl
	the concepts to selected practical problems	of coastal engineeri	ng. Students can define and de	termine the b	asics for design an
	dimensioning of coastal engineering constru-	ctions.			
Cl://l-					
SKIIIS	The students are capable to apply basic desi	gn approaches to se	lected and pre-defined design ta	isks in coastai	engineering.
Personal Competence					
Social Competence	The students are able to deploy their gained	d knowledge in appl	ied problems such as the desig	n of coastal p	rotection structure
	Additionaly, they will be able to work in team	n with engineers of o	ther disciplines, for instance des	igning of coas	tal breakwaters.
	-				
Autonomy	The students will be able to independently e	xtend their knowledg	je and applylt to new problems.		
Workload in Hours	Independent Study Time 124, Study Time in	Lecture 56			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	The duration of the examination is 2 hours	s. The examination	includes tasks with respect to	the general u	nderstanding of th
scale	lecture contents and calculations tasks.				
Assignment for the	Civil Engineering: Specialisation Coastal Eng	ineering: Compulsory	/		
Following Curricula	Civil Engineering: Specialisation Geotechnica	al Engineering: Comp	ulsory		
	Civil Engineering: Specialisation Structural Engineering	ngineering: Elective	Compulsory		
	Environmental Engineering: Specialisation En	nvironment and Clim	ate: Elective Compulsory		
	Environmental Engineering: Specialisation W	ater Quality and Wa	ter Engineering: Elective Compu	lsory	
	International Management and Engineering:	Specialisation II. Civi	il Engineering: Elective Compuls	ory	
	Water and Environmental Engineering: Speci	ialisation Environmer	nt: Elective Compulsory		
	Water and Environmental Engineering: Speci	ialisation Water: Elec	tive Compulsory		

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

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

Module M0827: Mode	ling in Water Management				
Courses					
Title		Тур	Hrs/w	k CP	
Groundwater Modeling using Modfl		Lecture	1	1	
Groundwater Modeling using Modfl		Recitation Section (small		2	
Modeling of Water Supply Network		Project-/problem-based L	earning 2	3	
Module Responsible Admission Requirements					
Recommended Previous					
Knowledge	Groundwater				
	 groundwater hydraulics and transport 	of substances			
	Pipe Systems				
	Knowledge on urban water infrastru	ictures, in particular drinking water syste	msand urban dr	ainage syste	ems including
	special structures				
	 Hydraulics of drinking water supply system 				
	 Basic knowledge on water management 	nt			
Educational Objectives	After taking part successfully, students have	reached the following learning results			
Professional Competence					
Knowledge	The students are able to describe the mode	ling of groundwater flow and transport as w	ell as urban wate	er infrastructu	ires. They cai
	carry out systems analyses and can detect	echnical and conceptual weak points withir	the systems in	case studies.	Besides the
	are able to analyse interdependencies of hydraulic and toxic phenomena in soil and water.				
Skills	The students are able to construct and apply scientific groundwater models indipendently. They can work on different scenarios				
	and can compare or assess different solutions for existing problems by application of selected software products. The students are				
	able to use different software solutions (e.g.	EPANET, EPA-SWMM).			
Personal Competence					
Social Competence	Wird nicht vermittelt.				
Autonomy	Wird nicht vermittelt.				
Workload in Hours	Independent Study Time 110, Study Time in	Lecture 70			
Credit points	6				
Course achievement	None				
Examination	Oral exam				
Examination duration and	30 min				
scale					
-	Civil Engineering: Specialisation Structural E				
Following Curricula					
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory				
	Civil Engineering: Specialisation Water and				
	Civil Engineering: Specialisation Computation				
	Water and Environmental Engineering: Spec				
	Water and Environmental Engineering: Spec Water and Environmental Engineering: Spec				
	water and Environmental Engineering: Spec	ansation water. Liettive Compulsory			

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

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

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

Engineering"				
Module M1724: Smar	t Monitoring			
Courses				
Title		Тур	Hrs/wk	СР
Smart Monitoring (L2762)		Integrated Lecture	2	2
Smart Monitoring (L2763)		Recitation Section (small)	2	4
Module Responsible	Prof. Kay Smarsly			
Admission Requirements	None			
Recommended Previous Knowledge		dustry 4.0 and cyber-physical sy	stems, as well a	
Educational Objectives	After taking part successfully, students have reached the following part successfully and the students have reached the following students	owing learning results		
Professional Competence				
		is (remote) monitoring of syste and to implement intelligent sense embedded computing methodolo ut the semester and will contribute a number of "intelligent" sensor arrning techniques. The smart mo es, or on scaled lab structures for his module will "automatically" par- ritten papers and oral examination t smart sensor systems, used for , structural, or comfort monitori t of group projects, tailored to t sting embedded computing and pro- ports.	ems in the built or systems using gies. Besides lect ite to the grade. is to be implement initoring systems r validation purpo articipate with tho ons form the final r monitoring a with ing. The students their knowledge for rogramming. Final	and in the natur state-of-the-art da cures, project work In small groups, the will be mounted of ses. The outcome eir smart monitoring grades. The modu de range of physic s will be capable backgrounds, and Ily, the students w
	achieving the common project goals.	ing and solving problems in eng		
	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Con	News			
Course achievement	1			
	None Written elaboration			
Examination	1			
Examination Examination duration and scale	Written elaboration	Compulsory		
Examination Examination duration and scale	Written elaboration 10 pages of work with 15-minute oral presentation Civil Engineering: Specialisation Water and Traffic: Elective C			
Examination Examination duration and scale Assignment for the	Written elaboration 10 pages of work with 15-minute oral presentation Civil Engineering: Specialisation Water and Traffic: Elective C	lective Compulsory		
Examination Examination duration and scale Assignment for the	Written elaboration 10 pages of work with 15-minute oral presentation Civil Engineering: Specialisation Water and Traffic: Elective C Civil Engineering: Specialisation Geotechnical Engineering: El	lective Compulsory e Compulsory		
Examination Examination duration and scale Assignment for the	Written elaboration 10 pages of work with 15-minute oral presentation Civil Engineering: Specialisation Water and Traffic: Elective C Civil Engineering: Specialisation Geotechnical Engineering: El Civil Engineering: Specialisation Coastal Engineering: Elective	lective Compulsory e Compulsory tive Compulsory		
Examination Examination duration and scale Assignment for the	Written elaboration 10 pages of work with 15-minute oral presentation Civil Engineering: Specialisation Water and Traffic: Elective C Civil Engineering: Specialisation Geotechnical Engineering: El Civil Engineering: Specialisation Coastal Engineering: Elective Civil Engineering: Specialisation Structural Engineering: Elect	lective Compulsory e Compulsory tive Compulsory : Elective Compulsory		
Examination Examination duration and scale Assignment for the	Written elaboration 10 pages of work with 15-minute oral presentation Civil Engineering: Specialisation Water and Traffic: Elective C Civil Engineering: Specialisation Geotechnical Engineering: El Civil Engineering: Specialisation Coastal Engineering: Elective Civil Engineering: Specialisation Coastal Engineering: Elective Civil Engineering: Specialisation Structural Engineering: Elective Civil Engineering: Specialisation Structural Engineering: Elective Computer Science: Specialisation II: Intelligence Engineering:	lective Compulsory e Compulsory tive Compulsory : Elective Compulsory rces: Elective Compulsory		
Examination Examination duration and scale Assignment for the	Written elaboration 10 pages of work with 15-minute oral presentation Civil Engineering: Specialisation Water and Traffic: Elective C Civil Engineering: Specialisation Geotechnical Engineering: El Civil Engineering: Specialisation Coastal Engineering: Elective Civil Engineering: Specialisation Structural Engineering: Elective Civil Engineering: Specialisation Structural Engineering: Elective Computer Science: Specialisation II: Intelligence Engineering: Environmental Engineering: Specialisation Energy and Resource	lective Compulsory e Compulsory tive Compulsory : Elective Compulsory rces: Elective Compulsory Climate: Elective Compulsory	npulsory	
Examination Examination duration and scale Assignment for the	Written elaboration 10 pages of work with 15-minute oral presentation Civil Engineering: Specialisation Water and Traffic: Elective C Civil Engineering: Specialisation Geotechnical Engineering: El Civil Engineering: Specialisation Coastal Engineering: Elective Civil Engineering: Specialisation Structural Engineering: Elective Civil Engineering: Specialisation Structural Engineering: Elective Computer Science: Specialisation II: Intelligence Engineering: Environmental Engineering: Specialisation Energy and Resou Environmental Engineering: Specialisation Environment and Computer Science Engineering:	lective Compulsory e Compulsory tive Compulsory : Elective Compulsory rces: Elective Compulsory Climate: Elective Compulsory I Water Engineering: Elective Com	npulsory	
Examination Examination duration and scale Assignment for the	Written elaboration 10 pages of work with 15-minute oral presentation Civil Engineering: Specialisation Water and Traffic: Elective C Civil Engineering: Specialisation Geotechnical Engineering: El Civil Engineering: Specialisation Coastal Engineering: Elective Civil Engineering: Specialisation Structural Engineering: Elective Civil Engineering: Specialisation Structural Engineering: Elective Computer Science: Specialisation II: Intelligence Engineering: Environmental Engineering: Specialisation Energy and Resou Environmental Engineering: Specialisation Water Quality and	lective Compulsory e Compulsory tive Compulsory : Elective Compulsory rces: Elective Compulsory Climate: Elective Compulsory I Water Engineering: Elective Com	npulsory	
Examination Examination duration and scale Assignment for the	Written elaboration 10 pages of work with 15-minute oral presentation Civil Engineering: Specialisation Water and Traffic: Elective C Civil Engineering: Specialisation Geotechnical Engineering: El Civil Engineering: Specialisation Coastal Engineering: Elective Civil Engineering: Specialisation Structural Engineering: Elective Civil Engineering: Specialisation Structural Engineering: Elective Computer Science: Specialisation II: Intelligence Engineering: Environmental Engineering: Specialisation Energy and Resou Environmental Engineering: Specialisation Water Quality and Mechatronics: Technical Complementary Course: Elective Complementary	lective Compulsory e Compulsory tive Compulsory : Elective Compulsory rrces: Elective Compulsory Climate: Elective Compulsory I Water Engineering: Elective Com mpulsory		
Examination Examination duration and scale Assignment for the	Written elaboration 10 pages of work with 15-minute oral presentation Civil Engineering: Specialisation Water and Traffic: Elective C Civil Engineering: Specialisation Geotechnical Engineering: El Civil Engineering: Specialisation Coastal Engineering: Elective Civil Engineering: Specialisation Structural Engineering: Elective Civil Engineering: Specialisation Structural Engineering: Elective Computer Science: Specialisation II: Intelligence Engineering: Environmental Engineering: Specialisation Energy and Resou Environmental Engineering: Specialisation Water Quality and Mechatronics: Technical Complementary Course: Elective Com Mechatronics: Core Qualification: Elective Compulsory	lective Compulsory e Compulsory tive Compulsory : Elective Compulsory rrces: Elective Compulsory Climate: Elective Compulsory I Water Engineering: Elective Com mpulsory and Computer Science: Elective C		
Examination Examination duration and scale Assignment for the	Written elaboration 10 pages of work with 15-minute oral presentation Civil Engineering: Specialisation Water and Traffic: Elective C Civil Engineering: Specialisation Geotechnical Engineering: El Civil Engineering: Specialisation Coastal Engineering: Elective Civil Engineering: Specialisation Structural Engineering: Elective Civil Engineering: Specialisation Structural Engineering: Elective Computer Science: Specialisation II: Intelligence Engineering: Environmental Engineering: Specialisation Energy and Resou Environmental Engineering: Specialisation Environment and C Environmental Engineering: Specialisation Water Quality and Mechatronics: Technical Complementary Course: Elective Com Mechatronics: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Specialisation Robotics	lective Compulsory e Compulsory tive Compulsory : Elective Compulsory (Climate: Elective Compulsory Water Engineering: Elective Com mpulsory and Computer Science: Elective Co Elective Compulsory		

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

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

Courses					
Title		Tun	Hrs/wk	СР	
Offshore Geotechnical Engineering	(10067)	Typ Lecture	1	1	
Hydro Power Use (L0013)		Lecture	1	1	
Wind Turbine Plants (L0011)		Lecture	2	3	
Wind Energy Use - Focus Offshore	L0012)	Lecture	1	1	
Module Responsible	Dr. Marvin Scherzinger				
Admission Requirements	None				
Recommended Previous	Module: Technical Thermodynamics I,				
Knowledge	Market and the standard standard and the standard				
	Module: Technical Thermodynamics II,				
	Module: Fundamentals of Fluid Mechanics				
Educational Objectives	After taking part successfully, students have reached	the following learning results			
Professional Competence					
Knowledge	By ending this module students can explain in det offshore conditions and can critical comment these to describe fundamentally the use of water power to in the implementation of renewable energy projects	aspects in consideration of curre generate electricity. The studen	nt developments. Furthe	rmore, they are al	
	Through active discussions of various topics within application of the theoretical background and are the			derstanding and t	
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	y and multidisciplinary within a s	eminar.		
Autonomy	Students can independently exploit sources in the lecture and to acquire the particular knowledge about		lecture material to clear	r the contents of t	
Workload in Hours	Independent Study Time 110, Study Time in Lecture	70			
Credit points					
Course achievement					
Examination	Written exam				
Examination duration and	180 min				
scale					
	Civil Engineering: Specialisation Structural Engineering	ng: Elective Compulsory			
j	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory				
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory				
	International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Compulsory				
	International Management and Engineering: Specialisation II. Renewable Energy: Elective Compulsory Product Development, Materials and Production: Specialisation Product Development: Elective Compulsory				
	Product Development, Materials and Production: Specialisation Production: Elective Compulsory				
	Product Development, Materials and Production: Specialisation Materials: Elective Compulsory				
	Renewable Energies: Core Qualification: Compulsory				
	Theoretical Mechanical Engineering: Specialisation E				
	Process Engineering: Specialisation Environmental Pr		puisory		
	Water and Environmental Engineering: Specialisation				
	Water and Environmental Engineering: Specialisation	Environment: Elective Compulse	ory		
	Water and Environmental Engineering: Specialisation	Matan Elective Course Inc			

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

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

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

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

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

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

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

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

Module M2032: Adva	nced Vadose Zone Hydrology	1		
Courses				
Гitle		Тур	Hrs/wk	СР
Modeling Processes in Vadose Zone	e (L2735)	Recitation Section (sr	nall) 2	2
Vadose Zone Hydrology (L2732)		Lecture	2	2
Vadose Zone Hydrology (L2733)		Recitation Section (la	rge) 2	2
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
Recommended Previous	Basic knowledge in water and soil			
Knowledge				
	Comfortable with math and physics, critic	al thinking, creative problem solving		
	Analytic skills			
Educational Objections				
Educational Objectives	After taking part successfully, students ha	ave reached the following learning results		
Professional Competence	The students will loss shout and the	notorization (colid and liquid share) the	opprove state of a "	water the self
Knowledge		acterization (solid and liquid phase), the		water, the soll wat
	characteristic curve, now in saturated and	d unsaturated soil as well as about solute tra	ansport in son	
Skills	Students will work on practical examp	les modelling transport processes in soil	using different quanti	itative tools includi
	computer simulations and analytical tools	. This will help them to apply knowledge in	order to solve problems	and tasks.
Personal Competence				
Social Competence	The module aims at raising awareness	and enthusiasm for new knowledge relat	ed to water, soil and (environment. This v
	positively contribute to shape their work a	and life environment.		
Autonomy	The students will be involved in man	y problem solving exercises. This will o	ontribute toward their	r willingness to wo
, lacenemy	independently and responsibly.	, providin solving exclasses this thin e		i ininginess to inc
Workload in Hours	Independent Study Time 96, Study Time i	n Lecture 84		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Report and Presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Computa	tional Engineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Water an			
2	Environmental Engineering: Core Qualifica			
	Water and Environmental Engineering: Sp			
		pecialisation Environment: Elective Compuls	ory	
			,	

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

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

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

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

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

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

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

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

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

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

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

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

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

Module M0822: Proce	ess Modeling in Water Technology	y		
Courses				
Title		Тур	Hrs/wk	СР
Process Modelling of Wastewater T	reatment (L0522)	Project-/problem-based Learning	2	3
Process Modeling in Drinking Water		Project-/problem-based Learning	2	3
Module Responsible	Dr. Klaus Johannsen			
Admission Requirements	None			
Recommended Previous	Knowledge of the most important processes in a	drinking water and waste water treatment.		
Knowledge				
Educational Objectives	After taking part successfully, students have rea	ached the following learning results		
Professional Competence				
Knowledge	Students are able to explain selected processe basics as well as possibilities and limitations of	s of drinking water and waste water treatment i dynamic modeling.	n detail. The	y are able to explair
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 in a group with members of different technical background. They are able to give appropriate feedback and can work constructively with feedback concerning their work.			
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 Leo	cture 56		
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traf	fic: Elective Compulsory		
Following Curricula	Chemical and Bioprocess Engineering: Technica	l Complementary Course: Elective Compulsory		
	Environmental Engineering: Specialisation Wate	r Quality and Water Engineering: Elective Compu	lsory	
	Process Engineering: Specialisation Environmen	tal Process Engineering: Elective Compulsory		
	Process Engineering: Specialisation Process Eng	ineering: Elective Compulsory		
	Water and Environmental Engineering: Specialis	sation Water: Elective Compulsory		
	Water and Environmental Engineering: Specialis			
	Water and Environmental Engineering: Specialis	ation Cities: Elective Compulsory		

Course L0522: Process Mode	lling of Wastewater Treatment	
Тур	Project-/problem-based Learning	
Hrs/wk	2	
СР	3	
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer	Dr. Joachim Behrendt	
Language	DE/EN	
Cycle	WiSe	
Content	Mass and energy balances	
	Tracer modelling	
	Activated Sludge Model	
	Wastewater Treatment Plant Modelling (continously and SBR)	
	Sludge Treatment (ADM, aerobic autothermal)	
	Biofilm Modelling	
Literature	Henze, Mogens (Seminar on Activated Sludge Modelling, ; Kollekolle Seminar on Activated Sludge Modelling, ;)	
	Activated sludge modelling : processes in theory and practice ; selected proceedings of the 5th Kollekolle Seminar on Activated	
	Sludge Modelling, held in Kollekolle, Denmark, 10 - 12 September 2001	
	SBN: 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	
	Weinheim : WILEY-VCH, 2007 TUB_HH_Katalog	

Course L0314: Process Modeling in Drinking Water Treatment	
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Klaus Johannsen
Language	EN
Cycle	WiSe
Content	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 M0802: Memb	orane Technology			
Courses				
Title		Тур	Hrs/wk	СР
Membrane Technology (L0399)		Lecture	2	3
Membrane Technology (L0400) Membrane Technology (L0401)		Recitation Section (small) Practical Course	1	2
	Deef Mathies French	Flactical Course	T	Ţ
Module Responsible Admission Requirements	None			
Recommended Previous	Basic knowledge of water chemistry. Knowledge of th	a care processes involved in water, and	and stoom troots	nont
Knowledge	basic knowledge of water chemistry. Knowledge of th	e core processes involved in water, gas	and steam treat	nenc
-	After taking part successfully, students have reached	the following learning results		
Professional Competence	The carries part successionly, stadents have reached			
	Students will be able to rank the technical application	os of industrially important membrane n	rocesses They w	vill be able to expla
Kilowicage	the different driving forces behind existing membra			
	membrane filtration and their advantages and disad			
	membranes in water, other liquid media, gases and ir		, ,	
Skills	Students will be able to prepare mathematical equa			
	calculate key parameters in the membrane separatio			
	available boundary data and provide recommendat		•	÷
	experiments, students will be able to classify the			
	membrane materials. Students will be able to charact measures to control this.	lense the formation of the fouling layer i	n dinerent water	s and apply technic
	measures to control this.			
Personal Competence				
Social Competence	Students will be able to work in diverse teams on tas	sks in the field of membrane technology	. They will be ab	le to make decisior
	within their group on laboratory experiments to be un	dertaken jointly and present these to ot	hers.	
Autonomy	Students will be in a position to solve homework or	the topic of membrane technology in	dependently. The	w will be capable
Autonomy	finding creative solutions to technical questions.	The topic of memorale technology in	acpendenciy. The	ly will be capable i
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	56		
Credit points	6			
Course achievement	None			
Examination				
Examination duration and	90 min			
scale				
-	Civil Engineering: Specialisation Water and Traffic: Ele			
Following Curricula	Bioprocess Engineering: Specialisation A - General Bio			
	Bioprocess Engineering: Specialisation B - Industrial B			
	Chemical and Bioprocess Engineering: Specialisation			
	Chemical and Bioprocess Engineering: Specialisation			
	Chemical and Bioprocess Engineering: Technical Com			
	Environmental Engineering: Specialisation Water Qua	, , ,	inpuisory	
	Process Engineering: Specialisation Process Engineering:			
	Process Engineering: Specialisation Environmental Pro Water and Environmental Engineering: Specialisation			
	Water and Environmental Engineering: Specialisation Water and Environmental Engineering: Specialisation			
	Water and Environmental Engineering: Specialisation Water and Environmental Engineering: Specialisation	, ,		
	water and Environmental Engineering. Specialisation	cities. Liective compuisory		

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

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

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

Module M0949: Rural	Development and Resources Oriented	Sanitation for diffe	erent Climate Zon	es
Courses				
Title		Тур	Hrs/wk	СР
Rural Development and Resources	Oriented Sanitation for different Climate Zones (L0942)	Seminar	2	3
Rural Development and Resources	Oriented Sanitation for different Climate Zones (L0941)	Lecture	2	3
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
Recommended Previous	Basic knowledge of the global situation with rising pover	ty, soil degradation, lack of w	ater resources and sanita	tion
Knowledge				
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence				
Knowledge	Students can describe resources oriented wastewater	systems mainly based on so	urce control in detail. The	ey can comment on
	techniques designed for reuse of water, nutrients and so	oil conditioners.		
	Students are able to discuss a wide range of proven app	roaches in Rural Developmen	t from and for many regio	ons of the world.
	5		,	
Skills	Students are able to design low-tech/low-cost sanitat			
	rehabilitation of top soil quality combined with food and		consult on the basics of s	soli bullaing through
	"Holisitc Planned Grazing" as developed by Allan Savory			
Personal Competence				
Social Competence	The students are able to develop a specific topic in a tea	am and to work out milestone	s according to a given pla	n.
Autonomy	Students are in a position to work on a subject and t	o organize their work flow i	dependently. They can	lea present on this
Autonomy	subject.	o organize their work now in	idependentity. They can a	iso present on this
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	During the course of the semester, the students work t	owards mile stones. The worl	< includes presentations a	and papers. Detailed
scale	information will be provided at the beginning of the sme	ster.		
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elect	ive Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation A - General Biopr	ocess Engineering: Elective C	ompulsory	
	Chemical and Bioprocess Engineering: Specialisation Ge			
	Environmental Engineering: Specialisation Environment			
	Environmental Engineering: Specialisation Water Quality			
	International Management and Engineering: Specialisati			Lompulsory
	Process Engineering: Specialisation Environmental Proce		puisory	
	Process Engineering: Specialisation Process Engineering Water and Environmental Engineering: Specialisation W			
	Water and Environmental Engineering: Specialisation W Water and Environmental Engineering: Specialisation Er		orv	
	Water and Environmental Engineering: Specialisation Ei Water and Environmental Engineering: Specialisation Ci			

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

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

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

Module M0581: Wate	r Protection			
Courses				
Title		Typ	Hrs/wk	СР
Water Protection and Wastewater M	Janagement (10226)	Typ Lecture	3	3
Water Protection and Wastewater M	5	Project Seminar	3	3
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
Recommended Previous				
Knowledge	Basic knowledge in water managem			
	Good knowledge in urban drainage;			
	 Good knowledge of wastewater trea Good knowledge of pollutants (o.g. (COD, BOD, TS, N, P) and their properties;		
	• Good knowledge of politicants (e.g. (
Educational Objectives	After taking part successfully, students have	ve reached the following learning results		
Professional Competence				
Knowledge	The students can describe the basic principation of the basic principa	ples of the regulatory framework related to the	e international and Eu	iropean water sect
		substance cycles and water morphology in		
		ch as ecosystem service and wastewater trea	tment with a special	focus on innovat
	solutions, remediation measures as well as	s conceptual approaches.		
Skills	Students can accurately assess current pr	oblems and situations in a country-specific or	local context. They of	can suggest concre
	actions to contribute to the planning of	tomorrow's urban water cycle. Furthermore,	they can suggest a	ppropriate technic
	administrative and legislative solutions to	solve these problems.		
Personal Competence				
	The students can work together in internat	tional groups		
Social competence	The statents can work together in internat			
Autonomy		low to prepare presentations and discussions.	They can acquire ap	propriate knowled
	by making enquiries independently.			
Workload in Hours	Independent Study Time 96, Study Time in	Lecture 84		
Credit points				
Course achievement				
Examination	Presentation			
Examination duration and	Term paper plus presentation			
scale				
-	Civil Engineering: Specialisation Structural			
Following Curricula	Civil Engineering: Specialisation Geotechni	5 5 1 ,		
	Civil Engineering: Specialisation Coastal Er			
	Civil Engineering: Specialisation Water and		Compulsor	
		Water Quality and Water Engineering: Elective		
	Water and Environmental Engineering: Spe	g: Specialisation II. Civil Engineering: Elective C	lompuisory	
	Water and Environmental Engineering: Spe			
	water and Environmental Engineering: SDE			

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

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

Module M1720: Emerg	ging Trends in Environment	al Engineering		
Courses				
Title		Тур	Hrs/wk	СР
Environmental Research Trends (L2	752)	Seminar	2	2
Microplastics in Environment (L275	0)	Lecture	2	2
Scientific Communication and Meth	ods (L2751)	Lecture	1	2
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
Recommended Previous	Basic knowledge on water, soil and envir	ronmental research.		
Knowledge				
Educational Objectives	After taking part successfully, students h	have reached the following learning results		
Professional Competence				
Knowledge	The students will be exposed to up-to-date research topics focused on soil, water and climate related challenges with a particular focus on the effects of microplastics in environment. Data analysis, data measurement, curation and presentation will be other skills that the students will develop in this module.			
Skills	Students' research skills will be improved in this module. How to prepare and deliver an effective presentation, how to write an abstract, research paper and proposal will be discussed in this module. Moreover, through Research-Based Learning approaches, the students will be exposed to current research trends in environmental engineering.			
Personal Competence				
Social Competence	Developing teamwork and problem solvi	ing skills through Research-Based Teaching approa	ches will be at the	core of this module.
Autonomy	The students will be involved in writing individual reports and presentation. This will contribute to the students' ability and willingness to work independently and responsibly.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	Report and Presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Water a	nd Traffic: Elective Compulsory		
Following Curricula	Environmental Engineering: Specialisation	on Environment and Climate: Elective Compulsory		
	Water and Environmental Engineering: S	Specialisation Cities: Elective Compulsory		
	Water and Environmental Engineering: S	Specialisation Environment: Elective Compulsory		
	Water and Environmental Engineering: S			

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

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

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

Courses										
ītle							ур		Hrs/wk	СР
ustainable Nature-based Coastal F	1		ing Climate (SeaPiaC) (L2	2926)	F	roject-/problem-based l	Learning	4	6
Module Responsible		Peter Fröhle								
Admission Requirements	None									
Recommended Previous	•	Hydraulic E	ngineering							
Knowledge			anics, Hydra	aulics						
	•	Fundamen	als of Coasta	al Engineer	ing, Coastal- a	and Flood Pr	otection			
Educational Objectives	After	taking part :	uccessfully,	students h	ave reached t	he following	learning results			
Professional Competence										
Knowledge										
			d Climate Ch							
					e on Wind Reg		ater Cycle			
			tection in Ta		for Coastal Pro	JUESSES				
			als of Climat		-					
					Coastal Protect	tion				
Skills										
SKIIS		Critical thir	king: analys	is of proces	sses and relati	ons, assess	ment of needs for act	ion		
							l adaptation measure			
	•		inking: inclu	usion of re	estrictions, app	olication of	calculation approach	ies, meth	nods, numeric	al models, plan
		methods								
	•	Considerat	on of comple	ex tasks						
Personal Competence										
Social Competence		M. 11								
			heterogenou							
			internationa		non-scientific d	disciplines				
		Self reflect		scientine / i		liscipiiries				
Autonomy		Application	oriented use	e of knowle	dge and skills					
			s work on co							
Washing die Union	lundour	and and Church	. Time 124	Church Time	- in Lastura Fr	_				
Workload in Hours Credit points		endent Stud	y 11me 124,	Study Time		0				
Examination	Writte	en elaboratio	n							
Examination duration and	Prepa	ration of a	vritten repor	rt on a com	nplex task with	n a presenta	ation and subsequent	discussi	on. The work	on the complex
scale	happe	ens in the co	urse of the le	ecture.						
Assignment for the	Civil E	ingineering:	Specialisatio	on Coastal I	Engineering: E	lective Com	pulsory			
Following Curricula			•		nical Engineer	-				
		5 5			al Engineering		1			
					nd Traffic: Elec					
							te: Elective Compulso	ry		
	Water	and Enviro	nmental Eng	ineering: S	pecialisation C	ities: Electi	ve Compulsory			
	147 .						: Elective Compulsory			

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

Module M0859: Coast	al Hydraulic Engineering II			
Courses				
Title		Тур	Hrs/wk	СР
Coastal- and Flood Protection (L080		Lecture	2	3
Coastal- and Flood Protection (L14)		Project-/problem-based Learning	1 2	1
Maintenance and Defence of Flood		Lecture	Z	2
Module Responsible				
Admission Requirements				
Recommended Previous	Coastal Engineering I			
Knowledge				
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
Knowledge	The students have the capability to define	and explain in detail the important aspects of erosic	on protection	and flood protection
	and are able to apply the aspects to pract	ical coastal protection problems. They are able to	design and	dimension importan
	coastal protection measures from the function	onal and from the constructional point of view.		
Skills	The students are able to select design apr	roaches for the functional and constructional desig	in of erosion	and flood protectio
	measures and apply these approaches to pr		,	
	···· ··· · · · · · · · · · · · · · · ·			
Personal Competence				
Social Competence	The students are able to deploy their gain	ed knowledge in applied problems such as the fund	ctional and c	onstructive design o
	coastal and flood protection structures. Addi	tionaly, they will be able to work in team with engine	ers of other o	disciplines.
Autonomy	The students will be able to independently e	xtend their knowledge and apply it to new problems.		
Workload in Hours	Independent Study Time 110, Study Time in	Lecture 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	The duration of the examination is 130 mi	n. The examination includes tasks with respect to	the general	understanding of the
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Coastal Eng	ineering: Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnica	al Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Structural E	ngineering: Elective Compulsory		
	Environmental Engineering: Specialisation E	nvironment and Climate: Elective Compulsory		
	Environmental Engineering: Specialisation W	ater Quality and Water Engineering: Elective Compu	lsory	
	Water and Environmental Engineering: Spec	ialisation Environment: Elective Compulsory		
	Water and Environmental Engineering: Spec	ialisation Water: Elective Compulsory		

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

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

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

Courses				
Title		Тур	Hrs/wk	СР
Adaptation to climate change in hy	draulic engineering (L2291)	Project-/problem-based Learning	4	6
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous Knowledge	 Hydrology, Hydraulic Engineering Hydromechanic, Hydraulics Fundamentals of Coastal Engineering, Coastal-a Hydrological Systems 	and Flood Protection		
Educational Objectives	After taking part successfully, students have reached t	he following learning results		
Professional Competence Knowledge Skills	 Climate protection and climate adaptation Insights into climate change and its regional cha Impacts of climate change on the components of Fundamentals of analysis of climate data Consequences of the impact of the climate char Measures for climate adaptation Assessment, prioritization and communication of Fundamentals of the analysis of hydrometeorolo Critical thinking: analysis of processes and relat Creative thinking: inclusion of restrictions, ap methods Consideration of complex tasks 	f the regional hydrological cycle ge f adaptation measures gical and hydrological data ions, assessment of needs for action rategies and adaptation measures		
Personal Competence Social Competence Autonomy	 Working in heterogenous groups Working with different scientific / non-scientific of Self reflection Application oriented use of knowledge and skills 			
	Autonomous work on complex tasks			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 5	5		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and scale	Preparation of a written report and a presentation of a	complex task.		
Assignment for the	Civil Engineering: Specialisation Coastal Engineering: E			
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineer			
	Civil Engineering: Specialisation Structural Engineering			
	Civil Engineering: Specialisation Water and Traffic: Elec			
	Water and Environmental Engineering: Specialisation C			
	Water and Environmental Engineering: Specialisation E Water and Environmental Engineering: Specialisation V			

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

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

Thesis

MOQUIE M1801: Maste	er thesis (dual study program)		
Courses			
Fitle	Тур	Hrs/wk	СР
Module Responsible	Professoren der TUHH		
Admission Requirements	None		
Recommended Previous			
Knowledge			
Educational Objectives	After taking part successfully, students have reached the following learning results		
Professional Competence	Dual students		
<i>Skills</i> Personal Competence <i>Social Competence</i>	 use the specialised knowledge (facts, theories and methods) from their field knowledge confidently to deal with technical and practical professional issues. can explain the relevant approaches and terminologies in depth in one or n describe current developments and take a critical stance. formulate their own research assignment to tackle a professional problem and c They ascertain the current state of research and critically assess it. Dual students can select suitable methods for the respective subject-related professional proble as required. acquire new academic knowledge in their subject area and critically evaluate it. Dual students Loual students acquire new academic knowledge in their subject area and critically evaluate it. can present a professional problem in the form of an academic question in a si correct manner, both in writing and orally, for a specialist audience and for profession answer questions as part of a professional discussion in an expert, appropriate n 	more of their subject contextualise it with em, apply them and cal phases) and app ed manner.	t's specialist ar n their subject a develop them fur ly their expertis
Autonomy	 of view and assessments convincingly. Dual students can structure their own project into work packages, work through them at an a regard to feasible courses of action for professional practice. work in-depth in a partially unknown area within the discipline and acquire the inf apply the techniques of academic work comprehensively in their own research problem and question. 	formation required t	o do so.
Workload in Hours	Independent Study Time 900, Study Time in Lecture 0		
Credit points			
Course achievement	None		
Examination	Thesis		
Examination duration and scale	According to General Regulations		
	Civil Engineering: Thesis: Compulsory		
Following Curricula	Bioprocess Engineering: Thesis: Compulsory		
	Chemical and Bioprocess Engineering: Thesis: Compulsory		
	Chemical and Bioprocess Engineering: Thesis: Compulsory		
	Computer Science: Thesis: Compulsory		
	Data Science: Thesis: Compulsory		
	Electrical Engineering: Thesis: Compulsory		
	Electrical Engineering: Thesis: Compulsory Energy Systems: Thesis: Compulsory		
	Electrical Engineering: Thesis: Compulsory		
	Electrical Engineering: Thesis: Compulsory Energy Systems: Thesis: Compulsory Environmental Engineering: Thesis: Compulsory		
	Electrical Engineering: Thesis: Compulsory Energy Systems: Thesis: Compulsory Environmental Engineering: Thesis: Compulsory Aircraft Systems Engineering: Thesis: Compulsory		
	Electrical Engineering: Thesis: Compulsory Energy Systems: Thesis: Compulsory Environmental Engineering: Thesis: Compulsory Aircraft Systems Engineering: Thesis: Compulsory Computer Science in Engineering: Thesis: Compulsory Information and Communication Systems: Thesis: Compulsory International Management and Engineering: Thesis: Compulsory		
	Electrical Engineering: Thesis: Compulsory Energy Systems: Thesis: Compulsory Environmental Engineering: Thesis: Compulsory Aircraft Systems Engineering: Thesis: Compulsory Computer Science in Engineering: Thesis: Compulsory Information and Communication Systems: Thesis: Compulsory International Management and Engineering: Thesis: Compulsory Logistics, Infrastructure and Mobility: Thesis: Compulsory		
	Electrical Engineering: Thesis: Compulsory Energy Systems: Thesis: Compulsory Environmental Engineering: Thesis: Compulsory Aircraft Systems Engineering: Thesis: Compulsory Computer Science in Engineering: Thesis: Compulsory Information and Communication Systems: Thesis: Compulsory International Management and Engineering: Thesis: Compulsory Logistics, Infrastructure and Mobility: Thesis: Compulsory Aeronautics: Thesis: Compulsory		
	Electrical Engineering: Thesis: Compulsory Energy Systems: Thesis: Compulsory Environmental Engineering: Thesis: Compulsory Aircraft Systems Engineering: Thesis: Compulsory Computer Science in Engineering: Thesis: Compulsory Information and Communication Systems: Thesis: Compulsory International Management and Engineering: Thesis: Compulsory Logistics, Infrastructure and Mobility: Thesis: Compulsory Aeronautics: Thesis: Compulsory Materials Science and Engineering: Thesis: Compulsory		
	Electrical Engineering: Thesis: Compulsory Energy Systems: Thesis: Compulsory Environmental Engineering: Thesis: Compulsory Aircraft Systems Engineering: Thesis: Compulsory Computer Science in Engineering: Thesis: Compulsory Information and Communication Systems: Thesis: Compulsory International Management and Engineering: Thesis: Compulsory Logistics, Infrastructure and Mobility: Thesis: Compulsory Aeronautics: Thesis: Compulsory Materials Science and Engineering: Thesis: Compulsory Materials Science: Thesis: Compulsory		
	Electrical Engineering: Thesis: Compulsory Energy Systems: Thesis: Compulsory Environmental Engineering: Thesis: Compulsory Aircraft Systems Engineering: Thesis: Compulsory Computer Science in Engineering: Thesis: Compulsory Information and Communication Systems: Thesis: Compulsory International Management and Engineering: Thesis: Compulsory Logistics, Infrastructure and Mobility: Thesis: Compulsory Aeronautics: Thesis: Compulsory Materials Science and Engineering: Thesis: Compulsory		

Microelectronics and Microsystems: Thesis: Compulsory
Product Development, Materials and Production: Thesis: Compulsory
Renewable Energies: Thesis: Compulsory
Naval Architecture and Ocean Engineering: Thesis: Compulsory
Theoretical Mechanical Engineering: Thesis: Compulsory
Process Engineering: Thesis: Compulsory
Water and Environmental Engineering: Thesis: Compulsory