

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 and projects geared to environmental protection and to plan them paying due attention to the necessary clarifications and examination of existing information and resources. They can

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

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

odule M0523: Busin	ess & Management
Module Responsible	Prof. Matthias Meyer
Admission Requirements	Successful completion of the modul "Foundations of Management"
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	6

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	Successful completion of practical modules as part of the dual Bachelor's course
Knowledge	Module "interlinking theory and practice as part of the dual Master's course"
	Todale intermining theory and procede as part of the additional sections
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 engineering
	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 field of 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 their 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
	Written elaboration
Examination duration and	Studienbegleitende und semesterübergreifende Dokumentation: Die Leistungspunkte für das Modul werden durch die Anfertigung
scale	
	und Reflexion der Lernerfahrungen und der Kompetenzentwicklung im Bereich der Personalen Kompetenz.

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
	 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

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
	Seminarapparat

Module M1756: Pract	tical module 1 (dual study program, Master's degree)	
Courses		
Title	Typ Hrs/wk	CP
Practical term 1 (dual study progra Module Responsible		10
Admission Requirements		
Recommended Previous	3	
Knowledge	 Successful completion of a compatible dual B.Sc. at TU Hamburg or comparable practical work experier in the area of interlinking theory and practice 	ice and competence
	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 of practical knowledge - in particular their knowledge of practical professional procedures and approache of activity in engineering. have a critical understanding of the practical applications of their engineering subject. 	
G1.11		
Skills	s Dual students	
	 apply technical theoretical knowledge to complex, interdisciplinary problems within the compar 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 responsi 	
Personal Competence		
Social Competence	Pual students	
	 work responsibly in project teams within their working area and proactively deal with problems within represent complex engineering viewpoints, facts, problems and solution approaches in discussion 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 implement the university's application recommendations and the associated challenges to positively between theory and practice. 	
Workload in Hours	Independent Study Time 300, Study Time in Lecture 0	
Credit points	s 10	
Course achievement		
	Written elaboration	a digital loarning and
	Documentation accompanying studies and across semesters: Module credit points are earned by completing development report (e-portfolio). This documents and reflects individual learning experiences and skills development	
	interlinking theory and practice, as well as professional practice. In addition, the partner company produal@TUHH Coordination Office that the dual student has completed the practical phase.	
	e Civil Engineering: Core Qualification: Compulsory	
Following Curricula	a Bioprocess Engineering: Core Qualification: Compulsory Chemical and Bioprocess Engineering: Core Qualification: Compulsory	
	Computer Science: Core Qualification: Compulsory	
	Data Science: Core Qualification: Compulsory	
	Electrical Engineering and Information Technology: 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	
	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 L2887: Practical term	n 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
	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

Module M1974: Envir	onmental microbiology and	l analytics		
Courses				
Title		Тур	Hrs/wk	СР
Environmental Analysis (L0354)		Lecture	2	3
Environmental microbiology (L322)	3)	Lecture	2	3
Module Responsible	Dr. Dorothea Rechtenbach			
Admission Requirements	None			
Recommended Previous	Fundamentals of inorganic/organic che	mistry and biology (knowledge acquired at school).		
Knowledge				
Educational Objectives	After taking part successfully, students	have reached the following learning results		
Professional Competence				
Knowledge	biological metabolic routes and can c	ts will be able to describe the mechanisms of biolo ategorise their influence on global metabolic rout d assessing the quality of various environmental co	es. They will be far	
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 relationships 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 work	ing processes within a team in a targeted way and	based on the divison	of labour.
Autonomy	Students can independently exploit sou	urces, acquire the particular knowledge of the subje	ct and apply it to ne	w problems.
Workload in Hours	Independent Study Time 124, Study Time	me in Lecture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water	and Traffic: Elective Compulsory		
Following Curricula	Water and Environmental Engineering:	Core Qualification: Compulsory		

Course L0354: Environmenta	al Analysis
Тур	Lecture
Hrs/wk	2
СР	3
	Independent Study Time 62, Study Time in Lecture 28
	Dr. Dorothea Rechtenbach, Dr. Henning Mangels
Language Cycle	
	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	al 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	ainable Circular Economy			
	,			
Courses				
Title		Тур	Hrs/wk	СР
Circular Economy (L3264)		Seminar	2	3
Environment and Sustainability (L0	1319)	Lecture	2	3
Module Responsible	Prof. Kerstin Kuchta			
Admission Requirements	None			
Recommended Previous	none			
Knowledge				
Educational Objectives	After taking part successfully, students	have reached the following learning results		
Professional Competence				
Knowledge	Students are able to describe single t	echniques and to give an overview for the fie	ld of safety and risk a	ssessment, Circu
	Economy as well as environmental and	sustainable engineering, in detail:		
	h 1	Look Stock Continue		
	basics in safety and reliability of			
	risk assessment and reliability ar Gircularity of material	naiysis metnods		
	Circularity of material Identification and evaluation of material	catavial flavos		
	 Identification and evaluation of n energy production and supply 	naterial flows		
	sustainable product design			
CI-III-	Chudanta and alla and unitarializate		l	
Skills	Students are able apply interdisciplinary system-oriented methods for Circularity and risk assessment as well as sustainability reporting. They can evaluate the effort and costs for processes and select economically feasible treatment concepts.			
	reporting. They can evaluate the enort	and costs for processes and select economically	reasible treatment con	cepts.
Personal Competence				
Social Competence				
Autonomy	Students can gain knowledge of the si	ubject area from given sources and transform i	t to new questions. Fu	rthermore, they o
	define targets for new application or re	search-oriented duties in for risk management a	nd sustainability conce	pts accordance w
	the potential social, economic and cultu	ural impact.		
Markland in Harre	Independent Study Time 124 Study Tim	no in Lockura E6		
Workload in Hours		ne in Lecture 56		
Credit points Course achievement				
Examination				
Examination duration and	,	es in groups)		
scale				
Assignment for the				
Following Curricula		n C - Bioeconomic Process Engineering, Focu	is Management and (Controlling: Elect
	Compulsory			
		Specialisation General Process Engineering: Elect		
		Specialisation Bioprocess Engineering: Elective C		
		Specialisation Chemical Process Engineering: Ele		
		Specialisation Chemical and Bio process Enginee	ring: Elective Compulso	ory
		ion Energy and Resources: Elective Compulsory	la aktiva Canada Ida	
	· ·	oduction: Specialisation Product Development: E		
	· ·	oduction: Specialisation Production: Elective Com		
	· ·	oduction: Specialisation Materials: Elective Comp	uisury	
	Water and Environmental Engineering:	core Qualification: Compulsory		

Course L3264: Circular Econo	Course 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.	

Module M1/57: Pract	ical module 2 (dual study prograr	n, Master's degree)	
Courses			
Title		Тур	Hrs/wk CP
Practical term 2 (dual study progra Module Responsible	Ì		0 10
Admission Requirements	-		
Recommended Previous			
Knowledge	Successful completion of practical module course D from the module on interlinking to	·	Master's course
	- course b from the module on mentioning	theory and practice as part of the dual i	ruster's course
	After taking part successfully, students have read	ched the following learning results	
Professional Competence	Dual students		
Momeage			
	 combine their knowledge of facts, prir practical knowledge - in particular their kr of activity in engineering. have a critical understanding of the pra 	nowledge of practical professional proce	edures and approaches, in the current fi
Skills	Dual students		
	apply technical theoretical knowledge associated work processes and results, tal implement the university's application if the university's application in the develop (new) solutions as well as princluding in the case of frequently changing	king into account different possible cour recommendations with regard to their c rocedures and approaches in their fie	rses of action. urrent tasks.
Personal Competence			
Social Competence	Dual students		
	work responsibly in cross-departments their team.	al and interdisciplinary project teams	and proactively deal with problems wit
	represent complex engineering viewp external stakeholders and develop these f		proaches in discussions with internal a
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 rebetween theory and practice. 	in their area of responsibility. modules specialisations and specialis	•
Workload in Hours	Independent Study Time 300, Study Time in Lect	ture 0	
Credit points	10		
Course achievement	None		
	Written elaboration		
	Documentation accompanying studies and acros development report (e-portfolio). This document interlinking theory and practice, as well as public dual@TUHH Coordination Office that the dual studies.	ts and reflects individual learning experience or of the control o	riences and skills development relating partner company provides proof to
Assignment for the			
Following Curricula	Bioprocess Engineering: Core Qualification: Com		
	Chemical and Bioprocess Engineering: Core Qual Computer Science: Core Qualification: Compulso		
	Data Science: Core Qualification: Compulsory	•	
	Electrical Engineering and Information Technolog	gy: Core Qualification: Compulsory	
	Electrical Engineering: Core Qualification: Compu Energy Systems: Core Qualification: Compulsory	ılsory	
	Environmental Engineering: Core Qualification: C	Compulsory	
	Aircraft Systems Engineering: Core Qualification:		
	Computer Science in Engineering: Core Qualifica		
	Information and Communication Systems: Core C International Management and Engineering: Core		
	Logistics, Infrastructure and Mobility: Core Qualif		
	Aeronautics: Core Qualification: Compulsory		
	Materials Science and Engineering: Core Qualification: Materials Science: Core Qualification: Compulsor		
	Mechanical Engineering and Management: Core		
	Mechatronics: Core Qualification: Compulsory	•	
	Biomedical Engineering: Core Qualification: Com		
	Microelectronics and Microsystems: Core Qualific	ation: 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

Course L2888: Practical term	2 (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.) Taking personal responsibility within 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
	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

Water and Environmental Engineering: Core Qualification: Compulsory

Module M1758: Pract	ical module 3 (dual study program, I	Master's degree)	
Courses			
Title		Тур	Hrs/wk CP
Practical term 3 (dual study progra	m, Master's degree) (L2889)		0 10
Module Responsible	Dr. Henning Haschke		
Admission Requirements	None		
Recommended Previous Knowledge	 Successful completion of practical module 2 as course E from the module on interlinking theor 	·	laster's course
Educational Objectives	After taking part successfully, students have reached	the following learning results	
Professional Competence	Arter taking part successfully, students have reached	the following learning results	
·	Dual students		
	 combine their comprehensive and speciali strategy-oriented practical knowledge gained f have a critical understanding of the practi implementing innovations. 	rom their current field of work and a	area of responsibility.
Skills	Dual students		
	 apply specialised and conceptual skills to sevaluate the associated work processes and re implement the university's application record develop new solutions as well as procedure when facing frequently changing requirements can use academic methods to develop ne these with regard to their usability. 	sults, taking into account different promoted in the summendations with regard to their cust and approaches to implement op and unpredictable changes (system	possible courses of action. urrent tasks. erational projects and assignments - ever nic skills).
Personal Competence			
Social Competence	Dual students		
	 work responsibly in cross-departmental ar 	d interdisciplinary project teams a	and proactively deal with problems within
	their team. • can promote the professional development • represent complex and interdisciplinary enwith internal and external stakeholders and de	of others in a targeted manner. gineering viewpoints, facts, problen	
Autonomy	Dual students		
	 reflect on learning and work processes in th define goals for new application-oriented ta company and the public. reflect on the relevance of areas of specuniversity's application recommendations and and practice. 	sks, projects and innovation plans visialisation and research for work a	as an engineer, and also implement the
Workload in Hours	Independent Study Time 300, Study Time in Lecture)	
Credit points	10		
Course achievement	None		
Examination	Written elaboration		
	Documentation accompanying studies and across set development report (e-portfolio). This documents are interlinking theory and practice, as well as profe	d reflects individual learning expensional practice. In addition, the	riences and skills development relating t partner company provides proof to th
Applement for the	dual@TUHH Coordination Office that the dual student	nas completed the practical phase.	•
Assignment for the Following Curricula	Civil Engineering: Core Qualification: Compulsory Bioprocess Engineering: Core Qualification: Compulso	nrv	
2g carricula	Chemical and Bioprocess Engineering: Core Qualifica	•	
	Chemical and Bioprocess Engineering: Core Qualifica		
	Computer Science: Core Qualification: Compulsory		
	Data Science: Core Qualification: Compulsory	0 10 11 -	
	Electrical Engineering and Information Technology: C		
	Electrical Engineering: Core Qualification: Compulsor Energy Systems: Core Qualification: Compulsory	1	
	Environmental Engineering: Core Qualification: Comp	ulsory	
	Aircraft Systems Engineering: Core Qualification: Con		
	Computer Science in Engineering: Core Qualification:	Compulsory	
	Information and Communication Systems: Core Quali		
	International Management and Engineering: Core Qualification		
	Logistics, Infrastructure and Mobility: Core Qualificati	on: compulsory	
	[10]		

Aeronautics: Core Qualification: Compulsory
Mechanical Engineering - Product Development and Production: Core Qualification: Compulsory
Materials Science and Engineering: Core 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	a 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

	rated Transportation Planning
Courses	
Title	Typ Hrs/wk CP
Integrated Transportation Planning	
Module Responsible	Prof. Carsten Gertz
Admission Requirements	None
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	Arter taking part successfully, stauches have reached the following realiting results
	Students are able to:
	 describe interdependencies between land-use/location choice and transportation/mobility behaviour explain and evaluate the social, ecological and economic effects of transport and land-use policy measures. relate current issues in the area of integrated transport planning and formulate an opinion on them.
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 teaching. constructively handle feedback on their own work. produce results in group work and document these.
Autonomy	Students are able to: • assess potential consequences of their future professional activities • independently plan working on a pre-defined project topic, acquire the necessary knowledge and use appropriate means f its execution.
	Independent Study Time 124, Study Time in Lecture 56
Credit points	
Course achievement	None Market Control of the Control o
Examination	Written elaboration
Examination duration and scale	written assignment with presentation during the semester
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory
	Civil Engineering: Specialisation Water and Traffic: Compulsory
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure and Mobility: Elective Compulsory
	Water and Environmental Engineering: Specialisation Cities: Compulsory

Course L1068: Integrated Transportation Planning		
Тур	Project-/problem-based Learning	
Hrs/wk	4	
СР	6	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	
Lecturer	Prof. Carsten Gertz, Dr. Philine Gaffron, Jacqueline Bianca Maaß	
Language	DE	
Cycle	WiSe	
Content	The course will provide students with an understanding of interdependencies between land-use and transportation. Specific topics include a.o.: • interactions between transport and the environment and consequent limitations • characteristics of integrated planning • complex planning processes • interdependencies of location choice and mobility behaviour • transport and land-use policies • project on current issues in transportation studies	
Literature	Kutter, Eckhard (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)	

Engineering"				
Module M0827: Mode	ling in Water Management			
Courses				
Title		Тур	Hrs/wk	СР
Groundwater Modeling using Modflow (L0543)		Lecture	1	1
Groundwater Modeling using Modfle		Recitation Section (small)	2	2
Modeling of Water Supply Network		Project-/problem-based Learning	2	3
Module Responsible	·			
	None			
Recommended Previous	Groundwater			
Knowledge	 groundwater hydraulics and transport of substa 	ances		
	Pipe Systems			
	ripe systems			
	Knowledge on urban water infrastructures, in	n particular drinking water systemsand u	rban drainag	e systems including
	special structures	special structures		
	Hydraulics of drinking water supply systems ar	d sewer systems		
	Basic knowledge on water management			
Educational Objectives	After taking part successfully, students have reached	the following learning results		
Professional Competence				
Knowledge	The students are able to describe the modelling of gro	oundwater flow and transport as well as urb	an water infr	astructures. They can
	carry out systems analyses and can detect technical	and conceptual weak points within the syst	ems in case	studies. Besides they
	are able to analyse interdependencies of hydraulic an	d toxic phenomena in soil and water.		
Skills	The students are able to construct and apply scienti			
	and can compare or assess different solutions for exis		ftware produ	cts. 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.			
7.10.207707779	The ment remitted.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture	70		
Credit points	6			
Course achievement	None			
Examination				
Examination duration and	30 min			
scale				
Assignment for the				
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering:			
	Civil Engineering: Specialisation Coastal Engineering:	• •		
	Civil Engineering: Specialisation Water and Traffic: Ele Civil Engineering: Specialisation Computational Engin			
	Water and Environmental Engineering: Specialisation			
	Water and Environmental Engineering: Specialisation			
	Water and Environmental Engineering: Specialisation	· · ·		

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

Course L0544: Groundwater	Course L0544: Groundwater Modeling using Modflow	
Тур	Recitation Section (small)	
Hrs/wk	2	
СР	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 M0828: Urbai	n Environmental Management			
Courses				
Title	Тур	Hrs/wk	CP	
Noise Protection (L1109)	Lecture	2	2	
Urban Infrastructures (L0874)	Project-/problem-based Learn	ng 2	4	
Module Responsible				
Admission Requirements	None			
Recommended Previous	Knowledge on Urban planning			
Knowledge	Knowledge on measures for climate protection			
	General knowledge of scientific writing/working			
	J			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge	Students can describe urban development corridors as well as current and future urban envi	ronmental proble	ems. They are able to	
	explain the causes of environmental problems (like noise).			
	Students can specify applications for various technical innovations and explain why these co	ntribute to the in	nprovement of urba	
	life. They can, for example, derive and discuss measures for effective noise abatement.			
Skills	Students are able to develop specific solutions for correcting existing or future env	ronment-related	problems of urba	
Sims	development. They can define a range of conceptual and technical solutions for environment		·	
	paths. To solve specific urban environmental problems they can select technical innovations and integrate them into the urban			
	context.	J		
Personal Competence				
Social Competence	The students can work together in international groups.			
Autonomy		ontributions to t	the discussions. The	
	can acquire appropriate knowledge by making enquiries independently.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	-		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Written Report plus oral Presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory			
	Environmental Engineering: Core Qualification: Elective Compulsory			
	Joint European Master in Environmental Studies - Cities and Sustainability: Core Qualification	Compulsory		
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure and Mobility: Elective Com	oulsory		
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory			
	Water and Environmental Engineering: Specialisation Cities: Compulsory			

Course L1109: Noise Protect	ion
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		Lecture	3	4
	ring / Integrated Flood Protection (L0961)	Project-/problem-based Learning	2	2
Module Responsible				
Admission Requirements				
	Fundamentals of Hydromechanics, Hydraulics, H	ydrology and Hydraulic Engineering; Hydra	ulic Engineer	ing I and Hydraulic
Knowledge	Engineering II			
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge	Students are able to define in detail the basic p	rocesses that are related to the modelling	of flows in hy	draulic engineering.
	Besides, they can describe the basic aspects of nu	merical modelling and actual numerical mod	els for the sin	nulation of flows and
	waves. They can also depict the concepts of nature	oriented hydraulic engineering.		
Skille	Students are able to apply hydrodynamic-numerica	I models to practical hydraulic engineering ta	cks Furtherm	ore the students are
Skills	able to set up flood-risk management concepts and			
	able to set up nood-risk management concepts and	rare able to apply basic concepts of renataral	tion to practice	ar problems.
Personal Competence				
Social Competence	The students are able to deploy their gained know	ledge in applied problems of the practical na	ature-based hy	ydraulic engineering.
	Additionaly, they will be able to work in team with e	engineers of other disciplines.		
Autonomy	The students will be able to independently extend t	heir knowledge and apply it to new problems		
Workload in Hours	Independent Study Time 110, Study Time in Lectur	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 respect 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 - C	ities and Sustainability: Core Qualification: Co	mpulsory	
	Water and Environmental Engineering: Specialisation	on Water: Compulsory		
	Water and Environmental Engineering: Specialisation	on Environment: Compulsory		
	Water and Environmental Engineering: Specialisation	on Cities: Elective Compulsory		

Course L0810: Modelling of	Flow in Rivers and Estuaries
	Lecture Lecture
Hrs/wk	
CP	
	Independent Study Time 78, Study Time in Lecture 42
	Prof. Edgar Nehlsen, Prof. Peter Fröhle
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 Literaturempfehlungen Pund der Ingenieure für Wesserwirtschaft Abfallwirtschaft und Kulturbau (1997): Hydraylische Berechnung von naturnaben
	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

9 9					
Module M0871: Hydro	ological Systems				
Courses					
Title		Тур	Hrs/wk	СР	
Applied Surface Hydrology (L0289)		Lecture	2	2	
Applied Surface Hydrology (L1412)		Project-/problem-based Learning	1	2	
Interaction Water - Environment in	Fluvial Areas (L0295)	Project-/problem-based Learning	1	2	
Module Responsible	Prof. Peter Fröhle				
Admission Requirements	None				
Recommended Previous	Fundamentals of Hydromechanics and Hydraulic En	gineering: Hydraulic Engineering I and Hydrau	ulic Engineerir	ng II	
Knowledge					
Educational Objectives	After taking part successfully, students have reache	d the following learning results			
Professional Competence					
Knowledge	The students are able to define the basic concepts	of hydrology and water management. They	are able to d	escribe and quantify	
	the relevant processes of the hydrological water cy	cle. Besides, the students know the main asp	ects of rainfa	ll-run-off-models and	
	are able to theoretically derive established reservoir	r / storage models and a unit-hydrograph.			
Skille	The students are able to use the basic hydrologic	al concents and approaches and are able t	n theoreticall	v derive established	
Skills	The students are able to use the basic hydrological concepts and approaches and are able to theoretically derive established				
	reservoir / storage models or a unit-hydrograph as the basis for rainfall-run-off-models. The student are able to explain the basic concepts of measurements of hydrological and hydrodynamic values in nature and are able to perform, analyze and statistically				
	assess these measurements. Furthermore, they are	•	•		
	assess these measurements i arthur they are	able to apply a lift along teal model to basic in	, y ar oro grear pr	0.010.11.01	
Personal Competence					
Social Competence	The students are able to deploy their gained knowle	edge in applied problems of the hydrology and	d water mana	gement. Additionaly,	
	they will be able to work in team with engineers of o	other disciplines.			
Autonomy	The students will be able to independently extend the	heir knowledge and apply it to new problems			
Workload in Hours	Independent Study Time 124, Study Time in Lecture	2 56			
Credit points	6				
Course achievement	None				
Examination	Written exam				
Examination duration and	The duration of the examination is 90 min. The exam	mination includes tasks with respect to the ge	neral underst	anding of the lecture	
scale	contents and calculations tasks.				
Assignment for the	Civil Engineering: Specialisation Computational Engi	ineering: Elective Compulsory			
Following Curricula	Civil Engineering: Specialisation Water and Traffic: 0	Compulsory			
	Environmental Engineering: Core Qualification: Elect	tive Compulsory			
	Joint European Master in Environmental Studies - Cit	ties and Sustainability: Core Qualification: Co	mpulsory		
	Water and Environmental Engineering: Specialisatio	n Cities: Elective Compulsory			
	Water and Environmental Engineering: Specialisatio	n Environment: Elective Compulsory			
	Water and Environmental Engineering: Specialisatio	n Water: Elective Compulsory			

ourse L0289: Applied Surface Hydrology			
Тур	Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Prof. Peter Fröhle		
Language	DE/EN		
Cycle	SoSe		
Content	 Basics of hydrology: 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	ater - Environment in Fluvial Areas
Тур	Project-/problem-based Learning
Hrs/wk	1
СР	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Peter Fröhle
Language	DE/EN
Cycle	SoSe
Content	A problem based learning course. The problem will be solved by the students more or less self-contained. The topics will be introduced and elaborated over the semester.
Literature	-

Module M0874: Wasto	awater Systems			
Module Moo7 4: Wast	ewater Systems			
Courses				
Title		Тур	Hrs/wk	СР
Biological Wastewater Treatment (I	_0517)	Lecture	2	2
Biological Wastewater Treatment (I	_3122)	Recitation Section (large)	1	1
Advanced Wastewater Treatment (Lecture	2	2
Advanced Wastewater Treatment (L0358)	Recitation Section (large)	1	1
Module Responsible	,			
	None			
Recommended Previous	Knowledge of wastewater management and the key	processes involved in wastewater treatme	ent.	
Knowledge				
Educational Objectives	After taking part successfully, students have reached	d the following learning results		
Professional Competence				
Knowledge	Students are able to outline key areas of the full rar	ige of treatment systems in waste water	management, as	well as their mutual
	dependence for sustainable water protection. They o	an describe relevant economic, environm	ental and social	factors.
Skills	Students are able to pre-design and explain the av	ailable wastewater treatment processes	and the scene of	of their application in
SKIIIS	municipal and for some industrial treatment plants.	allable wastewater treatment processes	and the scope t	п спен аррисации п
	municipal and for some moustrial treatment plants.			
Personal Competence				
Social Competence	Social skills are not targeted in this module.			
Autonomy	Students are in a position to work on a subject ar	nd to organize their work flow independent	ently. They can	also present on this
	subject.			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 8	34		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineeri	ng: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engine	eering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering	: Elective Compulsory		
	Civil Engineering: Specialisation Water and Traffic: C	ompulsory		
	Bioprocess Engineering: Specialisation A - General B	ioprocess Engineering: Elective Compulso	ry	
	Environmental Engineering: Specialisation Water Qu	ality and Water Engineering: Elective Com	pulsory	
	International Management and Engineering: Speciali	• •		
	International Management and Engineering: Speciali	•	eering: Elective	Compulsory
	Process Engineering: Specialisation Environmental P	rocess Engineering: Elective Compulsory		
	Process Engineering: Specialisation Process Enginee	ring: Elective Compulsory		
	Water and Environmental Engineering: Specialisation	· · ·		
	Water and Environmental Engineering: Specialisation			
	Water and Environmental Engineering: Specialisation	n Cities: Compulsory		

Course L0517: Biological Wa	ourse 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	

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

 $ISBN: 3527312196 \ (Gb.) \ URL: \ http://deposit.ddb.de/cgi-bin/dokserv?id=2774611\&prov=M\&dok_var=1\&dok_ext=htm. \\ ISBN: 3527312196 \ (Gb.) \ URL: \ http://deposit.ddb.de/cgi-bin/dokserv?id=2774611\&prov=M\&dok_var=1\&dok_ext=htm. \\ ISBN: 3527312196 \ (Gb.) \ URL: \ http://deposit.ddb.de/cgi-bin/dokserv?id=2774611\&prov=M\&dok_var=1\&dok_ext=htm. \\ ISBN: 3527312196 \ (Gb.) \ URL: \ http://deposit.ddb.de/cgi-bin/dokserv?id=2774611\&prov=M\&dok_var=1\&dok_ext=htm. \\ ISBN: 3527312196 \ (Gb.) \ URL: \ http://deposit.ddb.de/cgi-bin/dokserv?id=2774611\&prov=M\&dok_var=1\&dok_ext=htm. \\ ISBN: 3527312196 \ (Gb.) \ URL: \ http://deposit.ddb.de/cgi-bin/dokserv?id=2774611\&prov=M\&dok_var=1\&dok_ext=htm. \\ ISBN: 3527312196 \ (Gb.) \ URL: \ http://deposit.ddb.de/cgi-bin/dokserv?id=2774611\&prov=M\&dok_var=1\&dok_ext=htm. \\ ISBN: 3527312196 \ (Gb.) \ URL: \ http://deposit.ddb.de/cgi-bin/dokserv?id=2774611\&prov=M\&dok_var=1\&dok_ext=htm. \\ ISBN: 3527312196 \ (Gb.) \ URL: \ http://deposit.ddb.de/cgi-bin/dokserv?id=2774611\&prov=M\&dok_var=1\&dok_ext=htm. \\ ISBN: 3527312196 \ (Gb.) \ URL: \ http://deposit.ddb.de/cgi-bin/dokserv?id=2774611\&prov=M\&dok_ext=htm. \\ ISBN: 3527312196 \ (Gb.) \ URL: \ http://deposit.ddb.de/cgi-bin/dokserv?id=2774611\&prov=M\&dok_ext=htm. \\ ISBN: 3527312196 \ (Gb.) \ URL: \ http://deposit.ddb.de/cgi-bin/dokserv.de/cg$

Weinheim: WILEY-VCH, 2007

TUB_HH_Katalog

Course L3122: Biological 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	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	SoSe
Content	Survey on advanced wastewater treatment
	reuse of reclaimed municipal wastewater
	Precipitation
	Flocculation
	Depth filtration
	Membrane Processes
	Activated carbon adsorption
	Ozonation
	"Advanced Oxidation Processes"
	Disinfection
Literature	Metcalf & Eddy, Wastewater Engineering: Treatment and Reuse, McGraw-Hill, Boston 2003
	Wassertechnologie, H.H. Hahn, Springer-Verlag, Berlin 1987
	Membranverfahren: Grundlagen der Modul- und Anlagenauslegung, T. Melin und R. Rautenbach, Springer-Verlag, Berlin 2007
	Trinkwasserdesinfektion: Grundlagen, Verfahren, Anlagen, Geräte, Mikrobiologie, Chlorung, Ozonung, UV-Bestrahlung, Membranfiltration, Qualitätssicherung, W. Roeske, Oldenbourg-Verlag, München 2006
	Organische Problemstoffe in Abwässern, H. Gulyas, GFEU, Hamburg 2003

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

Module M0875: Nexus	Engineering - Water, Soil, Food and	Energy		
Courses				
Title		Тур	Hrs/wk	СР
Ecological Town Design - Water, En		Seminar	2	2
Water & Wastewater Systems in a 0		Lecture	2	4
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
	Basic knowledge of the global situation with rising p	overty, soil degradation, migrat	tion to cities, lack of v	vater resources and
Knowledge	sanitation			
Educational Objectives	After taking part successfully, students have reached the	ne following learning results		
Professional Competence				
Knowledge	Students can describe the facets of the global water sit	uation. Students can judge the e	normous potential of th	e implementation of
	synergistic systems in Water, Soil, Food and Energy su	oply.		
Chille	Students are able to design applicated cottlements for	different geographic and secie	oconomic conditions fo	ur the main climates
SKIIIS	Students are able to design ecological settlements for around the world.	different geographic and socio-	economic conditions ic	or the main climates
	around the world.			
Personal Competence				
Social Competence	The students are able to develop a specific topic in a te	am and to work out milestones a	according to a given pla	n.
Autonomy	Students are in a position to work on a subject and	to organize their work flow inde	enendently They can a	also present on this
Autonomy	subject.	to organize their work now man	ependently. They can t	1130 present on this
	Subject.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	<u> </u>		
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	During the course of the semester, the students work	towards mile stones. The work i	ncludes presentations a	and papers. Detailed
scale	information can be found at the beginning of the smest	er in the StudIP course module h	andbook.	
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elec	tive Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation A - General Biop	rocess Engineering: Elective Con	npulsory	
	Chemical and Bioprocess Engineering: Specialisation G	eneral Process Engineering: Elec	tive Compulsory	
	Environmental Engineering: Core Qualification: Elective			
	Joint European Master in Environmental Studies - Cities	•		
	Process Engineering: Specialisation Environmental Proc		ılsory	
	Process Engineering: Specialisation Process Engineering			
	Water and Environmental Engineering: Specialisation W			
	Water and Environmental Engineering: Specialisation E		/	
	Water and Environmental Engineering: Specialisation C	ities: Elective Compulsory		

Course L1229: Ecological Tov	vn 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

C 10030- W-t 5 W	Sunday Sunday in a Clabal Sanday
	tewater Systems in a Global Context
	Lecture
Hrs/wk	
СР	
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Ralf Otterpohl
Language	EN
Cycle	SoSe
Content	
Literature	 Keynote lecture and video Water & Soil: Water availability as a consequence of healthy soils Water and it's utilization, Integrated Urban Water Management Water & Energy, lecture and panel discussion pro and con for a specific big dam project Rainwater Harvesting on Catchment level, Holistic Planned Grazing, Multi-Use-Reforestation Sanitation and Reuse of water, nutrients and soil conditioners, Conventional and Innovative Approaches Why are there excreta in water? Public Health, Awareness Campaigns Rehearsal session, Q&A
Literature	 Montgomery, David R. 2007: Dirt: The Erosion of Civilizations, University of California Press Liu, John D.: http://eempc.org/hope-in-a-changing_climate/ (Integrated regeneration of the Loess Plateau, China, and sites in Ethiopia and Rwanda) http://youtu.be/9hmkgn0nBgk (Miracle Water Village, India, Integrated Rainwater Harvesting, Water Efficiency, Reforestation and Sanitation)

Module M0922: City F	Planning
Courses	
litle little	Typ Hrs/wk CP
City Planning (L1066)	Project-/problem-based Learning 4 6
Module Responsible	Prof. Carsten Gertz
Admission Requirements	None
	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.
Personal Competence Social Competence	Students are able to: • discuss intermediate results with each other. • constructively accept feedback on their own work. • provide constructive feedback to others.
Autonomy	Students are able to: • independently complete a written report including drawings following a broadly pre-defined process. • assess the consequences of their proposed solutions. • independently acquire knowledge and apply this to new issues or problem areas.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	
Examination duration and	written assignment, designwork during the semester
scale	
Assignment for the	
Following Curricula	
	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
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Carsten Gertz
Language	DE
Cycle	SoSe
Content	"Principles of Urban Planning" deals with the determinants of urban development and their interactions. Topics include:
	 legal framework, instruments and methods of planning, functional requirements, stakeholders and actors basic design requirements different planning levels and historical contexts. The objective of the course is for students to acquire a basic understanding of urban development problems and approaches for solving them. They will also be able to comprehend the process of urban planning. The course also covers the various functional and aesthetic requirements for designing streetscape as the most important elements of public space. The project work deals with a real life scenario and includes drawing up a development plan, an urban design concept, a building masterplan and a street redesign.
Literature	Albers, Gerd; Wekel, Julian (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-/ţ	problem-based Learning	3	3
Water and Environment (L2753)	Lecture		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 learning	ng results		
Professional Competence				
Knowledge	Common research tools and techniques together with the fundamen challenges present in water and environmental research will be discus considered.	3		
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 w	vill be at the core	e of this module.
Autonomy	The students will be involved in writing individual reports and presen willingness to work independently and responsibly.	ntation. This will contrib	oute to the stud	dents' ability and
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 Compulsory	/		
Following Curricula	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory			
	Environmental Engineering: Specialisation Environment and Climate: Elec	tive Compulsory		
	Water and Environmental Engineering: Specialisation Cities: Elective Com	pulsory		
	Water and Environmental Engineering: Specialisation Water: Elective Com	npulsory		
	Water and Environmental Engineering: Specialisation Environment: Comp	ulsory		

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 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

Module M1724: Smar	t Monitoring
Courses	
Title	Typ Hrs/wk CP
Smart Monitoring (L2762)	Integrated Lecture 2 2 Recitation Section (small) 2 4
Smart Monitoring (L2763)	
Module Responsible	
Admission Requirements	
	Basic knowledge or interest in object-oriented modeling, programming, and sensor technologies are helpful. Interest in mode
Knowleage	research and teaching areas, such as Internet of Things, Industry 4.0 and cyber-physical systems, as well as the will to deeper skills of scientific working, are required. Basic knowledge in scientific writing and good English skills.
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students will become familiar with the principles and practices of smart monitoring. The students will be able to design
Personal Competence	environment. In addition, the students will learn to design and to implement intelligent sensor systems using state-of-the-art da analysis techniques, modern software design concepts, and embedded computing methodologies. Besides lectures, project work also part of this module, which will be conducted throughout the semester and will contribute to the grade. In small groups, the students will design smart monitoring systems that integrate a number of "intelligent" sensors to be implemented by the student Specific focus will be put on the application of machine learning techniques. The smart monitoring systems will be mounted real-world (built or natural) systems, such as bridges or slopes, or on scaled lab structures for validation purposes. The outcome every group will be documented in a paper. All students of this module will "automatically" participate with their smart monitorin system in the annual "Smart Monitoring" competition. The written papers and oral examinations form the final grades. The modul will be taught in English. Limited enrollment. The students will gain insights into operating state-of-the-art smart sensor systems, used for monitoring a wide range of physic processes relevant to engineering, such as environmental, structural, or comfort monitoring. The students will be capable devising monitoring strategies of physical processes as part of group projects, tailored to their knowledge backgrounds, and implement the strategies in smart wireless sensor nodes, using embedded computing and programming. Finally, the students were able to document the findings of their projects in short reports. The students will be able to work in groups, share parts of the work for their projects, and develop communication skills, towar achieving the common project goals.
Autonomy	The students will be able to gain a solid basis on approaching and solving problems in engineering, as well as on documenting 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	
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory
	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory
	Computer Science: Specialisation II: Intelligence Engineering: Elective Compulsory
	Environmental Engineering: Specialisation Energy and Resources: Elective Compulsory
	Environmental Engineering: Specialisation Environment and Climate: Elective Compulsory
	Environmental Engineering: Specialisation Water Quality and Water Engineering: Elective Compulsory
	Mechatronics: Technical Complementary Course: Elective Compulsory
	Mechatronics: Core Qualification: Elective Compulsory
	Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory
	Water and Environmental Engineering: Specialisation Cities: Elective Compulsory
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory
	Water and Environmental Engineering: Specialisation Water: Elective Compulsory

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

Modulo M1979: Susta	sinable energy from wind and water			
Module M10/6: Susta	inable energy from wind and water			
Courses				
Title Offshore Geotechnical Engineering (L0067) Hydro Power Use (L0013)		Typ Lecture Lecture	Hrs/wk 1 1	CP 1 1
Wind Turbine Plants (L0011) Wind Energy Use - Focus Offshore	(L0012)	Lecture Lecture	2 1	3 1
Module Responsible	Dr. Marvin Scherzinger			
Admission Requirements	None			
Recommended Previous	Module: Technical Thermodynamics I,			
Knowledge	Module: Technical Thermodynamics II,			
	Module: Fundamentals of Fluid Mechanics			
Educational Objectives	After taking part successfully, students have reached	d the following learning results		
Professional Competence Knowledge	By ending this module students can explain in detail knowledge of wind turbines with a particular focus of wind energy use in offshore 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.			
Skills	Through active discussions of various topics within the seminar of the module, students improve their understanding and the application of the theoretical background and are thus able to transfer what they have learned in practice. 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			
Personal Competence Social Competence Autonomy	Students can discuss scientific tasks subjet-specificly and multidisciplinary within a seminar.			
	lecture and to acquire the particular knowledge abou	ut the subject area.		
Workload in Hours	Independent Study Time 110, Study Time in Lecture	70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 min			
scale Assignment for the Following Curricula	Civil Engineering: Specialisation Structural Engineeri Civil Engineering: Specialisation Geotechnical Engine Civil Engineering: Specialisation Coastal Engineering International Management and Engineering: Speciali International Management and Engineering: Speciali Product Development, Materials and Production: Speciality Development, Materials and Production: Specialisation Environmental Putter and Environmental Engineering: Specialisation Water and Environmental Engineering: Specialisation	eering: Elective Compulsory g: Elective Compulsory g: Elective Compulsory g: Sation II. Energy and Environmenta g: Sation II. Renewable Energy: Elective geoialisation Product Development: Elective Com geoialisation Materials: Elective Com geoialisation Elective Compulsor georges Systems: Elective Compulsor grocess Engineering: Elective Comp gn Cities: Elective Compulsory	ve Compulsory Elective Compulsory mpulsory pulsory ry ulsory	Compulsory

Course L0067: Offshore Geot	Course L0067: Offshore Geotechnical 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

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

Module M2002: Wast	e and Resource	Management	t			
Courses						
Title				Тур	Hrs/wk	СР
Waste management (L3261)				Project-/problem-based Learning	3	3
International waste concepts (L325	59)			Lecture	2	2
International waste concepts (L326	50)			Recitation Section (small)	1	1
Module Responsible	Prof. Kerstin Kuchta					
Admission Requirements	None					
Recommended Previous	Basics in process eng	jineering				
Knowledge						
Educational Objectives	After taking part succ	essfully, students ha	ave reached the following	ng learning results		
Professional Competence						
Knowledge	The students are able	e to describe waste	as a resource as well a	as advanced technologies for re	cycling and re	covery of resources
	from waste in detail.	This covers collection	n, transport, treatment	and disposal in national and inte	ernational cont	exts.
Skills	Students are able to	select suitable proce	sses for the treatment	with respect to the national or cu	iltural and dev	velonmental context
Skins		•		of different technologies and ma		•
	They can evaluate in	c cco.og.capace	and the teenmed energ	or american techniologics and me	anagement by	
Personal Competence						
Social Competence	Students can work to	ogether as a team	of 2-5 persons, particip	pate in subject-specific and inte	erdisciplinary (discussions, develop
	·			t of others and promote the scie	entific develop	ment of colleagues.
	Furthermore, they ca	n give and accept pr	ofessional constructive	criticisms.		
Autonomy	Students can indepe	ndently gain addition	onal knowledge of the	subject area and apply it in so	lvina the aive	en course tasks and
	projects.	, ,		,	3 - 3	
	, ,					
Workload in Hours	Independent Study Ti	me 96, Study Time i	n Lecture 84			
Credit points						
Course achievement	Compulsory Bonus Yes 20 %	Form Written elaboration	Description			
Examination	Presentation	vviitteii ciaboratio				
Examination duration and	1	tion (10.15 minutes)				
scale	rowerroint presentat	.ioii (10-13 iiiiilates)				
Assignment for the	Civil Engineering: Spe	ocialisation Water an	d Traffic: Elective Com	oulcory		
Following Curricula				ocess Engineering: Elective Comp	nulsory	
Tonowing curricula	·			Engineering: Elective Compulsor	-	
		3 3 1		rocess Engineering: Elective Con	•	
				nd Bio process Engineering: Elec		ry
	·		re Qualification: Electiv			•
			n Energy and Resources			
	_			newable Energy: Elective Compu	Isory	
	_	_		eering: Elective Compulsory	-	
	Water and Environme	ental Engineering: Sp	pecialisation Cities: Elec	tive Compulsory		
	Water and Environme	ental Engineering: Sp	ecialisation Environme	nt: 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:
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
СР	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 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	sportation Modelling
Courses	
Title	Typ Hrs/wk CP
Transportation Modelling (L1180)	Project-/problem-based Learning 4 6
Module Responsible	Prof. Carsten Gertz
Admission Requirements	None
Recommended Previous	some knowledge of transport planning, e.g. through taking the undergraduate class "Transport Planning and Traffic Engineering"
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to understand the operation and potential applications of transport models.
Skills	Students are able to:
	 use travel demand modelling software packages for solving practical problems. design a database structure for travel demand models. assess modelling results. appraise potential applications and limitations of such models.
	Students are able to independently develop and document solutions. Students are able to: independently organise, manage and solve set tasks. independently prepare written reports.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written elaboration
Examination duration and scale	
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Compulsory
Following Curricula	
	Water and Environmental Engineering: Specialisation Cities: Elective Compulsory

Course L1180: Transportation	n Modelling
Тур	Project-/problem-based Learning
Hrs/wk	4
СР	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 landuse and transport models as well as the use of models for evaluating locations) Practice-oriented project for assessing consequences of infrastructure projects and changes in land-use
Literature	Lohse, Dieter und Schnabel, Werner (2011): Grundlagen der Straßenverkehrstechnik und der Verkehrsplanung – Band 2. 3. Auflage. Beuth. Ortúzar, Juan de Dios und Willumsen, Luis G. (2011): Modelling Transport. 4. Auflage. John Wiley & Sons.

Module M0801: Wate	r Resources and -Supply			
Courses				
Title		Тур	Hrs/wk	СР
Chemistry of Drinking Water Treatr	nent (L0311)	Lecture	2	1
Chemistry of Drinking Water Treatr	nent (L0312)	Recitation Section (large)	1	2
Water Resource Management (L04)		Lecture	2	2
Water Resource Management (L04)		Recitation Section (small)	1	1
Module Responsible				
Admission Requirements	None			
	Knowledge of water management and the key processes	involved in water treatment.		
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	e following learning results		
Professional Competence				
Knowleage	Students will be able to outline key areas of conflict in water management, as well as their mutual dependence for sustainable water supply. They will understand relevant economic, environmental and social factors. Students will be able to explain and outline the organisational structures of water companies. They will be able to explain the available water treatment processes and the scope of their application.			
Skills	Students will be able to assess complex problems in drinking water production and establish solutions involving water management and technical measures. They will be able to assess the evaluation methods that can be used for this. Students will be able to carry out chemical calculations for selected treatment processes and apply generally accepted technical rules and standards to these processes.			
Personal Competence				
Social Competence Autonomy	Working in a diverse group of specialists, students will be able to develop and document complex solutions for the management and treatment of drinking water. They will be able to take an appropriate professional position, for example representing user interests. They will be able to develop joint solutions in teams of diverse experts and present these solutions to others. Students will be in a position to work on a subject independently and present on this subject.			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and	60 min (chemistry) + presentation			
scale	*			
Assignment for the	Civil Engineering: Specialisation Structural Engineering:	Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineerin			
	Civil Engineering: Specialisation Water and Traffic: Comp	ulsory		
	Civil Engineering: Specialisation Coastal Engineering: Ele	ctive Compulsory		
	Chemical and Bioprocess Engineering: Technical Comple	mentary Course: Elective Compulsor	y	
	Chemical and Bioprocess Engineering: Technical Comple	mentary Course: Elective Compulsor	y	
	International Management and Engineering: Specialisation	on II. Energy and Environmental Engi	neering: Elective	Compulsory
	Process Engineering: Specialisation Environmental Proce			
	Process Engineering: Specialisation Process Engineering:			
	Water and Environmental Engineering: Specialisation Wa			
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory			
	Water and Environmental Engineering: Specialisation Cit	ies: 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.

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

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

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

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

Engineering				
Module M0802: Meml	orane Technology			
Courses				
Title		Тур	Hrs/wk	CP
Membrane Technology (L0399)		Lecture	2	3
Membrane Technology (L0400)		Recitation Section (small)	1	2 1
Membrane Technology (L0401)		Practical Course	1	1
Module Responsible	Prof. Mathias Ernst			
Admission Requirements	None			
Recommended Previous	Basic knowledge of water chemistry. Knowledge of t	the 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 w	vill be able to explain
	the different driving forces behind existing membi	rane separation processes. Students wil	I be able to nan	ne materials used in
	membrane filtration and their advantages and disa		lain the key diffe	rences in the use o
	membranes in water, other liquid media, gases and	in liquid/gas mixtures.		
Skills	Students will be able to prepare mathematical equ	ations for material transport in porous a	nd solution-diffus	sion membranes and
	calculate key parameters in the membrane separat			
	available boundary data and provide recommenda			
	experiments, students will be able to classify the			
	membrane materials. Students will be able to charac			
	measures to control this.			
Personal Competence				
Social Competence	Students will be able to work in diverse teams on to	asks in the field of membrane technology	. They will be ab	le to make decision
	within their group on laboratory experiments to be u	undertaken jointly and present these to ot	hers.	
Autonomy	Students will be in a position to solve homework of	on the tonic of membrane technology in	denendently The	v will be canable o
riaconomy	finding creative solutions to technical questions.	on the topic of membrane technology in	acpendently. The	y will be capable o
Workload in Hours	Independent Study Time 124, Study Time in Lecture	: 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic: E	lective Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation A - General B	ioprocess Engineering: Elective Compulso	ory	
	Bioprocess Engineering: Specialisation B - Industrial	Bioprocess Engineering: Elective Compul	sory	
	Chemical and Bioprocess Engineering: Specialisation	n General Process Engineering: Elective C	ompulsory	
	Chemical and Bioprocess Engineering: Specialisation	n Chemical Process Engineering: Elective	Compulsory	
	Chemical and Bioprocess Engineering: Technical Cor	mplementary Course: Elective Compulsor	у	
	Chemical and Bioprocess Engineering: Technical Cor	mplementary Course: Elective Compulsor	у	
	Environmental Engineering: Specialisation Water Qu	ality and Water Engineering: Elective Cor	npulsory	
	Process Engineering: Specialisation Process Enginee	ring: Elective Compulsory		
	Process Engineering: Specialisation Environmental P	rocess Engineering: Elective Compulsory		
	Water and Environmental Engineering: Specialisation	n Water: Elective Compulsory		
	Water and Environmental Engineering: Specialisation	n Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation	n Cities: Elective Compulsory		

Course L0399: Membrane Technology			
Тур	Lecture		
Hrs/wk			
СР			
Workload in Hours	dependent 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 Technology		
itation Section (small)		
1		
2		
Independent Study Time 46, Study Time in Lecture 14		
Prof. Mathias Ernst		
EN		
WiSe		
See interlocking course		
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	

Title Typ Hrs/wk CP Process Modelling of Wastewater Treatment (L0522) Project-/problem-based Learning 2 3 Process Modeling in Drinking Water Treatment (L0314) Project-/problem-based Learning 2 3 Module Responsible Dr. Klaus Johannsen Admission Requirements None Recommended Previous Knowledge of the most important processes in drinking water and waste water treatment. Knowledge Educational Objectives After taking part successfully, students have reached the following learning results			
Process Modelling of Wastewater Treatment (L0522) Process Modeling in Drinking Water Treatment (L0314) Module Responsible Dr. Klaus Johannsen Admission Requirements None Recommended Previous Knowledge Knowledge			
Process Modeling in Drinking Water Treatment (L0314) Module Responsible Admission Requirements Recommended Previous Knowledge Project-/problem-based Learning 2 3 **Treatment (L0314) **Project-/problem-based Learning 2 3 **Treatment (L0314) **Project-/problem-based Learning 2 3 **Treatment (L0314) **Treatment (L0314)			
Module Responsible Dr. Klaus Johannsen Admission Requirements None Recommended Previous Knowledge of the most important processes in drinking water and waste water treatment. Knowledge			
Admission Requirements None Recommended Previous Knowledge of the most important processes in drinking water and waste water treatment. Knowledge			
Recommended Previous Knowledge of the most important processes in drinking water and waste water treatment. Knowledge			
Knowledge			
	Knowledge of the most important processes in drinking water and waste water treatment.		
Educational Objectives After taking part successfully, students have reached the following learning results			
Professional Competence			
Knowledge Students are able to explain selected processes of drinking water and waste water treatment in detail. They are able to	o explain		
basics as well as possibilities and limitations of dynamic modeling.			
Skills Students are able to use the most important features Modelica offers. They are able to transpose selected processes in	n drinkina		
water and waste water treatment into a mathematical model in Modelica with respect to equilibrium, kinetics and mass	-		
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.			
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 Lecture 56			
Credit points 6			
Course achievement None			
Examination Oral exam			
Examination duration and 30 min			
scale			
Assignment for the Civil Engineering: Specialisation Water and Traffic: Elective Compulsory			
Following Curricula Chemical and Bioprocess Engineering: Technical Complementary Course: Elective Compulsory			
Chemical and Bioprocess Engineering: Technical Complementary Course: Elective Compulsory			
Environmental Engineering: Specialisation Water Quality and Water Engineering: Elective Compulsory			
Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory Process Engineering: Specialisation Process Engineering: Elective Compulsory			
Water and Environmental Engineering: Specialisation Water: Elective Compulsory			
Water and Environmental Engineering: Specialisation Environment: Elective Compulsory			
Water and Environmental Engineering: Specialisation Cities: Elective Compulsory			

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

Course L0314: Process Modeling 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 M0981: Opera	ation of Public Transportation Systems
Courses	
Title Operation of Public Transportation	Typ Hrs/wk CP Systems (L1179) Project-/problem-based Learning 4 6
Module Responsible	
Admission Requirements	
	some knowledge of transport planning, e.g. through taking the undergraduate class "Transport Planning and Traffic Engineering
Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to:
	describe public transport (PT) systems in technical language.
	outline the entire PT system including the interdependencies of the different elements.
	explain the requirements for a PT system from different perspectives.
	explain the role of PT in the transport system.
Skills	Students are able to:
	systematically develop a public transport system when there are no clear cut correct or incorrect approaches.
	cope with imprecise and incomplete data.
	develop and appraise alternative solutions.
	distinguish or develop appropriate methods of analysis and modes of presentation.
	reflect and evaluate their own transport concept, considering competing requirements.
Personal Competence	
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	
riaconomy	independently develop a bus PT concept within a given framework.
	determine and justify the focus of their work.
	organize and follow their work process regarding time and content.
	independently author a written report.
	assess the consequences of the solutions they develop.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
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	
СР	6	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	
Lecturer	Prof. Carsten Gertz	
Language	DE	
Cycle	WiSe	
Content	The course primarily deals with the planning and operational challenges of public transport systems. A bus-system is the example for studying these problems in depth. The following topics and systemic elements are covered: PT network planning improved 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 M1505: Adap	tation to Climate Change in Hydraulic Engineering (AKWAS)
Courses	
Title Adaptation to climate change in hy	Typ Hrs/wk CP rdraulic engineering (L2291) Project-/problem-based Learning 4 6
Module Responsible	Prof. Peter Fröhle
Admission Requirements	
Recommended Previous	
Knowledge	
	Hydromechanic, Hydraulics Fundamentals of Coastal Engineering, Coastal, and Flood Protestion
	 Fundamentals of Coastal Engineering, Coastal- and Flood Protection Hydrological Systems
	1 Trydrological Systems
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Climate protection and climate adaptation
	Insights into climate change and its regional characteristics - fundamentals, climate modelling / climate models
	Impacts of climate change on the components of the regional hydrological cycle
	Fundamentals of analysis of climate data
	Consequences of the impact of the climate change
	Measures for climate adaptation
	Assessment, prioritization and communication of adaptation measures
	Fundamentals of the analysis of hydrometeorological and hydrological data
Skills	
	Critical thinking: analysis of processes and relations, assessment of needs for action
	 Creative thinking: development of adaptation strategies and adaptation measures Practical thinking: inclusion of restrictions, application of calculation approaches, methods, numerical models, plannir
	methods
	Consideration of complex tasks
Personal Competence	
Social Competence	a Warking is betarageness groups
	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
	Preparation of a written report and a presentation of a complex task.
scale	
-	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory
Following Curricula	
	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation Water and Traffic: Elective Compulsory
	Water and Environmental Engineering: Specialisation Cities: Elective Compulsory
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory Water and Environmental Engineering: Specialisation 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. 		

Module M1123: Selec	ed Topics in Environmental E	Engineering		
Courses				
Title		Тур	Hrs/wk	СР
Environmental Aquatic Chemistry (L1444)		Lecture	2	3
Solid Matter Process Technology for Biomass (L0052)		Lecture	2	3
Sustainable landfill design and operation (L3270)		Integrated Lecture	3	3
Sludge Treatment (L0520)		Lecture	2	3
pecial topics of the Environmental			1	1
Special topics of the Environmental			2	2
Special topics of the Environmental			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 Qualification: Elective Compulsory			
Following Curricula	Water and Environmental Engineering: Specialisation Cities: Elective Compulsory			
	Water and Environmental Engineering: Spe	ecialisation Environment: Elective Compulsory		
	Water and Environmental Engineering: Spe	ocialisation Water: Flective Compulsory		

Course L1444: Environmenta	l Aquatic Chemistry		
Тур	ecture		
Hrs/wk	2		
СР	3		
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28		
Examination Form	Klausur		
Examination duration and	60 min		
scale			
Lecturer	Dr. Klaus Johannsen		
Language	EN		
Cycle	SoSe		
Content	 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 I	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

andfill design and operation	
ntegrated Lecture	
3	
3	
Independent Study Time 48, Study Time in Lecture 42	
Klausur	
60 min	
Dr. Marco Ritzkowski	
EN	
SoSe	
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.	
1) Waste Management. Bernd Bilitewski; Georg Härdtle; Klaus Marek (Eds.), ISBN: 9783540592105 , Springer Verlag	
Lehrbuchsammlung der TUB, Signatur USH-305	
2) Solid Waste Technology and Management. Thomas Christensen (Ed.), ISBN: 978-1-4051-7517-3, Wiley Verlag	
Lesesaal 2: US - Umweltschutz, Signatur USH-332	
3) Solid Waste Landfilling - Concepts, Processes, Technologies. Cossu, R. and Stegmann, R. (Eds.), ISBN: 978-0-12-818336-	
6	
PDF (Volltext) über TUB	

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	
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	
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. Alectricity conception technologies, flugges treatment technologies, asked and their use.	
	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	
Literature	Authorities, Fig. Flat sinding, Fit (11139). Energie das biolitasse, Springer, Berlin, Fletdelberg, 2003, 2. Authage	

Course L2386: Thermal Biomass 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	
	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 M1720: Emer	ging Trends in Environmental	Engineering		
Courses				
Title		Тур	Hrs/wk	СР
Environmental Research Trends (L2752)		Seminar	2	2
Microplastics in Environment (L275		Lecture	2	2
Scientific Communication and Meth		Lecture	1	2
Module Responsible				
Admission Requirements				
	Basic knowledge on water, soil and environ	mental research.		
Knowledge				
Educational Objectives	After taking part successfully, students hav	re reached the following learning results		
Professional Competence				
Knowledge	The students will be exposed to up-to-date	research topics focused on soil, water and clin	nate related challen	ges with a particular
	focus on the effects of microplastics in en	vironment. Data analysis, data measurement,	curation and prese	ntation will be other
	skills that the students will develop in this r	module.		
Skills	Students' research skills will be improved	in this module. How to prepare and deliver an	effective presentat	ion, how to write ar
	abstract, research paper and proposal will	be discussed in this module. Moreover, through	h Research-Based L	earning approaches
		earch trends in environmental engineering.		3 ,,
	·	3		
Personal Competence				
•	Developing teamwork and problem solving	skills through Research-Based Teaching approa	ches will be at the c	ore of this module
Social competence	Beveloping teamwork and problem solving	Skins through Research Buseu reaching approu	enes will be de the e	ore or this intoduce.
Autonomy	The students will be involved in writing	individual reports and presentation. This will	contribute to the s	students' ability and
	willingness to work independently and resp	onsibly.		
Workload in Hours	Independent Study Time 110, Study Time in	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 and	Traffic: Elective Compulsory		
Following Curricula		Environment and Climate: Elective Compulsory		
-	Water and Environmental Engineering: Spe	cialisation Cities: Elective Compulsory		
		cialisation Environment: Elective Compulsory		
	Water and Environmental Engineering: Spe			

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

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

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

Module M1779: Susta	ninable Nature-based Coastal Protecti	on in a Changing Climate (Se	eaPiaC)	
Courses				
Title		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				
Knowledge	Hydraulic Engineering			
-	Hydromechanics, Hydraulics			
	Fundamentals of Coastal Engineering, Coastal- a	nd Flood Protection		
Educational Objectives	After taking part successfully, students have reached to	ne following learning results		
Professional Competence				
Knowledge				
	Climate and Climate Change Copyral Impacts of Climate Change on Wind Res	time and Water Cycle		
	General Impacts of Climate Change on Wind Reg Consequences of Climate Change for Coastal Pro			
	Coastal Protection in Taiwan and Germany	ree33c3		
	Fundamentals of Climate Adaptation			
	Nature-based Solutions (NBS) for Coastal Protect	ion		
Skills	Critical thinking: analysis of processes and relati	ons, assessment of needs for action		
	Creative thinking: development of adaptation str	rategies and adaptation measures		
	Practical thinking: inclusion of restrictions, app.	olication of calculation approaches, meth	nods, numerica	l models, plannir
	methods			
	Consideration of complex tasks			
Personal Competence				
Social Competence				
,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	Working in heterogenous groups			
	Working in international groups			
	Working with different scientific / non-scientific contact in the scientific contact in the	lisciplines		
	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	5		
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Preparation of a written report on a complex task with	a presentation and subsequent discussion	on. The work o	n the complex tas
scale	happens in the course of the lecture.			
Assignment for the				
Following Curricula				
	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation Water and Traffic: Elective Compulsory Environmental Engineering: Specialisation Environment and Climate: Elective Compulsory			
	Water and Environmental Engineering: Specialisation C			
	Water and Environmental Engineering: Specialisation E			
	Water and Environmental Engineering: Specialisation V	vater. 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 M2003: Biolog	gical Waste Treatment			
Courses				
Title	Typ Hrs/wk CP			
Vaste and Environmental Chemisti	<i>7</i>			
Biological Waste Treatment (L0318				
Module Responsible	Prof. Kerstin Kuchta			
Admission Requirements				
· · · · · · · · · · · · · · · · · · ·	chemical and biological basics			
Knowledge	Chemical and biological busics			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence	Arter taking part successivily, stations have reaction the following fearning results			
Knowledge				
Knowieuge	design and layout of anaerobic and aerobic waste treatment plants in detail, describe different techniques for waste gas treatment			
	plants for biological waste treatment plants and explain different methods for waste analytics.			
Skills	The students are able to discuss the compilation of design and layout of plants. They can critically evaluate techniques and qua			
	control measurements. The students can recherché and evaluate literature and date connected to the tasks given in der mod			
	and plan additional tests. They are capable of reflecting and evaluating findings in the group.			
Personal Competence				
Social Competence Students can participate in subject-specific and interdisciplinary discussions, develop cooperated solutions and				
	work results in front of others and promote the scientific development in front of colleagues. Furthermore, they can give a			
	accept professional constructive criticism.			
Autonomy	Students can independently tap knowledge from literature, business or test reports and transform it to the course projects. The			
	are capable, in consultation with supervisors as well as in the interim presentation, to assess their learning level and define furth-			
	steps on this basis. Furthermore, they can define targets for new application-or research-oriented duties in accordance with t			
	potential social, economic and cultural impact.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement				
	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: 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			
	Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory			
	Chemical and Bioprocess Engineering: Specialisation General Process Engineering: Elective Compulsory			
	Chemical and Bioprocess Engineering: Specialisation Chemical Process Engineering: Elective Compulsory			
	Chemical and Bioprocess Engineering: Specialisation Chemical and Bioprocess Engineering: Elective Compulsory			
	Chemical and Bioprocess Engineering: Specialisation Bioprocess Engineering: Elective Compulsory			
	Chemical and Bioprocess Engineering: Specialisation Chemical and Bioprocess Engineering: Elective Compulsory			
	Environmental Engineering: Core Qualification: Compulsory			
	International Management and Engineering: Specialisation II. Renewable Energy: Elective Compulsory			
	Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory			
	Water and Environmental Engineering: Specialisation Cities: Elective Compulsory			
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory			

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		

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

Module M2009: Study	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.) 			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
	The students are able to demonstrate their detailed knowledge in the field of Water and Environmental Engineering. They can exemplify the state of technology and application and discuss critically in the context of actual problems and general conditions of science and society. The students can develop solving strategies and approaches for fundamental and practical problems in the field of Water and Environmental Engineering. They may apply theory based procedures and integrate safety-related, ecological, ethical, and economic view points of science and society.			
	Scientific work techniques that are used can be described and critically reviewed.			
Skills	The students are able to independently select methods or planning approaches for the project work and to justify their choice. They can explain how these methods or approaches relate to solutions in the field of work and how the context of application has to be adjusted. General findings and further developments may essentially be outlined.			
Personal Competence				
Social Competence	The students are able to condense the relevance and the structure of the project work, the work steps and the sub-problems for the presentation and discussion in front of a bigger group. They can lead the discussion and give a feedback on the project to their colleagues.			
Autonomy	The students are capable of independently planning and documenting the work steps and procedures while considering the given deadlines. This includes the ability to accurately procure the newest scientific information. Furthermore, they can obtain feedback from experts with regard to the progress of the work, and to accomplish results on the state of the art in science and technology.			
Workload in Hours	Independent Study Time 360, Study Time in Lecture 0			
Credit points				
Course achievement				
Examination				
Examination duration and scale				
Assignment for the Following Curricula	Water and Environmental Engineering: Specialisation Cities: Compulsory			

Module M2006: Wast	e Treatment and Recycling				
Courses					
Courses					
Title	(1.2267)	Typ	Hrs/wk	СР	
Planning of waste treatment plants Recycling technologies and therma		Project-/problem-based Learning Lecture	3	3 2	
Recycling technologies and therma		Recitation Section (small)	1	1	
Module Responsible					
Admission Requirements	None				
Recommended Previous					
Knowledge	Basics of thermo dynamics				
ioeage	Basics of fluid dynamics				
	fluid dynamics chemistry				
Educational Objectives	After taking part successfully, students have reached the follo	wing learning results			
Professional Competence					
•	The students can name, describe current issue and problems in the field of waste treatment (mechanical, chemical and therm				
Momeage	and contemplate them in the context of their field.	on the held of waste treatment (ii	recriamear, er	ernical and enerman	
	The industrial application of unit operations as part of process			waste technologies	
	Compostion, particle sizes, transportation and dosing of waste	es are described as important unit o	perations .		
	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 with respect to their characterist			their characteristics	
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 techn 	nical tasks			
participate in subject-specific and interdisciplinary discussions,					
	develop cooperated solutions				
	 promote the scientific development and accept profess 	sional constructive criticism.			
Autonomy	Students can independently tan knowledge of the subject	et area and transform it to now	augstions T	nov are canable in	
Autonomy	y Students can independently tap knowledge of the subject area and transform it to new questions. They are capab consultation with supervisors, to assess their learning level and define further steps on this basis. Furthermore, they can define further steps on this basis.				
	targets for new application-or research-oriented duties in accordance with the potential social, economic and cultural 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 Co	ompulsory			
Following Curricula	Bioprocess Engineering: Specialisation A - General Bioprocess	Engineering: Elective Compulsory			
	Chemical and Bioprocess Engineering: Specialisation General Process Engineering: Elective Compulsory				
	Chemical and Bioprocess Engineering: Specialisation Bioproce		-		
	Chemical and Bioprocess Engineering: Specialisation Chemical	•			
	Chemical and Bioprocess Engineering: Specialisation Chemical and Bioprocess Engineering: Elective Compulsory				
	Chemical and Bioprocess Engineering: Specialisation Chemical and Bioprocess Engineering: Elective Compulsory				
	invironmental Engineering: Specialisation Energy and Resources: Elective Compulsory				
	International Management and Engineering: Specialisation II. Renewable Energy: Elective Compulsory Renewable Energies: Specialisation Rigenergy Systems: Elective Compulsory				
	Renewable Energies: Specialisation Bioenergy Systems: Elective Compulsory Process Engineering: Specialisation Chemical Process Engineering: Elective Compulsory				
	Process Engineering: Specialisation Chemical Process Engineering: Elective Compulsory				
	Process Engineering: Specialisation Process Engineering: Elective Compulsory Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory				
	Water and Environmental Engineering: Specialisation Environment: Compulsory				
	Water and Environmental Engineering. Specialisation Environment				

Course L3267: Planning of w	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 tecl	hnologies 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		

Module M2076: Introd	duction to Climate Informed Engine	eering		
Courses				
Title		Тур	Hrs/wk	СР
Methods in Climate Informed Engin	eering (L3347)	Lecture	3	3
Topics in Climate Informed Engineer	ering (L3348)	Lecture	3	3
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
Recommended Previous	Students are expected to have a foundational u	nderstanding of environmental scie	ence, basic engineerin	g principles, and an
Knowledge	interest in sustainability. Recommended knowledge	e includes climate science, data anal	ysis, and familiarity wit	h engineering desigr
	processes. Analytical and critical thinking and creat	tive problem-solving skills are also be	eneficial	
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge	This module explores next-generation climate mo	dels and high-resolution data, emph	asizing their impact o	n environmental and
	engineering products and processes. It covers how	various engineering disciplines can	benefit from climate in	formation. Research-
	based learning activities, expert talks, and prese	ntations will expose students to sta	te-of-the-art modeling	, measurement, and
	analysis in climate-informed engineering.			
Skills	Climate data analysis, engineering adaptation	strategies problem-solving resea	rch-hased learning a	and interdisciplinary
Skiiis	collaboration.	strategies, problem-solving, resea	iren-basea rearming, t	and interdiscipiinary
	conduction.			
Personal Competence				
Social Competence	Collaboration, interdisciplinary teamwork, commu	nication skills, problem-solving, eth	ical responsibility, and	d decision-making in
	climate-resilient engineering.			
Autonomy	Time management, self-directed learning, critical thinking, accountability, initiative, and the ability to conduct independent			
,	research and make informed decisions in climate-informed engineering.			•
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		Flori's Constitution		
Assignment for the Following Curricula	Civil Engineering: Specialisation Coastal Engineerin			
Following Curricula	Civil Engineering: Specialisation Geotechnical Engin Civil Engineering: Specialisation Structural Enginee			
	Civil Engineering: Specialisation Structural Engineer	, ,		
	Civil Engineering: Specialisation Computational Engineering	, ,		
	Data Science: Specialisation III. Applications: Electiv			
	Environmental Engineering: Core Qualification: Elec			
	Process Engineering: Specialisation Process Engine	• •		
	Water and Environmental Engineering: Specialisation			
	Water and Environmental Engineering: Specialisation		/	
	Water and Environmental Engineering: Specialisation	on Water: Elective Compulsory		

Course L3347: Methods in Cl	imate Informed Engineering
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Nima Shokri, Prof. Cathy Hohenegger, Prof. Irina Smirnova
Language	EN
Cycle	WiSe
	Students will learn techniques for incorporating climate data and environmental factors into engineering design. It covers climate modelling and the use of sensors and devices to measure climate-related parameters and engineering processes. Students will have the opportunity to conduct their own measurements, analyze the collected data, and write a report on their findings. This hands-on experience will be assessed and contribute to their final grade.
Literature	

Course L3348: Topics in Clim	ate Informed Engineering
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Irina Smirnova, Prof. Cathy Hohenegger, Prof. Nima Shokri
Language	EN
Cycle	WiSe
Content	Exploring specific applications of climate data in various engineering disciplines. Invited speakers will present their research and discuss the relevance of climate-informed engineering to their work. Additionally, there will be a segment on effective communication, covering how to give impactful presentations and write research papers. Students will also give presentations on their own class projects related to climate-informed engineering, applying the concepts they've learned. This hands-on experience will be assessed and contribute to their final grade.
Literature	

Engineering						
Module M2156: Wate	r Protection					
Caurage						
Courses						
Title Water Protection (L3459)			Typ	ated Lecture	Hrs/wk 6	CP 6
Module Responsible	Prof. Simon Michael	Panaloviou	integr	ated Lecture	0	0
Admission Requirements	None	rapaiexiou				
Recommended Previous	None					
Knowledge	Basic knowled	lge in water managemen	t;			
3		lge in urban drainage;				
		lge of wastewater treatm	•			
	Good knowled	ige of pollutants (e.g. CO	D, BOD, TS, N, P) and thei	r properties;		
Educational Objectives	After taking part suc	cessfully, students have	reached the following lear	ning results		
Professional Competence						
Knowledge	The students can de	scribe the basic principle	es of the regulatory frame	work related to the	international and Eur	opean water sector
	They can explain lir	mnological processes, su	ubstance cycles and water	er morphology in (detail. They are able	to assess complex
	[·		as ecosystem service and	d wastewater treat	tment with a special	focus on innovative
	solutions, remediation	on measures as well as co	onceptual approaches.			
Skills	Students can accura	tely assess current prob	lems and situations in a d	country-specific or	local context. They ca	an suggest concrete
	actions to contribut	e to the planning of to	morrow's urban water cy	cle. Furthermore,	they can suggest ap	propriate technical
	administrative and le	egislative solutions to sol	ve these problems.			
Personal Competence						
•	The students can wo	The students can work together in international groups.				
,		-				
Autonomy	Students are able to	organiza thair work flow	u to propore procentation	a and discussions	Thou can acquire any	ranciata kanulada
Autonomy	Students are able to organize their work flow to prepare presentations and discussions. They can acquire appropriate knowledge					
	by making enquires	by making enquiries independently.				
Workload in Hours	Independent Study T	ime 96, Study Time in Le	ecture 84			
Credit points	6					
Course achievement	Compulsory Bonus	Form	Description			
	Yes 20 %	Presentation	10-minütige Präsen	tation von Arbeitse	ergebnissen	
Examination	Written exam					
Examination duration and	150 minutes					
scale Assignment for the	Civil Engineering: Co	ecialisation Coastal Essi	neering: Elective Compuls	ory		
Following Curricula	3 3 1		neering: Elective Compuls I Engineering: Elective Col	,		
. ooming curricula			igineering: Elective Comp			
			raffic: Elective Compulsory			
	3 3 1		ater Quality and Water En		Compulsory	
	_		Specialisation II. Civil Engi			
	Water and Environm	ental Engineering: Speci	alisation Cities: Elective C	ompulsory		
	Water and Environm	ental Engineering: Speci	alisation Environment: Co	mpulsory		
	Water and Environm	ental Engineering: Speci	alisation Water: Elective C	ompulsory		

Course L3459: Water Protect	ourse L3459: Water Protection		
Тур	egrated Lecture		
Hrs/wk	6		
СР	6		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84		
Lecturer	Prof. Simon Michael Papalexiou		
Language	EN		
Cycle	WiSe		
Content			
Literature			

Module M2155: Unce	rtainty Modellin	g for Engine	ers			
Courses						
Title				Тур	Hrs/wk	СР
Uncertainty Modelling for Engineer				Integrated Lecture	6	6
<u> </u>	Prof. Simon Michael Pa	apalexiou				
Admission Requirements						
Recommended Previous Knowledge	 General familia 	rity with engineerin	ng concepts.			
Kilowieuge	2. Elementary pro	bability and statisti	ics, and mathematical	skills.		
	· ·	r skills for handling				
	4. Interest in solvi	ng engineering pro	blems using statistica	l and probabilistic methods	i.	
Educational Objectives	After taking part succe	essfully, students h	nave reached the follow	ving learning results		
Professional Competence						
Knowledge	Students will develop	a strong foundati	ion in uncertainty, pro	bability, and risk analysis	in engineering appl	ications. The cours
				frequency-based methods		
				ty distributions, and stoch		
				linear and nonlinear regre its will gain insight into ris		
			-	to optimize engineering so		·
CL'III.	D. Herrick of the con-			Walter and Jakan and Arts		
SKIIIS	1 -			ilistic models to quantify un outions, performing extrem	•	-
		•		l also develop skills in lir	-	
				mprove risk predictions. Th		
	they will learn to imp	lement stochastic r	methods and optimiza	tion techniques to support	reliability-based des	sign and engineerin
	decision-making.					
Personal Competence						
•		p the ability to w	ork collaboratively of	n engineering risk assess	ments, communicati	ng technical result
,	1			will engage in discussion		
	uncertainty quantifica	ation, ensuring tha	at engineering analys	ses are both rigorous and	d applicable to real	-world infrastructur
	challenges.					
Autonomy	Students will learn to	independently ana	alyze and model engir	eering uncertainties, selec	ting and applying ap	propriate probabilit
	distributions, regressi	on methods, and s	stochastic techniques	for various applications. T	hey will also gain th	e ability to evaluat
	risks associated with natural and human-made hazards, ensuring they can make informed engineering decisions in design, safety					
	assessment, and disas	ster mitigation.				
Workload in Hours	Independent Study Tir	me 96, Study Time	in Lecture 84			
Credit points	6					
Course achievement		Form	Description	- · · · · · · · · · · · · · · · · · · ·		
F	Yes 20 %	Presentation	10-minutig	e Präsentation von Arbeitse	ergebnissen	
Examination Examination and	Written exam					
scale	130 111111					
	Civil Engineering: Spe	cialisation Coastal	Engineering: Elective	Compulsory		
Following Curricula			-			
-	Civil Engineering: Spe	cialisation Structur	al Engineering: Electiv	e Compulsory		
	Civil Engineering: Spe	cialisation Computa	ational Engineering: E	ective Compulsory		
			nd Traffic: Elective Co	, ,		
	Civil Engineering: Spe					
	Civil Engineering: Special Civil Engineering: Sp		nical Engineering: Ele			
	Civil Engineering: Spec					
	Civil Engineering: Spec	•				
	Environmental Engine					
	Environmental Engine	ering: Core Qualific	cation: Elective Compu	lsory		
	Water and Environmen		•			
				nent: Elective Compulsory		
	Water and Environment Water and Environment					
				nent: Elective Compulsory		
			pecialisation Water: E			

Course L3458: Uncertainty M	lodelling for Engineers
Тур	Integrated Lecture
Hrs/wk	6
СР	6
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Lecturer	Prof. Simon Michael Papalexiou
Language	EN
Cycle	SoSe
Content	Engineering decisions are rarely made with complete certainty—uncertainty affects material properties, environmental conditions, structural performance, and risk assessments. This course provides students with theoretical foundations and practical tools to quantify uncertainty, assess risks, and enhance decision-making in civil, structural, geotechnical, and environmental engineering applications. Students will begin with fundamental probability concepts, learning how Bayes' Theorem, probability distributions, and extreme value theory help evaluate engineering uncertainties. They will explore linear and nonlinear regression methods for analyzing complex datasets, as well as joint probability distributions and stochastic optimization to improve predictive modeling and reliability assessments. The course also introduces Bayesian Decision Theory, offering a structured approach to decision-making under uncertainty. With a focus on real-world engineering problems, students will apply probabilistic models, extreme value analysis, and stochastic techniques to assess risks in infrastructure design, system reliability, and disaster resilience. Handson computational exercises will reinforce key concepts, preparing students to work with data-driven models and uncertainty quantification techniques used in engineering practice. This course is ideal for students interested in engineering risk assessment, reliability analysis, and data-driven modeling. By the end of the course, students will have developed critical analytical and problem-solving skills, equipping them for careers in structural safety, geotechnical engineering, environmental risk management, and beyond.
Literature	

Specialization Environment

Module M0581: Wate	r Protection			
Courses				
Title		Тур	Hrs/wk	СР
Water Protection and Wastewater	Management (L0226)	Lecture	3	3
Water Protection and Wastewater	Management (L2008)	Project Seminar	3	3
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
Recommended Previous				
Knowledge	Basic knowledge in water management;			
	Good knowledge in urban drainage;			
	Good knowledge of wastewater treatment technic Good knowledge of pollutants (o.g. COD, BOD, TO	•		
	Good knowledge of pollutants (e.g. COD, BOD, TS	s, N, P) and their properties;		
Educational Objectives	After taking part successfully, students have reached the	ne following learning results		
Professional Competence				
Knowledge	The students can describe the basic principles of the re	gulatory framework related to the	international and Eu	ropean water sector.
	They can explain limnological processes, substance of	cycles and water morphology in	detail. They are able	e to assess complex
	problems related to water protection, such as ecosyst	tem service and wastewater trea	tment with a special	focus on innovative
	solutions, remediation measures as well as conceptual	approaches.		
Skills	Students can accurately assess current problems and	situations in a country-specific or	local context. They c	an suggest concrete
Skills	actions to contribute to the planning of tomorrow's	, ,	,	33
	administrative and legislative solutions to solve these p	•	,,	,
Personal Competence				
Social Competence	The students can work together in international groups			
Autonomy	Students are able to organize their work flow to prepa	re presentations and discussions.	They can acquire ap	propriate knowledge
	by making enquiries independently.	•	, , ,	
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Presentation			
Examination duration and	Term paper plus presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering:	Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering	ng: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineering: E	lective Compulsory		
	Civil Engineering: Specialisation Water and Traffic: Elec	tive Compulsory		
	Environmental Engineering: Specialisation Water Qualit	y and Water Engineering: Elective	Compulsory	
	International Management and Engineering: Specialisat	ion II. Civil Engineering: Elective C	ompulsory	
	Water and Environmental Engineering: Specialisation C	ities: Elective Compulsory		
	Water and Environmental Engineering: Specialisation W			
	Water and Environmental Engineering: Specialisation E	nvironment: Compulsory		

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

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

Engineering				
Module M2006: Waste	e Treatment and Recycling			
Courses				
Title		Тур	Hrs/wk	СР
Planning of waste treatment plants (L3267)		Project-/problem-based Learning	3	3
Recycling technologies and therma		Lecture	2	2
Recycling technologies and therma		Recitation 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			
Educational Objectives	After taking part successfully, students have reached the follow	ving learning results		
Professional Competence				
Knowledge	The students can name, describe current issue and problems	in the field of waste treatment (n	nechanical, ch	emical and thermal)
	and contemplate them in the context of their field.			
	The industrial application of unit operations as part of process	engineering is explained by actual	examples of v	vaste technologies .
	Compostion, particle sizes, transportation and dosing of wastes	are described as important unit o	perations .	
	Children will be able to desire and desire week to be about the			
	Students will be able to design and design waste treatment ter	chinology equipment.		
Skills	The students are able to select suitable processes for the treat	ment of wastes or raw material w	ith respect to	their characteristics
	and the process aims. They can evaluate the efforts and costs	for processes and select economic	cally feasible tr	eatment concepts.
Personal Competence				
Social Competence	Students can			
Social competence	Stadents can			
	 respectfully work together as a team and discuss technic 			
	participate in subject-specific and interdisciplinary discuss	ssions,		
	develop cooperated solutions			
	 promote the scientific development and accept professi 	onal constructive criticism.		
Autonomy	Students can independently tap knowledge of the subject	area and transform it to new	questions. Th	ey are capable, in
	consultation with supervisors, to assess their learning level a	nd define further steps on this ba	sis. Furthermo	ore, they can define
	targets for new application-or research-oriented duties in accor	dance with the potential social, ed	conomic and c	ultural impact.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points				
Course achievement				
	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elective Cor	npulsory		
Following Curricula	Bioprocess Engineering: Specialisation A - General Bioprocess E	Engineering: Elective Compulsory		
	Chemical and Bioprocess Engineering: Specialisation General P	rocess Engineering: Elective Comp	oulsory	
	Chemical and Bioprocess Engineering: Specialisation Bioproces	s Engineering: Elective Compulsor	У	
	Chemical and Bioprocess Engineering: Specialisation Chemical	•		
	Chemical and Bioprocess Engineering: Specialisation Chemical		tive Compulso	ry
	Environmental Engineering: Specialisation Energy and Resource		laa	
	International Management and Engineering: Specialisation II. R		isory	
	Renewable Energies: Specialisation Bioenergy Systems: Electiv Process Engineering: Specialisation Chemical Process Engineer			
	Process Engineering: Specialisation Chemical Process Engineer Process Engineering: Specialisation Process Engineering: Electi	, ,		
	Process Engineering: Specialisation Environmental Process Engineering:			
	Water and Environmental Engineering: Specialisation Environm			
	Water and Environmental Engineering: Specialisation Cities: Ele			

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 tecl	hnologies and thermal waste treatment
	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	

Engineering				
Module M0513: System Aspects of Renewable Energies				
Courses				
Title Fuel Cells, Batteries, and Gas Storage: New Materials for Energy Production and Storage (L0021) Energy Trading (L0019) Energy Trading (L0020)		Typ Lecture Lecture Recitation Section (small)	Hrs/wk 2 1	CP 2 1
Deep Geothermal Energy (L0025)		Lecture	2	2
Module Responsible				
Admission Requirements	None			
Recommended Previous Knowledge	Module: Technical Thermodynamics I Module: Technical Thermodynamics II			
Educational Objectives	After taking part successfully, students have reached the foll	owing learning results		
Professional Competence	Arter taking part successionly, students have reached the foll	owing learning results		
Knowledge	Students are able to describe the processes in energy trading and the design of energy markets and can critically evaluate them in relation to current subject specific problems. Furthermore, they are able to explain the basics of thermodynamics of electrochemical energy conversion in fuel cells and can establish and explain the relationship to different types of fuel cells and their respective structure. Students can compare this technology with other energy storage options. In addition, students can give an overview of the procedure and the energetic involvement of deep geothermal energy.			
Skills	Students can apply the learned knowledge of storage systems for excessive energy to explain for various energy systems different approaches to ensure a secure energy supply. In particular, they can plan and calculate domestic, commercial and industrial heating equipment using energy storage systems in an energy-efficient way and can assess them in relation to complex power systems. In this context, students can assess the potential and limits of geothermal power plants and explain their operating mode. Furthermore, the students are able to explain the 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 Autonomy	Students are able to discuss issues in the thematic fields in the renewable energy sector addressed within the module.			
raconomy	questions.	Students can independently exploit sources , acquire the particular knowledge about the subject area and transform it to new questions.		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and scale	3 hours written exam			
Assignment for the	Bioprocess Engineering: Specialisation A - General Bioproces	s Engineering: Elective Compulso	ory	
Following Curricula	Aircraft Systems Engineering: Core Qualification: Elective Co International Management and Engineering: Specialisation II. International Management and Engineering: Specialisation II. International Management and Engineering: Specialisation II. Aeronautics: Core Qualification: Elective Compulsory Renewable Energies: Core Qualification: Compulsory Theoretical Mechanical Engineering: Specialisation Energy Sy Process Engineering: Specialisation Environmental Process Environmental Process Engineering: Specialisation Environmental Process Engineering: Specialisation Environmental Process Enviro	Renewable Energy: Elective Cor Energy and Environmental Engin Process Engineering and Biotect stems: Elective Compulsory Ingineering: Elective Compulsory	neering: Elective	
	Process Engineering: Specialisation Process Engineering: Ele- Water and Environmental Engineering: Specialisation Water: Water and Environmental Engineering: Specialisation Environ	Elective Compulsory		

Course L0021: Fuel Cells, Batteries, and Gas Storage: New Materials for Energy Production and Storage		
Тур	Lecture	
Hrs/wk		
СР		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28	
Lecturer	Prof. Michael Fröba	
Language	DE	
Cycle	SoSe	
Content		
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 Tradin	ourse L0020: Energy Trading	
Тур	Recitation Section (small)	
Hrs/wk	1	
СР	1	
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14	
Lecturer	Robert Gersdorf	
Language	DE	
Cycle	SoSe	
Content	See interlocking course	
Literature	See interlocking course	

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

Engineering"				
Module M0827: Modeling in Water Management				
Courses				
Title		Тур	Hrs/wk	СР
Groundwater Modeling using Modflow (L0543)		Lecture	1	1
Groundwater Modeling using Modfle		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 substance 	es		
	Pipe Systems			
	 Knowledge on urban water infrastructures, in 	particular drinking water systemsand u	ırban drainag	e systems including
	special structures			
	Hydraulics of drinking water supply systems and a	sewer systems		
	Basic knowledge on water management			
Educational Objectives	After taking part successfully, students have reached th	e following learning results		
Professional Competence	Their taking pare successionly, stadents have reached in	Tollowing learning results		
	The students are able to describe the modelling of grou	idwater flow and transport as well as urb	an water infra	astructures. They can
Knowledge	carry out systems analyses and can detect technical an	·		•
	are able to analyse interdependencies of hydraulic and			studies. Besides they
	, , , , , , , , , , , , , , , , , , , ,			
Skills	The students are able to construct and apply scientific	groundwater models indipendently. The	y can work o	n different scenarios
	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	Mg at about a control			
Social Competence	Wird nicht vermittelt.			
Autonomy	Wird nicht vermittelt.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
	Independent Study Time 110, Study Time in Lecture 70			
Course achievement				
Examination				
Examination duration and				
scale	30 111111			
Assignment for the	Civil Engineering: Specialisation Structural Engineering:	Elective Compulsory		
Following Curricula		, ,		
. ccming carricula	Civil Engineering: Specialisation Coastal Engineering: Ele			
	Civil Engineering: Specialisation Water and Traffic: Elect	• •		
	Civil Engineering: Specialisation Computational Enginee			
	Water and Environmental Engineering: Specialisation Er			
	Water and Environmental Engineering: Specialisation Ci			
	Water and Environmental Engineering: Specialisation W	ater: Elective Compulsory		

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

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

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

ourse L0875: Modeling of Water Supply 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	n Environmental Management			
Courses				
Title	Тур		Hrs/wk	СР
Noise Protection (L1109)	Lecture		2	2 4
Urban Infrastructures (L0874)	Project-/problem-based	Learning	2	4
Module Responsible	Dr. Dorothea Rechtenbach			
Admission Requirements	None			
Recommended Previous Knowledge	Knowledge on Urban planning			
Kilowieuge	Knowledge on measures for climate protection			
	General knowledge of scientific writing/working			
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence	J			
Knowledge	Students can describe urban development corridors as well as current and future urba	an environi	mental proble	ms. They are able to
	explain the causes of environmental problems (like noise).			
	Students can specify applications for various technical innovations and explain why th	ese contri	bute to the in	provement of urbar
	life. They can, for example, derive and discuss measures for effective noise abatement	t.		
Ckilla	Students are able to develop specific solutions for correcting existing or futur	o onviron	mont rolated	problems of urba
Skills	development. They can define a range of conceptual and technical solutions for enviro			
	paths. To solve specific urban environmental problems they can select technical inn			•
	context.	ovacions a	na meegrate	inem into the dibui
Personal Competence				
Social Competence	The students can work together in international groups.			
A	Charles and the constitution of the constituti			h - diai Th
Autonomy	Students are able to organize their work flow to prepare themselves for presentation	s and cont	tributions to t	ne discussions. They
	can acquire appropriate knowledge by making enquiries independently.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Written elaboration			
Examination duration and	Written Report plus oral Presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory			
	Environmental Engineering: Core Qualification: Elective Compulsory			
	Joint European Master in Environmental Studies - Cities and Sustainability: Core Qualifi			
	Logistics, Infrastructure and Mobility: Specialisation Infrastructure and Mobility: Electiv		sory	
	Water and Environmental Engineering: Specialisation Environment: Elective Compulso	ry		
	Water and Environmental Engineering: Specialisation Cities: Compulsory			

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

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

Module M0870: Mana	gement of Surface Water			
Courses				
Title		Тур	Hrs/wk	СР
Modelling of Flow in Rivers and Est	uaries (L0810)	Lecture	3	4
Nature-Oriented Hydraulic Enginee	ring / Integrated Flood Protection (L0961)	Project-/problem-based Learning	2	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous	Fundamentals of Hydromechanics, Hydraulics, Hydrology an	d Hydraulic Engineering; Hydrau	ulic Engineerin	g I and Hydraulic
Knowledge	Engineering II			
Educational Objectives	After taking part successfully, students have reached the follow	ring learning results		
Professional Competence				
Knowledge	Students are able to define in detail the basic processes that	at are related to the modelling of	of flows in hyd	raulic engineering.
	Besides, they can describe the basic aspects of numerical mod	delling and actual numerical mode	els for the simu	ulation of flows and
	waves. They can also depict the concepts of nature oriented hy	draulic engineering.		
GL'III.		and the desired and the second		
SKIIIS	Students are able to apply hydrodynamic-numerical models to			
	able to set up flood-risk management concepts and are able to	apply basic concepts of renaturat	ion to practical	problems.
Personal Competence				
Social Competence	The students are able to deploy their gained knowledge in app	olied problems of the practical na	ture-based hyd	draulic engineering.
	Additionaly, they will be able to work in team with engineers of	other disciplines.		
Autonomy	The students will be able to independently extend their knowledge and apply it to new problems.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	The duration of the examination is 150 min. The examination	n includes tasks with respect to	the general un	derstanding of the
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Compulsory			
Following Curricula	Environmental Engineering: Core Qualification: Elective Compu	sory		
	Joint European Master in Environmental Studies - Cities and Sus	stainability: Core Qualification: Cor	mpulsory	
	Water and Environmental Engineering: Specialisation Water: Co	ompulsory		
	Water and Environmental Engineering: Specialisation Environm	ent: Compulsory		
	Water and Environmental Engineering: Specialisation Cities: Ele	ective Compulsory		

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

Course L0961: Nature-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

Linging				
Module M0874: Wastewater Systems				
Courses				
Title		Тур	Hrs/wk	CP
Biological Wastewater Treatment (I	_0517)	Lecture	2	2
Biological Wastewater Treatment (I		Recitation Section (large)	1	1
Advanced Wastewater Treatment (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 and the key	y processes involved in wastewater treatme	ent.	
Knowledge				
Educational Objectives	After taking part successfully, students have reache	ed the following learning results		
Professional Competence				
Knowledge	Students are able to outline key areas of the full ra	ange of treatment systems in waste water	management, as	well as their mutual
	dependence for sustainable water protection. They	can describe relevant economic, environm	ental and social	factors.
Skills	Students are able to pre-design and explain the a	·	and the scope of	of their application in
	municipal and for some industrial treatment plants.			
Personal Competence				
•	Social skills are not targeted in this module.			
, , , , , , , , , , , , , , , , , , , ,	3			
Autonomy	Students are in a position to work on a subject a	and to organize their work flow independe	ently. They can	also present on this
	subject.			
Workload in Hours	Independent Study Time 96, Study Time in Lecture	84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Enginee	ring: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engin			
	Civil Engineering: Specialisation Coastal Engineerin	, ,		
	Civil Engineering: Specialisation Water and Traffic:			
	Bioprocess Engineering: Specialisation A - General		rv	
	Environmental Engineering: Specialisation Water Q			
	International Management and Engineering: Specia			Compulsory
	International Management and Engineering: Specia			
	Process Engineering: Specialisation Environmental	•		
	Process Engineering: Specialisation Process Engineering: Specialisation Process Engineering:			
	Water and Environmental Engineering: Specialisation			
	Water and Environmental Engineering: Specialisation			
	Water and Environmental Engineering: Specialisation	• •		
	water and Environmental Engineering: Specialisation	on Cities. 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

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

 $ISBN: 3527312196 \ (Gb.) \ URL: \ http://deposit.ddb.de/cgi-bin/dokserv?id=2774611\&prov=M\&dok_var=1\&dok_ext=htm-provestare for the provestar for the prove$

Weinheim: WILEY-VCH, 2007

TUB_HH_Katalog

Course L3122: Biological 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	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	
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: Nexus Engineering - Water, Soil, Food and Energy				
Courses				
Title		Тур	Hrs/wk	СР
Ecological Town Design - Water, En		Seminar	2	2
Water & Wastewater Systems in a 0	Global Context (L0939)	Lecture	2	4
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
Recommended Previous	Basic knowledge of the global situation with rising \boldsymbol{p}	overty, soil degradation, migrat	tion to cities, lack of w	ater resources and
Knowledge	sanitation			
Educational Objectives	After taking part successfully, students have reached th	ne following learning results		
Professional Competence				
Knowledge	Students can describe the facets of the global water sit	uation. Students can judge the e	normous potential of th	e implementation of
	synergistic systems in Water, Soil, Food and Energy sup	oply.		
CI-III-	Children and able to decima and arised antibody and for	diff		
SKIIIS	Students are able to design ecological settlements for around the world.	different geographic and socio-	economic conditions to	r the main climates
	around the world.			
Personal Competence				
Social Competence	The students are able to develop a specific topic in a te	am and to work out milestones a	according to a given pla	n.
Autonomic	Students are in a position to work on a subject and	to arganize their work flow ind	anandanthi Thaii san a	lee procent on this
Autonomy	subject.	to organize their work now into	ependently. They can a	iiso present on this
	subject.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	During the course of the semester, the students work	towards mile stones. The work i	ncludes presentations a	ind papers. Detailed
scale	information can be found at the beginning of the smest	er in the StudIP course module h	andbook.	
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elec	tive Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation A - General Biop	rocess Engineering: Elective Con	npulsory	
	$ \hbox{Chemical and Bioprocess Engineering: Specialisation $G_{\mathbb{R}}^{2}$} \\$	eneral 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 Environmental Proc		ılsory	
	Process Engineering: Specialisation Process Engineering			
	Water and Environmental Engineering: Specialisation W			
	Water and Environmental Engineering: Specialisation E		1	
	Water and Environmental Engineering: Specialisation C	ities: 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

	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	
Litorotuvo	 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	Planning
Courses	
Title	Tun Hechule CD
City Planning (L1066)	TypHrs/wkCPProject-/problem-based Learning46
Module Responsible	
Admission Requirements	
Recommended Previous	
Knowledge	for "Designing Urban Streetscapes": some knowledge of transport planning, e.g. through taking the undergraduate class "Transpo
	Planning and Traffic Engineering"
	AGOLD I STORY OF THE STATE OF T
Educational Objectives	
Professional Competence	
Knowieage	Students are able to:
	use technical terms of urban planning.
	describe the main determinants of urban development.
	explain and compare different possibilities of how urban development can be influenced.
	discuss requirements for public streetscapes.
	explain the importance of street design.
Skills	Students are able to:
	read and analyze urban development concepts and designs for streetscapes
	appraise such concepts in the context of competing requirements.
	design, justify and reflect their own solutions for concrete examples.
Personal Competence	
Social Competence	Students are able to:
	discuss intermediate results with each other.
	constructively accept feedback on their own work.
	provide constructive feedback to others.
Autonomy	Students are able to:
	independently complete a written report including drawings following a broadly pre-defined process.
	assess the consequences of their proposed solutions.
	independently acquire knowledge and apply this to new issues or problem areas.
	,,,,
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written elaboration
Examination duration and	written assignment, designwork during the semester
scale	
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Elective 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
СР	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Carsten Gertz
Language	DE
Cycle	SoSe
Content	"Principles of Urban Planning" deals with the determinants of urban development and their interactions. Topics include:
	 legal framework, instruments and methods of planning, functional requirements, stakeholders and actors basic design requirements different planning levels and historical contexts. The objective of the course is for students to acquire a basic understanding of urban development problems and approaches for solving them. They will also be able to comprehend the process of urban planning. The course also covers the various functional and aesthetic requirements for designing streetscape as the most important elements of public space. The project work deals with a real life scenario and includes drawing up a development plan, an urban design concept, a building masterplan and a street redesign.
Literature	Albers, Gerd; Wekel, Julian (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 M1724: Smar	t Monitoring
Courses	
Title	Typ Hrs/wk CP
Smart Monitoring (L2762) Smart Monitoring (L2763)	Integrated Lecture 2 2 Recitation Section (small) 2 4
·	
Module Responsible	
Admission Requirements	
	Basic knowledge or interest in object-oriented modeling, programming, and sensor technologies are helpful. Interest in moder research and teaching areas, such as Internet of Things, Industry 4.0 and cyber-physical systems, as well as the will to deepe
Knowledge	skills of scientific working, are required. Basic knowledge in scientific writing and good English skills.
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students will become familiar with the principles and practices of smart monitoring. The students will be able to design
	decentralized smart systems to be applied for continuous (remote) monitoring of systems in the built and in the natural environment. In addition, the students will learn to design and to implement intelligent sensor systems using state-of-the-art data and the state of the state
	analysis techniques, modern software design concepts, and embedded computing methodologies. Besides lectures, project work also part of this module, which will be conducted throughout the semester and will contribute to the grade. In small groups, the
	students will design smart monitoring systems that integrate a number of "intelligent" sensors to be implemented by the students.
	Specific focus will be put on the application of machine learning techniques. The smart monitoring systems will be mounted or real-world (built or natural) systems, such as bridges or slopes, or on scaled lab structures for validation purposes. The outcome of
	every group will be documented in a paper. All students of this module will "automatically" participate with their smart monitorin
	system in the annual "Smart Monitoring" competition. The written papers and oral examinations form the final grades. The modu
	will be taught in English. Limited enrollment.
Skills	The students will gain insights into operating state-of-the-art smart sensor systems, used for monitoring a wide range of physical
	processes relevant to engineering, such as environmental, structural, or comfort monitoring. The students will be capable of
	devising monitoring strategies of physical processes as part of group projects, tailored to their knowledge backgrounds, and t
	implement the strategies in smart wireless sensor nodes, using embedded computing and programming. Finally, the students wi be able to document the findings of their projects in short reports.
Personal Competence	
•	The students will be able to work in groups, share parts of the work for their projects, and develop communication skills, toward
Social competence	achieving the common project goals.
	admenting the common project godie.
Autonomy	The students will be able to gain a solid basis on approaching and solving problems in engineering, as well as on documenting
	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
Examination duration and	10 pages of work with 15-minute oral presentation
scale	
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory
	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory
	Computer Science: Specialisation II: Intelligence Engineering: Elective Compulsory
	Environmental Engineering: Specialisation Energy and Resources: Elective Compulsory
	Environmental Engineering: Specialisation Environment and Climate: Elective Compulsory
	Environmental Engineering: Specialisation Water Quality and Water Engineering: Elective Compulsory
	Mechatronics: Technical Complementary Course: Elective Compulsory
	Mechatronics: Core Qualification: Elective Compulsory
	Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: 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
	Trace, and Entire interior Engineering. Specialization water, Elective Compaisory

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

Module M1721: Water	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
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
Recommended Previous	Basic knowledge in water and environmental research, Hydrolog	ıy		
Knowledge				
Educational Objectives	After taking part successfully, students have reached the followi	ng learning 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 Resear	rch-Based Teaching approaches v	vill be at the core	e of this module.
Autonomy	The students will be involved in writing individual reports ar willingness to work independently and responsibly.	nd presentation. This will contri	bute to the stu	dents' ability and
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 Co	ompulsory		
Following Curricula	Civil Engineering: Specialisation Water and Traffic: Elective Com	pulsory		
	Environmental Engineering: Specialisation Environment and Clin	nate: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Cities: Elec	ctive Compulsory		
	Water and Environmental Engineering: Specialisation Water: Ele	ctive Compulsory		
	Water and Environmental Engineering: Specialisation Environme	ent: 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

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)	Project-/problem-based Learning	1	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous	Basics of hydraulic engineering, hydrology and hydromecl	hanics		
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge	The students are able to define and explain the basic con-	cepts of coastal engineering and port e	ngineering. The	ey are able to apply
	the concepts to selected practical problems of coastal en	ngineering. Students can define and de	termine the ba	sics for design and
	dimensioning of coastal engineering constructions.			
Skills	The students are capable to apply basic design approache	es to selected and pre-defined design ta	isks in coastal 6	angineering
Skins	The students are capable to apply basic design approache	23 to selected and pre-defined design to	isks iii coustui (ingineering.
Personal Competence				
Social Competence	The students are able to deploy their gained knowledge	in applied problems such as the desig	n of coastal pro	otection structures.
	Additionaly, they will be able to work in team with engined	ers of other disciplines, for instance des	igning of coast	al breakwaters.
Autonomy	The students will be able to independently extend their kr	nowledge and applyit 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. The examin	nation includes tasks with respect to	the general un	derstanding of the
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Coastal Engineering: Com	npulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering	: Compulsory		
	Civil Engineering: Specialisation Structural Engineering: El	lective Compulsory		
	Environmental Engineering: Specialisation Environment ar	nd Climate: Elective Compulsory		
	Environmental Engineering: Specialisation Water Quality a	and Water Engineering: Elective Compu	lsory	
	International Management and Engineering: Specialisation	n II. Civil Engineering: Elective Compuls	ory	
	Water and Environmental Engineering: Specialisation Envi	ironment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Wat	er: Elective Compulsory		

Course L0807: Basics of Coas	stal 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 Functional and constructional design Determination of design parameters Design-approaches Filter Rubble mound constructions Piles Vertical constructions
Literature	Coastal Engineering Manual, CEM Vorlesungsumdruck

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

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 M1980: Field	measurements for environmental studies			
Courses				
Title Field measurements for environmental studies: Application (L3231) Field measurements for environmental studies: Theory (L3230)		yp roject-/problem-based Learning ecture	Hrs/wk 3 1	CP 4 2
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following	learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
Workload in Hours	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	e: Elective Compulsory		
Following Curricula	Environmental Engineering: Specialisation Environment and Climate	e: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Environment:	Elective Compulsory		
	Water and Environmental Engineering: Specialisation Environment:	Elective Compulsory		

Course L3231: Field measure	urse 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	

Engineering				
Module M1878: Sustainable 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			
	None			
	Module: Technical Thermodynamics I,			
Knowledge	Module: Technical Thermodynamics II,			
	Module, Fundamentals of Fluid Mechanics			
	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 detail kn	owledge of wind turbines w	ith a particular focus of	wind energy use in
	offshore conditions and can critical comment these aspec	cts in consideration of currer	nt developments. Further	more, they are able
	to describe fundamentally the use of water power to gene	erate electricity. The student	s reproduce and explain	the basic procedure
	in the implementation of renewable energy projects in cou	untries outside Europe.		
	Through active discussions of various topics within the	seminar of the module, stu	dents improve their und	derstanding and the
	application of the theoretical background and are thus ab			
G1 '''				
Skills	Students are able to apply the acquired theoretical four			
	assess technically the resulting relationships in the conte			
	compare critically the special procedure for the implemer in principle applied approach in Europe and can apply this			side Europe with the
	in principle applied approach in Europe and can apply this	procedure on exemplary the	eoreticai 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 conte	ext of the emphasis of the l	ecture material to clear	the contents of the
	lecture and to acquire the particular knowledge about the			
	-	•		
	, , ,			
Credit points				
Course achievement				
Examination				
Examination duration and	180 min			
Scale	Civil Engineering, Specialisation Structural Engineering, E	ostivo Compulson		
=	Civil Engineering: Specialisation Structural Engineering: El Civil Engineering: Specialisation Geotechnical Engineering			
Tollowing curricula	Civil Engineering: Specialisation Coastal Engineering: Elec			
	International Management and Engineering: Specialisation		al Engineering: Elective	Compulsory
	International Management and Engineering: Specialisation	• •	-	
	Product Development, Materials and Production: Specialis	•		
	Product Development, Materials and Production: Specialis	·		
	Product Development, Materials and Production: Specialis			
	Renewable Energies: Core Qualification: Compulsory			
	Theoretical Mechanical Engineering: Specialisation Energy	Systems: Elective Compulso	ory	
	Process Engineering: Specialisation Environmental Proces			
	Water and Environmental Engineering: Specialisation Cities	es: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Envi	ronment: Elective Compulso	ry	
	Water and Environmental Engineering: Specialisation Wat	er: Elective Compulsory		

Course L0067: Offshore Geotechnical 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 Literature	 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 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 M0871: Hydro	ological Systems			
Courses				
Title		Тур	Hrs/wk	СР
Applied Surface Hydrology (L0289)		Lecture	2	2
Applied Surface Hydrology (L1412)		Project-/problem-based Learning	1	2
Interaction Water - Environment in		Project-/problem-based Learning	1	2
Module Responsible				
Admission Requirements				
	Fundamentals of Hydromechanics and Hydraulic	Engineering: Hydraulic Engineering I and Hydra	ulic Engineeri	ng II
Knowledge				
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
Knowledge	The students are able to define the basic conce	epts of hydrology and water management. The	are able to d	describe and quantify
	the relevant processes of the hydrological water	cycle. Besides, the students know the main as	pects of rainfa	III-run-off-models and
	are able to theoretically derive established reser	voir / storage models and a unit-hydrograph.		
Skills	The students are able to use the basic hydrological	ogical concents and approaches and are able	to theoretical	ly derive established
Skiiis	reservoir / storage models or a unit-hydrograph	* ''		-
	concepts of measurements of hydrological and			•
	assess these measurements. Furthermore, they		•	
	,		,	
Personal Competence				
Social Competence	The students are able to deploy their gained kno	owledge in applied problems of the hydrology ar	nd water mana	gement. Additionaly,
	they will be able to work in team with engineers	of other disciplines.		
Autonomy	The students will be able to independently exter	nd their knowledge and apply it to new problems	5	
Workload in Hours	Independent Study Time 124, Study Time in Lec	ture 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	The duration of the examination is 90 min. The e	examination includes tasks with respect to the g	eneral unders	tanding of the lecture
scale	contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Computational I	Engineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Water and Traff	ic: Compulsory		
	Environmental Engineering: Core Qualification: E	Elective Compulsory		
	Joint European Master in Environmental Studies	- Cities and Sustainability: Core Qualification: Co	ompulsory	
	Water and Environmental Engineering: Specialis	ation Cities: Elective Compulsory		
	Water and Environmental Engineering: Specialis	ation Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialis	ation Water: Elective Compulsory		

Course 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	ater - 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: Wasto	e and Resource Management			
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	0)	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, students have reached the follo	wing learning results		
Professional Competence				
Knowledge	The students are able to describe waste as a resource as we	ell as advanced technologies for re	cycling and r	ecovery of resources
	from waste in detail. This covers collection, transport, treatme	nt and disposal in national and inte	ernational con	texts.
Ckilla	Students are able to coloct quitable processes for the treatment	nt with respect to the national or s	ultural and do	valanmantal contaut
SKIIIS	Students are able to select suitable processes for the treatme	·		·
	They can evaluate the ecological impact and the technical eff	ort of different technologies and ma	anagement sy	stems.
Personal Competence				
Social Competence	Students can work together as a team of 2-5 persons, part	icipate in subject-specific and inte	erdisciplinary	discussions, develop
	cooperated solutions and defend their own work results in fr	ont of others and promote the sci	entific develo	pment of colleagues.
	Furthermore, they can give and accept professional construct	ve criticisms.		
Autonomy	Students can independently gain additional knowledge of the	as subject area and apply it in as	uluina tha aiu	on course tacks and
Autonomy	Students can independently gain additional knowledge of the	ie subject area and apply it in sc	olving the giv	en course tasks and
	projects.			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	Compulsory Bonus Form Description			
	Yes 20 % Written elaboration			
Examination	Presentation			
Examination duration and	PowerPoint presentation (10-15 minutes)			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elective Co	mpulsory		
Following Curricula	Chemical and Bioprocess Engineering: Specialisation General			
	Chemical and Bioprocess Engineering: Specialisation Bioproce		-	
	Chemical and Bioprocess Engineering: Specialisation Chemical	•		
	Chemical and Bioprocess Engineering: Specialisation Chemica		tive Compuls	ory
	Chemical and Bioprocess Engineering: Core Qualification: Elec			
	Environmental Engineering: Specialisation Energy and Resour		L	
	International Management and Engineering: Specialisation II.		llsory	
	Process Engineering: Specialisation Environmental Process En			
	Water and Environmental Engineering: Specialisation Cities: E			
	Water and Environmental Engineering: Specialisation Environ	nent: 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:
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
СР	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	Course 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			
Courses				
Title		Тур	Hrs/wk	СР
Modeling Processes in Vadose Zone	e (L2735)	Recitation Section (small)	2	2
Vadose Zone Hydrology (L2732)		Lecture	2	2
Vadose Zone Hydrology (L2733)		Recitation Section (large)	2	2
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
Recommended Previous	Basic knowledge in water and soil			
Knowledge	Comfortable with math and physics, critical thinking, creative	ve problem solving		
	comortable with math and physics, childar thinking, creative	e problem solving		
	Analytic skills			
Educational Objectives	After taking part successfully, students have reached the fo	llowing learning results		
Professional Competence	3,1111111111111111111111111111111111111	<u> </u>		
-	The students will learn about soil characterization (solic	I and liquid phase), the energy	state of soil w	ater, the soil water
	characteristic curve, flow in saturated and unsaturated soil			
Skills	Students will work on practical examples modelling transport processes in soil using different quantitative tools including 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 to positively contribute to shape their work and life environme	-	ater, soil and er	nvironment. This will
Autonomy	The students will be involved in many problem solvin independently and responsibly.	g exercises. This will contribute	e toward their	willingness to 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	Report and Presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Computational Engineering	: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Water and Traffic: Elective	Compulsory		
	Environmental Engineering: Core Qualification: Elective Con	npulsory		
	Water and Environmental Engineering: Specialisation Water	: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Enviro	nment: Elective Compulsory		

Course L2735: Modeling Prod	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 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 M0801: Water	r Resources and -Supply			
Courses				
Title		Тур	Hrs/wk	СР
Chemistry of Drinking Water Treatr	Chemistry of Drinking Water Treatment (L0311)		2	1
Chemistry of Drinking Water Treatr	nent (L0312)	Recitation Section (large)	1	2
Water Resource Management (L04)	02)	Lecture	2	2
Water Resource Management (L04)	Recitation Section (small) 1 1			1
Module Responsible	Prof. Mathias Ernst			
Admission Requirements	None			
Recommended Previous	Knowledge of water management and the key processes in	volved in water treatment.		
Knowledge				
Educational Objectives	After taking part successfully, students have reached the f	ollowing learning results		
Professional Competence				
Knowledge	Students will be able to outline key areas of conflict in w	ater management, as well as thei	r mutual depend	ence for sustainable
	water supply. They will understand relevant economic, e	nvironmental and social factors.	Students will be	able to explain and
	outline the organisational structures of water companies. \ensuremath{T}	hey will be able to explain the ava	ilable water treat	tment processes and
	the scope of their application.			
Skille	Students will be able to assess complex problems in	drinking water production and	ostablish solutiv	one involving water
SKIIIS	management and technical measures. They will be able to	,		•
	be able to carry out chemical calculations for selected t			
	standards to these processes.	reactive processes and apply ge	nerally accepted	teeninear raies and
	standards to triese processes.			
Personal Competence				
Social Competence	Working in a diverse group of specialists, students will be	able to develop and document co	mplex solutions t	for the management
	and treatment of drinking water. They will be able to take	e an appropriate professional pos	sition, for exampl	le representing user
	interests. They will be able to develop joint solutions in tea	ms of diverse experts and present	these solutions to	o others.
Autonomy	Students will be in a position to work on a subject independ	dently and present on this subject		
riaconomy	Stadents will be in a position to work on a subject inacpent	tentry and present on ans subject.		
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	60 min (chemistry) + presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engineering: Ele	ective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering:	Elective Compulsory		
	Civil Engineering: Specialisation Water and Traffic: Compul	sory		
	Civil Engineering: Specialisation Coastal Engineering: Elect	ive Compulsory		
	Chemical and Bioprocess Engineering: Technical Complement	entary Course: Elective Compulsor	y	
	Chemical and Bioprocess Engineering: Technical Complement		-	
	International Management and Engineering: Specialisation	3,	3	Compulsory
	Process Engineering: Specialisation Environmental Process	, ,		
	Process Engineering: Specialisation Process Engineering: E			
	Water and Environmental Engineering: Specialisation Water			
	Water and Environmental Engineering: Specialisation Envir	' '		
	Water and Environmental Engineering: Specialisation Cities	:: Elective Compulsory		

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

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

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

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

Courses				
itle		Тур	Hrs/wk	СР
Membrane Technology (L0399)		Lecture	2	3
Membrane Technology (L0400)		Recitation Section (small)	1	2
Membrane Technology (L0401)		Practical Course	1	1
Module Responsible	Prof. Mathias Ernst			
Admission Requirements	None			
Recommended Previous	Basic knowledge of water chemistry. Knowledge of the core processes involved in water, gas and steam treatment			
Knowledge				
Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
Professional Competence				
Knowledge	Students will be able to rank the technical applications of industrially important membrane processes. They will be able to expl			
	the different driving forces behind existing meml	brane separation processes. Students wil	l be able to nam	ne materials used
	membrane filtration and their advantages and dis	sadvantages. Students will be able to exp	lain the key diffe	rences in the use
	membranes in water, other liquid media, gases and	d in liquid/gas mixtures.		
Ckilla	Students will be able to prepare mathematical as	wations for material transport in persus	nd calution diffus	ian mambranas
SKIIIS	Students will be able to prepare mathematical eq			
	calculate key parameters in the membrane separa			
	available boundary data and provide recommend			
	experiments, students will be able to classify the			
	membrane materials. Students will be able to chara measures to control this.	acterise the formation of the fouling layer i	n dinerent water	s and apply tech
	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 decisi
	within their group on laboratory experiments to be	undertaken jointly and present these to ot	hers.	
Autonomy	'	on the topic of membrane technology in	dependently. The	y will be capable
	finding creative solutions to technical questions.			
Workload in Hours	Independent Study Time 124, Study Time in Lectur	re 56		
Credit points	6			
Course achievement	None			
Examination	Written exam			
LAMIIIIIALIOII				
	90 min			
Examination duration and scale	90 min			
Examination duration and scale		Elective Compulsory		
Examination duration and scale Assignment for the	Civil Engineering: Specialisation Water and Traffic:		pry	
Examination duration and scale	Civil Engineering: Specialisation Water and Traffic: Bioprocess Engineering: Specialisation A - General	Bioprocess Engineering: Elective Compulso		
Examination duration and scale Assignment for the	Civil Engineering: Specialisation Water and Traffic: Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Specialisation B - Industria	Bioprocess Engineering: Elective Compulsoral Bioprocess Engineering: Elective Compulsoral Bioprocess Engineering: Elective Compulsoral Bioprocess	sory	
Examination duration and scale Assignment for the	Civil Engineering: Specialisation Water and Traffic: Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Specialisation B - Industria Chemical and Bioprocess Engineering: Specialisation	Bioprocess Engineering: Elective Compulso al Bioprocess Engineering: Elective Compulson on General Process Engineering: Elective Co	sory ompulsory	
Examination duration and scale Assignment for the	Civil Engineering: Specialisation Water and Traffic: Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Specialisation B - Industria Chemical and Bioprocess Engineering: Specialisation Chemical and Bioprocess Engineering: Specialisation	Bioprocess Engineering: Elective Compulso al Bioprocess Engineering: Elective Compulson on General Process Engineering: Elective Co on Chemical Process Engineering: Elective	sory ompulsory Compulsory	
Examination duration and scale Assignment for the	Civil Engineering: Specialisation Water and Traffic: Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Specialisation B - Industria Chemical and Bioprocess Engineering: Specialisatic Chemical and Bioprocess Engineering: Specialisatic Chemical and Bioprocess Engineering: Technical Commical and Bioprocess Engineering: Technical Commical and Bioprocess Engineering: Technical Commical Security Specialisatic Chemical and Bioprocess Engineering: Technical Commical Security Specialisation Security Security Specialisation Security Specialisation Security Specialisation Security Specialisation Security S	Bioprocess Engineering: Elective Compulso al Bioprocess Engineering: Elective Compulson on General Process Engineering: Elective Co on Chemical Process Engineering: Elective complementary Course: Elective Compulson	sory ompulsory Compulsory y	
Examination duration and scale Assignment for the	Civil Engineering: Specialisation Water and Traffic: Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Specialisation B - Industria Chemical and Bioprocess Engineering: Specialisatic Chemical and Bioprocess Engineering: Specialisatic Chemical and Bioprocess Engineering: Technical Commical Engineering: Technical Engineering:	Bioprocess Engineering: Elective Compulsor al Bioprocess Engineering: Elective Compulson General Process Engineering: Elective Con Chemical Process Engineering: Elective complementary Course: Elective Compulson complementary Course: Elective Compulson	sory ompulsory Compulsory y	
Examination duration and scale Assignment for the	Civil Engineering: Specialisation Water and Traffic: Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Specialisation B - Industria Chemical and Bioprocess Engineering: Specialisatic Chemical and Bioprocess Engineering: Specialisatic Chemical and Bioprocess Engineering: Technical Co Chemical and Bioprocess Engineering: Technical Co Environmental Engineering: Specialisation Water Q	Bioprocess Engineering: Elective Compulsoral Bioprocess Engineering: Elective Compulsor General Process Engineering: Elective Compulsor Chemical Process Engineering: Elective Complementary Course: Elective Compulsoromplementary Course: Elective Compulsoromality and Water Engineering: Elective Compulsoromality and Elective Engineering: Elective	sory ompulsory Compulsory y	
Examination duration and scale Assignment for the	Civil Engineering: Specialisation Water and Traffic: Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Specialisation B - Industria Chemical and Bioprocess Engineering: Specialisatio Chemical and Bioprocess Engineering: Specialisatio Chemical and Bioprocess Engineering: Technical Co Chemical and Bioprocess Engineering: Technical Co Chemical and Bioprocess Engineering: Technical Co Environmental Engineering: Specialisation Water Q Process Engineering: Specialisation Process Engineering	Bioprocess Engineering: Elective Compulsor al Bioprocess Engineering: Elective Compulsor General Process Engineering: Elective Compulsor Chemical Process Engineering: Elective complementary Course: Elective Compulsor Complementary Course: Elective Compulsor Quality and Water Engineering: Elective Compulsory	sory ompulsory Compulsory y	
Examination duration and scale Assignment for the	Civil Engineering: Specialisation Water and Traffic: Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Specialisation B - Industria Chemical and Bioprocess Engineering: Specialisatio Chemical and Bioprocess Engineering: Specialisatio Chemical and Bioprocess Engineering: Technical Co Chemical and Bioprocess Engineering: Technical Co Chemical and Bioprocess Engineering: Technical Co Environmental Engineering: Specialisation Water Q Process Engineering: Specialisation Process Engineering: Specialisation Environmental	Bioprocess Engineering: Elective Compulsors al Bioprocess Engineering: Elective Compulsors General Process Engineering: Elective Compulsors Compulsors Elective Elective Compulsors Elective Engineering: Elective Compulsors Elective Engineering: Elective Compulsors Elective Engineering: Elective Compulsors Elective Ele	sory ompulsory Compulsory y	
Examination duration and scale Assignment for the	Civil Engineering: Specialisation Water and Traffic: Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Specialisation B - Industria Chemical and Bioprocess Engineering: Specialisatio Chemical and Bioprocess Engineering: Specialisatio Chemical and Bioprocess Engineering: Technical Co Chemical and Bioprocess Engineering: Technical Co Chemical and Bioprocess Engineering: Technical Co Environmental Engineering: Specialisation Water Q Process Engineering: Specialisation Process Engineering	Bioprocess Engineering: Elective Compulsor al Bioprocess Engineering: Elective Compulsor General Process Engineering: Elective Compulsor Of Chemical Process Engineering: Elective Complementary Course: Elective Compulsor Complementary Course: Elective Compulsor Coupling and Water Engineering: Elective Compulsory Process Engineering: Elective Compulsory on Water: Elective Compulsory	sory ompulsory Compulsory y	

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

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

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

Module M0822: Proce	ss Modeling in Water Technology			
Courses				
Title		Тур	Hrs/wk	СР
Process Modelling of Wastewater T	reatment (L0522)	Project-/problem-based Learning	2	3
Process Modeling in Drinking Water	r Treatment (L0314)	Project-/problem-based Learning	2	3
Module Responsible	Dr. Klaus Johannsen			
Admission Requirements	None			
Recommended Previous	Knowledge of the most important processes in drinking water and waste water treatment.			
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	following learning results		
Professional Competence				
Knowledge	Students are able to explain selected processes of drink	ing water and waste water treatment i	n detail. They	are able to explain
	basics as well as possibilities and limitations of dynamic n	nodeling.		
Skills	Students are able to use the most important features Mo	odelica offers. They are able to transpo	se selected r	rocesses in drinking
	water and waste water treatment into a mathematical mathe	·		-
	They are able to set up and apply models and assess their	·		
Personal Competence				
Social Competence	Students are able to solve problems and document soluti	ons in a group with members of differe	nt technical b	ackground. They are
	able to give appropriate feedback and can work construct	ively with feedback concerning their wo	ork.	
Autonomy	Students are able to define a problem, gain the required k	nowledge and set up a model.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and	30 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Electiv	e Compulsory		
Following Curricula	Chemical and Bioprocess Engineering: Technical Complen	nentary Course: Elective Compulsory		
	Chemical and Bioprocess Engineering: Technical Complen	nentary Course: Elective Compulsory		
	Environmental Engineering: Specialisation Water Quality a		Isory	
	Process Engineering: Specialisation Environmental Proces			
	Process Engineering: Specialisation Process Engineering:			
	Water and Environmental Engineering: Specialisation Wat			
	Water and Environmental Engineering: Specialisation Envi			
	Water and Environmental Engineering: Specialisation Citie	es: Elective Compulsory		

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

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

Courses		
itle	Typ Hrs/wk CP	
daptation to climate change in hy		
Module Responsible	Prof. Peter Fröhle	
Admission Requirements	None	
Recommended Previous		
Knowledge	Hydrology, Hydraulic Engineering	
	Hydromechanic, Hydraulics Fundamentals of Coastal Engineering, Coastal, and Flood Bratastian	
	 Fundamentals of Coastal Engineering, Coastal- and Flood Protection Hydrological Systems 	
	• Hydrological Systems	
Educational Objectives	After taking part successfully, students have reached the following learning results	
Professional Competence		
Knowledge	Climate protection and climate adaptation	
	 Climate protection and climate adaptation Insights into climate change and its regional characteristics - fundamentals, climate modelling / climate models 	
	Impacts of climate change and its regional characteristics - inhalmentals, climate models	
	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	
Skills	Critical thinking: analysis of processes and relations, assessment of needs for action	
	Creative thinking: development of adaptation strategies and adaptation measures	
	Practical thinking: inclusion of restrictions, application of calculation approaches, methods, numerical models, plant	
	methods	
	Consideration of complex tasks	
Personal Competence		
Social Competence	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		
Course achievement	None	
Examination	Written elaboration	
Examination duration and	Preparation of a written report and a presentation of a complex task.	
scale		
Assignment for the	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory	
Following Curricula		
-	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory	
	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory	
	Water and Environmental Engineering: Specialisation Cities: Elective Compulsory	
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory	
	Water and Environmental Engineering: Specialisation Water: Elective Compulsory	

Course 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 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	l engineering 1CP (L3289)		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	5)	Practical Course	1	1
Module Responsible	Prof. Mathias Ernst			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have	reached the following learning results		
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
	Depends on choice of courses			
Credit points	6			
	Environmental Engineering: Core Qualificatio	n: Elective Compulsory		
-	Water and Environmental Engineering: Specia			
,	Water and Environmental Engineering: Specia			
	Water and Environmental Engineering: Specia	' '		

C	d a west is Chamistry.
Course L1444: Environmenta	
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	indfill 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	1) Waste Management. Bernd Bilitewski; Georg Härdtle; Klaus Marek (Eds.), ISBN: 9783540592105 , Springer Verlag
	Lehrbuchsammlung der TUB, Signatur USH-305
	2) Solid Waste Technology and Management. Thomas Christensen (Ed.), ISBN: 978-1-4051-7517-3, Wiley Verlag
	Lesesaal 2: US - Umweltschutz, Signatur USH-332
	3) Solid Waste Landfilling - Concepts, Processes, Technologies. Cossu, R. and Stegmann, R. (Eds.), ISBN: 978-0-12-818336-
	6
	PDF (Volltext) über TUB

Typ Lecture Hrs/wk 2 CP 3 Workload in Hours Independent Study Time 62, Study Time in Lecture 28 Examination Form Klausur Examination duration and Scale Lecture Dr. Joachim Behrendt Language EN Cottent Sedimentation characteristic and thickening, Centrifugation, Flotation, Flotation, Sludge Digestion, Sludge Digistion, Sludge Digistion, Sludge Digisting, 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: 0070142780 (als., paper) ISBN: 0071122508 (ISE (*pbk)) Boston (Lu. 3): McGraw-Hill, 2003 TUB_HH_Katalog Cleverson Vitorio Andreoli, Marcos von Sperling, Fernando Fernandes ISBN: 9781843391661	Course L0520: Sludge Treatment		
Workload in Hours Examination Form Klausur Examination duration and Scale Lecturer Dr. Joachim Behrendt Language EN Cycle SoSe Content Sedimentation characteristic and thickening, Centrifugation, Filotation, Filotation, Filotation, Sludge Digestion, Sludge Digestion, Sludge Digestion, Sludge Dewatering, Natural Processes for Sludge Treatment, Nutrient Recovery from Sludge, Thermal Processes and Incineration. Literature Etherature Uthobanoglous, 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	Тур	Lecture	
Workload in Hours Examination Form Klausur Examination duration and scale Lecturer Language Cycle SoSe Content Centrifugation, Filotation, Filtration, Aerobic sludge stabilisation, Sludge Digestion, Sludge Digestion, Sludge Dewatering, Natural Processes for Sludge Treatment, Nutrient Recovery from Sludge, Thermal Processes and Incineration. Literature Literature Examination duration characteristic and thickening, Centrifugation, Filotation, Filotation, Filotation, Sludge Digestion, Sludge Digestion, Sludge Dewatering, Natural Processes for Sludge Treatment, Nutrient Recovery from Sludge, Thermal Processes and Incineration. Literature Literature Ithebanoglous, 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	Hrs/wk	2	
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Examination duration and scale Lecturer Dr. Joachim Behrendt Language EN Cycle SoSe Content Sedimentation characteristic and thickening, Centrifugation, Filtration, Filtration, Sludge Digestion, Sludge Digestion, Sludge Digestion, Sludge Dewatering, Natural Processes for 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	Workload in Hours	Independent Study Time 62, Study Time in Lecture 28	
Lecturer Language EN SoSe Content Centrifugation, Filtration, Aerobic sludge stabilisation, Sludge Digestion, 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	Examination Form	Klausur	
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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			
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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	Literature	Tchobanoglous, George (Metcalf & Eddy, Inc., ;)	
Boston [u.a.]: McGraw-Hill, 2003 TUB_HH_Katalog Cleverson Vitorio Andreoli, Marcos von Sperling, Fernando Fernandes Sludge Treatment and Disposal ISBN 9781843391661		Wastewater engineering : treatment and reuse	
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IWA Publishing, 2007		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
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 book placetricity and/or finals.
	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 Biomass 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	
	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 M1720: Emer	ging Trends in Environmental Eng	ineering		
Courses				
Title		Тур	Hrs/wk	СР
Environmental Research Trends (L.		Seminar	2	2
Microplastics in Environment (L275		Lecture	2	2
Scientific Communication and Meth	ı	Lecture	1	2
Module Responsible				
Admission Requirements				
	Basic knowledge on water, soil and environmenta	al research.		
Knowledge				
Educational Objectives	After taking part successfully, students have read	thed the following learning results		
Professional Competence				
Knowledge	The students will be exposed to up-to-date resear	·		
	focus on the effects of microplastics in environ	nent. Data analysis, data measurement,	curation and preser	ntation will be other
	skills that the students will develop in this modul	e.		
Skills	Students' research skills will be improved in this	module. How to prepare and deliver ar	n effective presentati	on, 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 solving skills	through Research-Based Teaching approa	aches will be at the c	ore of this module.
,		3 11		
Autonomy	The students will be involved in writing individual	·	contribute to the s	tudents' ability and
	willingness to work independently and responsible	y.		
Workload in Hours	Independent Study Time 110, Study Time in Lect	ure 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 and Traffi	c: Elective Compulsory		
Following Curricula	Environmental Engineering: Specialisation Enviro	nment and Climate: Elective Compulsory		
	Water and Environmental Engineering: Specialisa	tion Cities: Elective Compulsory		
	Water and Environmental Engineering: Specialisa	tion Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialisa	tion Water: Elective Compulsory		

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

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

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

Module M1779: Susta	ninable Nature-based Coastal Protection	in a Changing Climate (So	eaPiaC)	
Courses				
Title Sustainable Nature-based Coastal	Protection in a Changing Climate (SeaPiaC) (L2926)	Typ Project-/problem-based Learning	Hrs/wk	CP 6
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous Knowledge	Hydraulic Engineering Hydromechanics, Hydraulics Fundamentals of Coastal Engineering, Coastal- 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 Consequences of Climate Change for Coastal Proce Coastal Protection in Taiwan and Germany Fundamentals of Climate Adaptation Nature-based Solutions (NBS) for Coastal Protection Critical thinking: analysis of processes and relation	ns, assessment of needs for action		
Personal Competence	 Creative thinking: development of adaptation strat Practical thinking: inclusion of restrictions, applic methods Consideration of complex tasks 		nods, numerica	al models, planning
Social Competence		ciplines		
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				
	Preparation of a written report on a complex task with a	presentation and subsequent discussion	on. The work o	on the complex task
Assignment for the Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Civil Engineering: Specialisation Structural Engineering: E Civil Engineering: Specialisation Water and Traffic: Electiv Environmental Engineering: Specialisation Environment a Water and Environmental Engineering: Specialisation Citic	g: Elective Compulsory lective Compulsory ee Compulsory and Climate: Elective Compulsory es: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Env Water and Environmental Engineering: Specialisation Wat	, ,		

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	08)	Lecture	2	3
Coastal- and Flood Protection (L141		Project-/problem-based Learning	1	1
Maintenance and Defence of Flood	· · ·	Lecture	2	2
Module Responsible	Prof. Peter Fröhle			
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 i	n detail the important aspects of erosion	on protection	and flood protection
	and are able to apply the aspects to practical coastal	protection problems. They are able to	design and d	dimension important
	coastal protection measures from the functional and from	the constructional point of view.		
Skills	The students are able to select design approaches for	the functional and constructional design	n of erosion	and flood protection
Simil	measures and apply these approaches to practical design	•	, 0. 0.05.0	and nood protection
Personal Competence				
Social Competence	The students are able to deploy their gained knowledg	e in applied problems such as the fund	ctional and co	onstructive design of
	coastal and flood protection structures. Additionaly, they	will be able to work in team with engine	eers of other d	lisciplines.
Autonomy	The students will be able to independently extend their k	nowledge 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 min. The exam	ination includes tasks with respect to	the general u	ınderstanding of the
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Coastal Engineering: Cor	npulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering	g: Elective Compulsory		
	Civil Engineering: Specialisation Structural Engineering: E	Elective Compulsory		
	Environmental Engineering: Specialisation Environment a	nd Climate: Elective Compulsory		
	Environmental Engineering: Specialisation Water Quality	and Water Engineering: Elective Compu	ılsory	
	Water and Environmental Engineering: Specialisation Env	rironment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Wa	ter: Elective Compulsory		

Course L0808: Coastal- and I	Flood Protection
Тур	Lecture
Hrs/wk	2
СР	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
	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	Vorlesungsumdruck
	Coastal Engineering Manual CEM

Course L1415: Coastal- and	Course L1415: Coastal- and 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

control measurements. The students can recherché and evaluate literature and date connected to the tasks given in der and plan additional tests. They are capable of reflecting and evaluating findings in the group. Personal Competence Social Competence Students can participate in subject-specific and interdisciplinary discussions, develop cooperated solutions and defend to work results in front of others and promote the scientific development in front of colleagues. Furthermore, they can exact accept professional constructive criticism. Autonomy Students can independently tap knowledge from literature, business or test reports and transform it to the course project are capable, in consultation with supervisors as well as in the interim presentation, to assess their learning level and defin	100ule M2003: Biolo	gical Waste Treatment			
The students are able to discuss the complation of design and layout of plants. They can critically evaluate techniques and plan additional tests. They are capable of reflecting and evaluate literature, business or test reports and transform it to the tasks given in den and plan additional tests. They are capable from the standard in front of colleagues. Furthermore, they can define targets for new application or research-oriented duties in accordance potential social, economic and utrational office. **Business of the Course exclusive many to the standard in the course project professional competence of the students and to should waste treatment plants in detail, describe different techniques for waste gas to plants for biological waste treatment plants in detail, describe different techniques for waste gas to plants for biological waste treatment plants and explain different methods for waste analytics. **SKIR** The students are able to discuss the complation of design and layout of plants. They can critically evaluate techniques and plan additional tests. They are capable of reflecting and evaluate literature and date connected to the tasks given in den and plan additional tests. They are capable of reflecting and evaluate literature and date connected to the tasks given in den and plan additional tests. They are capable of reflecting and evaluate literature and date connected to the tasks given in den and plan additional tests. They are capable of reflecting and evaluate literature and date connected to the tasks given in den and plan additional tests. They are capable of reflecting and evaluate literature and date connected to the tasks given in den and plan additional tests. They are capable of reflecting and evaluation findings in the group. **Students can independently tap knowledge from literature, business or test reports and transform it to the course project are capable, in consultation with supervisors as well as in the interim presentation, to assess their learning level and define a capable. I	Courses				
Personal Competence Social Competence Sudents are able to discuss the compilation of design and layout of plants. They can critically evaluate techniques and plan additional bests. They are capable for effecting and evaluating findings in the groups. Furthermore, they can accept professional Competence Social Compet			Typ	Hrs/wk	CP
Module Responsible Prof. Kerstin Küchta Admission Requirements None Recommended Previous Knowledge Education Objectives After taking part successfully, students have reached the following learning results Professional Competence Knowledge The module aims possess knowledge concerning the planning of biological waste treatment plants. Students are able to explain the for biological waste treatment plants in detail, describe different techniques for waste analytics. Skills The students are able to discuss the compilation of design and layout of plants. They can critically evaluate techniques an control measurements. The students can recherche and evaluate literature and date connected to the tasks given in derivant and plan additional tests. They are capable of reflecting and evaluate literature and date connected to the tasks given in derivance of the completence of the completence of the complete of the compl		ry (L0328)			
Admission Requirements Recommended Previous Chemical and biological basics Knowledge Educational Objectives Are taking part successfully, students have reached the following learning results The module aims possess knowledge concerning the planning of biological waste treatment plants. Students are able to evidesign and layout of anaerobic and aerobic waste treatment plants in detail, describe different techniques for waste agas to plants for biological waste treatment plants in detail, describe different techniques for waste agas to plants for biological waste treatment plants and explain different methods for waste analytics. Stills The students are able to discuss the compilation of design and layout of plants. They can critically evaluate techniques an octrotrol measurements. The students can recherché and evaluate literature and date connected to the tasks given in dea and plan additional tests. They are capable of reflecting and evaluating findings in the group. Personal Competence Social Competence Social Competence Social Competence Social Competence Social Competence Social Competence Suddents can participate in subject-specific and interdisciplinary discussions, develop cooperated solutions and defend it work results in front of others and promote the scientific development in front of colleagues. Furthermore, they can accept professional constructive criticism. Autonomy Students can independently tap knowledge from literature, business or test reports and transform it to the course project are capable, in consultation with supervisors as well as in the interim presentation, to assess their learning level and defin steppes on this basis. Interheumore, they can define targets for new application-or research-oriented duties in accordance potential social, economic and cultural impact. Credit points Course achievement Autonomy Internation discrete and cultural impact. Credit points Course achievement Credit points Course achievement Credit points Course achievement Credit poi	Biological Waste Treatment (L0318)	Project-/problem-based Learning	3	4
Recommended Previous Knowledge Educational Objectives After taking part successfully, students have reached the following learning results Professional Competence Knowledge The module aims possess knowledge concerning the planning of biological waste treatment plants. Students are able to explain and layout of anaerobic and aerobic waste treatment plants in detail, describe different techniques for waste gas to plants for biological waste treatment plants in detail, describe different techniques for waste gas to plants for biological waste treatment plants and explain different methods for waste analytics. Skills The students are able to discuss the compilation of design and layout of plants. They can critically evaluate techniques an control measurements, The students can recherche and evaluate literature and date connected to the tasks given in dei and plan additional tests. They are capable of reflecting and evaluating findings in the group. Personal Competence Social Competence Social Competence Sudents can participate in subject specific and interdisciplinary discussions, develop cooperated solutions and defined to work results in front of others and promote the scientific development in front of colleagues. Furthermore, they can define targets for members are capable, in consultation with supervisors as well as in the interim presentation, to assess their learning level and define steps on this basis. Furthermore, they can define targets for new application-or research-oriented duties in accordance potential social, economic and cultural impact. Workload in Hours Independent Study Time 110, Study Time in Lecture 70 Credit points Course achievement Examination duration and Elaboration and Presentation (15-25 minutes in groups) Scale Assignment for the Following Curricula Presentation Presen	Module Responsible	Prof. Kerstin Kuchta			
Educational Objectives After taking part successfully, students have reached the following learning results Professional Competence Knowledge The module aims possess knowledge concerning the planning of biological waste treatment plants. Students are able to expend the module aims possess knowledge concerning the planning of biological waste treatment plants in detail, describe different techniques for waste gas to plants for biological waste treatment plants and explain different methods for waste analytics. Skills The students are able to discuss the compilation of design and layout of plants. They can critically evaluate techniques an control measurements. The students can recherche and evaluate literature and date connected to the tasks given in detained and plan additional tests. They are capable of reflecting and evaluating findings in the group. Personal Competence Social Competence Social Competence Social Competence Sudents can participate in subject-specific and interdisciplinary discussions, develop cooperated solutions and defend to work results in front of others and promote the scientific development in front of colleagues. Furthermore, they can accept professional constructive criticism. Autonomy Sudents can independently tap knowledge from literature, business or test reports and transform it to the course project are capable, in consultation with supervisors as well as in the interim presentation, to assess their learning level and define steps on this, basis. Furthermore, they can define targets for new application-or research-oriented duties in accordance potential social, economic and cultural impact. Examination duration and Examination or liberature in the supervisors as well as in the interim presentation, to assess their learning level and define steps on this, basis. Furthermore, they can define targets for new application-or research-oriented duties in accordance potential social, economic and cultural impact. Examination or liberature in the supervisor in the supervisor i	Admission Requirements	None			
### Professional Competence **Ronal Competence** **Frotessional Competen	Recommended Previous	chemical and biological basics			
Professional Competence Knowledge The module aims possess knowledge concerning the planning of biological waste treatment plants. Students are able to explants for biological waste treatment plants and explain different methods for waste analytics. Skills The students are able to discuss the compilation of design and layout of plants. They can critically evaluate techniques and plan additional tests. They are capable of reflecting and evaluating findings in the group. Personal Competence Social Competence Social Competence Social Competence Suddents can participate in subject-specific and interdisciplinary discussions, develop cooperated solutions and defend to work results in front of others and promote the scientific development in front of colleagues. Furthermore, they can grace capable, in consultation with supervisors as well as in the interim presentation, to assess their learning level and definition are capable, in consultation with supervisors as well as in the interim presentation, to assess their learning level and definition are capable, in consultation with supervisors as well as in the interim presentation, to assess their learning level and definition are capable, in consultation with supervisors as well as in the interim presentation, to assess their learning level and definition and supervisors as the basis. Furthermore, they can define targets for new application-or research-oriented duties in accordance potential social, economic and cultural impact. Workload in Nour Credit points Course achievement Feamination duration and Scale Assignment for the City Engineering Specialisation of Costal Engineering: Elective Compulsory Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical Process Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical Process Engineering: Elective Compulsory C	Knowledge				
### Remodule aims possess knowledge concerning the planning of biological waste treatment plants. Students are able to explant story biological waste treatment plants in detail, describe different techniques for waste gas to plants for biological waste treatment plants and explain different methods for waste analytics. ###################################	Educational Objectives	After taking part successfully, students have reach	ed the following learning results		
design and layout of anaerobic and aerobic waste treatment plants in detail, describe different techniques for waste gas to plants for biological waste treatment plants and explain different methods for waste analytics. Skills	Professional Competence				
Course achievement Workload in Hours Credit points Examination Pesantation Examination duration and Examination of Pesantation Examination duration and Examination of Pesantation Examination duration and Examination of Colleaguering: Specialisation Geotechnical Engineering: Elective Compulsory Civil Engineering: Specialisation A: General Process Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical and Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical and Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical and Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical and Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical and Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical and Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical and Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Che	Knowledge	design and layout of anaerobic and aerobic waste t	reatment plants in detail, describe different to		·
Sudents can participate in subject-specific and interdisciplinary discussions, develop cooperated solutions and defend to work results in front of others and promote the scientific development in front of colleagues. Furthermore, they can a accept professional constructive criticism. **Autonomy*** Students can independently tap knowledge from literature, business or test reports and transform it to the course project are capable, in consultation with supervisors as well as in the interim presentation, to assess their learning level and define steps on this basis. Furthermore, they can define targets for new application-or research-oriented duties in accordance potential social, economic and cultural impact. **Workload in Hours** Independent Study Time 110, Study Time in Lecture 70 Credit points** Course achievement** Social Computeory** Examination Presentation Examination duration and scale Assignment for the Civil Engineering: Specialisation of Students in groups) Examination duration and Presentation (15-25 minutes in groups) Examination Curricula Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical Process Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical and Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical and Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical and Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical and Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Environmental Process Engineering: Elective Compulsory International Management and Engineering: Specialisation International	Skills	The students are able to discuss the compilation of design and layout of plants. They can critically evaluate techniques and qualit control measurements. The students can recherché and evaluate literature and date connected to the tasks given in der modu and plan additional tests. They are capable of reflecting and evaluating findings in the group.			
Sudents can participate in subject-specific and interdisciplinary discussions, develop cooperated solutions and defend to work results in front of others and promote the scientific development in front of colleagues. Furthermore, they can a accept professional constructive criticism. **Autonomy*** Students can independently tap knowledge from literature, business or test reports and transform it to the course project are capable, in consultation with supervisors as well as in the interim presentation, to assess their learning level and define steps on this basis. Furthermore, they can define targets for new application-or research-oriented duties in accordance potential social, economic and cultural impact. **Workload in Hours** Independent Study Time 110, Study Time in Lecture 70 Credit points** Course achievement** Social Computeory** Examination Presentation Examination duration and scale Assignment for the Civil Engineering: Specialisation of Students in groups) Examination duration and Presentation (15-25 minutes in groups) Examination Curricula Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical Process Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical and Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical and Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical and Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical and Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Environmental Process Engineering: Elective Compulsory International Management and Engineering: Specialisation International	Personal Competence				
work results in front of others and promote the scientific development in front of colleagues. Furthermore, they can a accept professional constructive criticism. **Autonomy*** Students can independently tap knowledge from literature, business or test reports and transform it to the course project are capable, in consultation with supervisors as well as in the interim presentation, to assess their learning level and define steps on this basis. Furthermore, they can define targets for new application-or research-oriented duties in accordance potential social, economic and cultural impact. **Workload in Hours*** Morkload in Hours*** Independent Study Time 110, Study Time in Lecture 70 Credit points	•	Students can participate in subject-specific and in	terdisciplinary discussions, develop cooperat.	ed solutions a	and defend their
are capable, in consultation with supervisors as well as in the interim presentation, to assess their learning level and definsteps on this basis. Furthermore, they can define targets for new application-or research-oriented duties in accordance potential social, economic and cultural impact. Morkload in Hours	Social competence	work results in front of others and promote the			
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Course achievement Course achievement Yes None Subject theoretical and practical work Examination Presentation Examination duration and scale Assignment for the Following Curricula Civil Engineering: Specialisation Chemical Engineering: Elective Compulsory Civil Engineering: Specialisation Water and Traffic: Elective Compulsory Civil Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical Process Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical Process Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical Process Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical Process Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical and Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical and Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical and Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical and Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical and Bioprocess Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical and Bioprocess Engineering: Elective Compulsory International Management and Engineering: Specialisation II. Renewable Energy: Elective Compulsory Process Engineering: Specialisation Environmental Process Engineering: Elective Compulsory Water and Environmental Engineering: Specialisation Cities: Elective Compulsory	Workload in Hours	Independent Study Time 110, Study Time in Lectur	re 70		
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react and Environmental Engineering, Specialisation Environment, Elective Compaisory		* * * * * * * * * * * * * * * * * * * *			
		water and Environmental Engineering. Specialisation	on Environment. Elective Compulsory		

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

Module M2013: Study	Work Spezialisation Environment				
Courses					
Title	Typ Hrs/wk CP				
Module Responsible	Dozenten des SD B				
Admission Requirements	None				
Recommended Previous					
Knowledge					
Educational Objectives	After taking part successfully, students have reached the following learning results				
Professional Competence					
Knowledge	The students are able to demonstrate their detailed knowledge in the field of Water and Environmental Engineering. They can exemplify the state of technology and application and discuss critically in the context of actual problems and general conditions of science and society.				
	The students can develop solving strategies and approaches for fundamental and practical problems in the field of Water and Environmental Engineering. They may apply theory based procedures and integrate safety-related, ecological, ethical, and economic view points of science and society.				
	Scientific work techniques that are used can be described and critically reviewed.				
Skills	The students are able to independently select methods or planning approaches for the project work and to justify their cho They can explain how these methods or approaches relate to solutions in the field of work and how the context of application to be adjusted. General findings and further developments may essentially be outlined.				
Personal Competence					
-	The students are able to condense the relevance and the structure of the project work, the work steps and the sub-problems f the presentation and discussion in front of a bigger group. They can lead the discussion and give a feedback on the project to the colleagues.				
Autonomy	The students are capable of independently planning and documenting the work steps and procedures while considering the give deadlines. This includes the ability to accurately procure the newest scientific information. Furthermore, they can obtain feedbar 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 Environment: Compulsory				
Following Curricula					

Module M2033: Subsu	rface Processes				
Courses					
Title		Тур		Hrs/wk	СР
Modeling of Subsurface Processes (I	L2731)	Recitation Sect	tion (small)	3	3
Subsurface Solute Transport (L2728		Lecture		2	2
Subsurface Solute Transport (L2729	1)	Recitation Sect	tion (large)	1	1
Module Responsible	Dr. Milad Aminzadeh				
Admission Requirements	None				
Recommended Previous	Basic Mathematics, Hydrology				
Knowledge					
Educational Objectives	After taking part successfully, students hav	re reached the following learning res	ults		
Professional Competence					
Knowledge	Upon completion of this module, the stud	dents will understand the mechanis	sms controlling	solute transport	in soil and natura
	porous media and will be able to work with	the equations that govern the fate	and transport o	of solutes in poro	us media. Analytical
	numerical and experimental tools and techn	niques will be used in this module.			
CL III.	The second secon	de de la Mille de la Contra de			
	In addition to the physical insights, the stud	·			•
	this module. This provides them with an ex future career.	cellent opportunity to improve their	Skills on multip	ole fronts which	wiii be userui in thei
	Tuture Career.				
Personal Competence	Teamwork C problem colving				
· ·	Teamwork & problem solving The students will be involved in writing in the students will be involved in the students will be a students will be involved in the students will be students will be involved in the students will be involved in th	individual reports and presentation	a This will con	stributo to the c	tudonts' ability and
*	willingness to work independently and resp	· ·	i. This will con	ithibute to the s	dudents ability and
	Independent Study Time 96, Study Time in				
	6	Lecture 64			
	None				
	Subject theoretical and practical work				
	Report				
scale					
-	Civil Engineering: Specialisation Structural I				
Following Curricula	Civil Engineering: Specialisation Geotechnic		1		
	Civil Engineering: Specialisation Coastal Engineering: Specialisation Water and				
	Civil Engineering: Specialisation Water and	, ,			
	Civil Engineering: Specialisation Computation Chemical and Bioprocess Engineering: Tech			,	
	Chemical and Bioprocess Engineering: Tech				
	Environmental Engineering: Core Qualificat		ve compuisory		
	Process Engineering: Specialisation Environ		ve Compulsory		
	Process Engineering: Specialisation Process	•	2 Compaisory		
		g g. E.ccarc copaisory			
	Water and Environmental Engineering: Spe	cialisation Water: Compulsorv			

Course L2731: Modeling of S	ubsurface Processes
Тур	Recitation Section (small)
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Mohammad Aziz Zarif
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 So	olute Transport
Тур	Lecture
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Milad Aminzadeh
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	ourse L2729: Subsurface Solute Transport				
Тур	citation Section (large)				
Hrs/wk					
СР					
Workload in Hours	dependent Study Time 16, Study Time in Lecture 14				
Lecturer	r. Milad Aminzadeh				
Language	EN				
Cycle	WiSe				
Content	See interlocking course				
Literature	See interlocking course				

Module M2076: Introd	duction to Climate Informed Eng	gineering			
Courses					
Title		Тур	Hrs/wk CP		
Methods in Climate Informed Engir	neering (L3347)	Lecture	3 3		
Topics in Climate Informed Engine	ering (L3348)	Lecture	3 3		
Module Responsible	Prof. Nima Shokri				
Admission Requirements	None				
Recommended Previous	Students are expected to have a foundation	nal understanding of environmental scie	ence, basic engineering principles, and		
Knowledge	interest in sustainability. Recommended know	ledge includes climate science, data anal	ysis, and familiarity with engineering desi		
	processes. Analytical and critical thinking and creative problem-solving skills are also beneficial				
Educational Objectives	After taking part successfully, students have r	eached the following learning results			
Professional Competence					
Knowledge	This module explores next-generation climate	e models and high-resolution data, emph	asizing their impact on environmental a		
	engineering products and processes. It covers	how various engineering disciplines can	benefit from climate information. Researc		
	based learning activities, expert talks, and p	presentations will expose students to sta	te-of-the-art modeling, measurement, a		
	analysis in climate-informed engineering.				
Skills	Climate data analysis, engineering adapta	ation strategies, problem-solving, resea	rch-based learning, and interdisciplina		
	collaboration.	, p	,		
Personal Competence					
Social Competence	· · ·	mmunication skills, problem-solving, eth	ical responsibility, and decision-making		
	climate-resilient engineering.				
Autonomy	Time management, self-directed learning, c	ritical thinking, accountability, initiative	, and the ability to conduct independe		
	research and make informed decisions in climate-informed engineering.				
Workload in Hours	Independent Study Time 96, Study Time in Le	cture 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 Engin	eering: 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				
	Civil Engineering: Specialisation Computational Engineering: Elective Compulsory				
	Data Science: Specialisation III. Applications: Elective Compulsory				
	Environmental Engineering: Core Qualification: Elective Compulsory				
	Process Engineering: Specialisation Process Engineering: Elective Compulsory				
	Water and Environmental Engineering: Specia		,		
	Water and Environmental Engineering: Specia	· · ·	′		
	Water and Environmental Engineering: Specialisation Water: Elective Compulsory				

Course L3347: Methods in Cl	imate Informed Engineering
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Nima Shokri, Prof. Cathy Hohenegger, Prof. Irina Smirnova
Language	EN
Cycle	WiSe
Content	Students will learn techniques for incorporating climate data and environmental factors into engineering design. It covers climate modelling and the use of sensors and devices to measure climate-related parameters and engineering processes. Students will have the opportunity to conduct their own measurements, analyze the collected data, and write a report on their findings. This hands-on experience will be assessed and contribute to their final grade.
Literature	

Course L3348: Topics in Clim	ate Informed Engineering
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Irina Smirnova, Prof. Cathy Hohenegger, Prof. Nima Shokri
Language	EN
Cycle	WiSe
Content	Exploring specific applications of climate data in various engineering disciplines. Invited speakers will present their research and discuss the relevance of climate-informed engineering to their work. Additionally, there will be a segment on effective communication, covering how to give impactful presentations and write research papers. Students will also give presentations on their own class projects related to climate-informed engineering, applying the concepts they've learned. This hands-on experience will be assessed and contribute to their final grade.
Literature	

Module M2155: Unce	rtainty Modelli	ng for Enginee	ers		
Courses					
Title			Тур	Hrs/wk	СР
Uncertainty Modelling for Engineer	s (L3458)		Integrated Lecture	6	6
Module Responsible	Prof. Simon Michael I	Papalexiou			
Admission Requirements	None				
Recommended Previous					
Knowledge		arity with engineering	g concepts. cs, and mathematical skills.		
		er skills for handling o			
	-		plems using statistical and probabilistic methods		
Educational Objectives	After taking part suc	cessfully, students ha	ive reached the following learning results		
Professional Competence					
Knowledge			n in uncertainty, probability, and risk analysis		
	-		incertainty, covering frequency-based methods		
			heory, joint probability distributions, and stoch e course also covers linear and nonlinear regre		
	, ,	• .	. Additionally, students will gain insight into risi		
	_		sian Decision Theory to optimize engineering so		
Skills	_		able to apply probabilistic models to quantify u		
			ing probability distributions, performing extrem lenges. Students will also develop skills in lir		
			pering datasets and improve risk predictions. Th		
	-		nethods and optimization techniques to support	-	•
	decision-making.		The state of the s	,	
Personal Competence					
Social Competence			rk collaboratively on engineering risk assess		
			ecision-makers. They will engage in discussion t engineering analyses are both rigorous and		
	challenges.	cation, ensuring that	e engineering unaryses are soon rigorous and	a applicable to real	world illinastractare
Autonomy			yze and model engineering uncertainties, selec		
	_		ochastic techniques for various applications. T made hazards, ensuring they can make informe		•
	assessment, and disa		made hazarus, ensuming they can make informe	ed engineering decisi	ons in design, salety
	assessment, and also	aster riningution			
Workload in Hours	Independent Study T	ime 96, Study Time i	n Lecture 84		
Credit points					
Course achievement	Compulsory Bonus	Form	Description	rachnicson	
Evamination	Yes 20 % Written exam	Presentation	10-minütige Präsentation von Arbeitse	rgebnissen	
Examination duration and					
scale	130 111111				
	Civil Engineering: Sp.	ecialisation Coastal F	ngineering: Elective Compulsory		
Following Curricula	3 3 1		nical Engineering: Elective Compulsory		
	Civil Engineering: Sp	ecialisation Structura	I Engineering: Elective Compulsory		
	Civil Engineering: Sp	ecialisation Computa	tional Engineering: Elective Compulsory		
	Civil Engineering: Sp	ecialisation Water an	d Traffic: Elective Compulsory		
			ngineering: Elective Compulsory		
	, ,		ical Engineering: Elective Compulsory		
			I Engineering: Elective Compulsory		
			tional Engineering: Elective Compulsory d Traffic: Elective Compulsory		
			ation: Elective Compulsory		
	_	-	ation: Elective Compulsory		
	_		ecialisation Cities: Elective Compulsory		
			ecialisation Environment: Elective Compulsory		
	Water and Environme	ental Engineering: Sp	ecialisation Water: Elective Compulsory		
	Water and Environme	ental Engineering: Sp	ecialisation Cities: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory				
			ecialisation Water: Elective Compulsory		

Course L3458: Uncertainty M	lodelling for Engineers
Тур	Integrated Lecture
Hrs/wk	6
СР	6
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Lecturer	Prof. Simon Michael Papalexiou
Language	EN
Cycle	SoSe
Content	Engineering decisions are rarely made with complete certainty—uncertainty affects material properties, environmental conditions, structural performance, and risk assessments. This course provides students with theoretical foundations and practical tools to quantify uncertainty, assess risks, and enhance decision-making in civil, structural, geotechnical, and environmental engineering applications. Students will begin with fundamental probability concepts, learning how Bayes' Theorem, probability distributions, and extreme value theory help evaluate engineering uncertainties. They will explore linear and nonlinear regression methods for analyzing complex datasets, as well as joint probability distributions and stochastic optimization to improve predictive modeling and reliability assessments. The course also introduces Bayesian Decision Theory, offering a structured approach to decision-making under uncertainty. With a focus on real-world engineering problems, students will apply probabilistic models, extreme value analysis, and stochastic techniques to assess risks in infrastructure design, system reliability, and disaster resilience. Handson computational exercises will reinforce key concepts, preparing students to work with data-driven models and uncertainty quantification techniques used in engineering practice. This course is ideal for students interested in engineering risk assessment, reliability analysis, and data-driven modeling. By the end of the course, students will have developed critical analytical and problem-solving skills, equipping them for careers in structural safety, geotechnical engineering, environmental risk management, and beyond.
Literature	

Specialization Water

Module M0801: Water	r Resources and -Supply			
Courses				
Title		Тур	Hrs/wk	CP
Chemistry of Drinking Water Treatr Chemistry of Drinking Water Treatr		Lecture Recitation Section (large)	2 1	1 2
Water Resource Management (L04)		Lecture	2	2
Water Resource Management (L04)		Recitation Section (small)	1	1
Module Responsible				
Admission Requirements	None			
Recommended Previous	Knowledge of water management and the key	processes involved in water treatment.		
Knowledge				
Educational Objectives	After taking part successfully, students have re	ached the following learning results		
Professional Competence				
Knowledge	Students will be able to outline key areas of o	onflict in water management, as well as the	neir mutual depend	dence for sustainable
	water supply. They will understand relevant e			
	outline the organisational structures of water c	ompanies. They will be able to explain the a	vailable water trea	tment processes and
	the scope of their application.			
Skills	Students will be able to assess complex p			
	management and technical measures. They wi			
	be able to carry out chemical calculations for	selected treatment processes and apply	generally accepted	i technical rules and
	standards to these processes.			
Personal Competence				
Social Competence	Working in a diverse group of specialists, students will be able to develop and document complex solutions for the management			
	and treatment of drinking water. They will be able to take an appropriate professional position, for example representing user			
	interests. They will be able to develop joint solu	tions in teams of diverse experts and prese	nt these solutions t	o others.
Autonomy	Students will be in a position to work on a subje	ect independently and present on this subject	-t	
Workload in Hours	Independent Study Time 96, Study Time in Lect	rure 84		
Credit points				
Course achievement	None			
Examination	Written exam			
Examination duration and scale	60 min (chemistry) + presentation			
Assignment for the	Civil Engineering: Specialisation Structural Engi	nooring, Floctive Compulsory		
•				
Following Curricula	Civil Engineering: Specialisation Geotechnical E Civil Engineering: Specialisation Water and Traf			
	Civil Engineering: Specialisation Water and Trail			
	Chemical and Bioprocess Engineering: Technical	. ,	orv	
	International Management and Engineering: Sp			Compulsory
	Process Engineering: Specialisation Environmer	• •	-	
	Process Engineering: Specialisation Process Engineering:		- ,	
	Water and Environmental Engineering: Speciali			
	Water and Environmental Engineering: Speciali	' '		
	Water and Environmental Engineering: Speciali	' '		

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

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

Course I 0403: Water Becour	es Managamanh
Course L0402: Water Resour	Lecture
Hrs/wk	
CP	
	Independent Study Time 32, Study Time in Lecture 28
	Prof. Mathias Ernst
Language	DE
Cycle	WiSe
Content	The lecture provides comprehensive knowledge on interaction of water ressource management and drinking water supply. Content overview: • Current situation of global water resources - User and Stakeholder conflicts - Wasserressourcenmanagement in urbane Gebieten - Rechtliche Aspekte, Organisationsformen Trinkwasserversorgungsunternehmen. - Ökobilanzierung, Benchmarking in der Wasserversorgung
Literature	 Aktuelle UN World Water Development Reports Branchenbild der deutschen Wasserwirtschaft, VKU (2011) Aktuelle Artikel wissenschaftlicher Zeitschriften Ppt der Vorlesung

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

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	ırface Processes			
Courses				
Title		Тур	Hrs/wk	СР
Modeling of Subsurface Processes (L2731)	Recitation Section (small)	3	3
Subsurface Solute Transport (L2728	3)	Lecture	2	2
Subsurface Solute Transport (L2729) Recitation Section (large) 1 1			1	
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
Recommended Previous	Basic Mathematics, Hydrology			
Knowledge				
Educational Objectives	After taking part successfully, students have rea	ached the following learning results		
Professional Competence				
Knowledge	Upon completion of this module, the students	will understand the mechanisms controllin	g solute transpor	t in soil and natural
	porous media and will be able to work with the	equations that govern the fate and transport	of solutes in poro	us media. Analytical,
	numerical and experimental tools and technique	es will be used in this module.		
51.11				
SKIIIS	In addition to the physical insights, the student	·		·
	this module. This provides them with an excelle	nt opportunity to improve their skills on mult	ipie fronts which	will be useful in their
Barranal Carrantona	future career.			
Personal Competence	Tananana Carabban ashira			
*	Teamwork & problem solving			
Autonomy	The students will be involved in writing individual reports and presentation. This will contribute to the students' ability and			
Medded in Herre	willingness to work independently and responsi			
	Independent Study Time 96, Study Time in Lect	ure 84		
Credit points	6			
Course achievement	None			
	Subject theoretical and practical work			
Examination duration and	Report			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Engi			
Following Curricula	Civil Engineering: Specialisation Geotechnical E			
	Civil Engineering: Specialisation Coastal Engine			
	Civil Engineering: Specialisation Water and Traf			
	Civil Engineering: Specialisation Computational			
	Chemical and Bioprocess Engineering: Technical		Ty .	
	Environmental Engineering: Core Qualification:			
	Process Engineering: Specialisation Environmen			
	Process Engineering: Specialisation Process Eng			
	Water and Environmental Engineering: Specialis			
	Water and Environmental Engineering: Specialis	ation Environment: Elective Compulsory		

Course L2731: Modeling of Subsurface Processes		
Тур	Recitation Section (small)	
Hrs/wk	3	
СР	3	
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42	
Lecturer	Mohammad Aziz Zarif	
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 So	Course L2728: Subsurface Solute Transport		
Тур	Lecture		
Hrs/wk	2		
СР	2		
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28		
Lecturer	Dr. Milad Aminzadeh		
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	ourse 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	Dr. Milad Aminzadeh	
Language	EN	
Cycle	WiSe	
Content	See interlocking course	
Literature	See interlocking course	

Module M0513: Syste	m Aspects of Renewable Energies			
Courses				
Title Fuel Cells, Batteries, and Gas Storage: New Materials for Energy Production and Storage (LC Energy Trading (L0019) Energy Trading (L0020)		Typ Lecture Lecture Recitation Section (small) Lecture	Hrs/wk 2 1 2	CP 2 1 1 2
Deep Geothermal Energy (L0025) Module Responsible	Prof. Martin Kaltschmitt	2000010		
Admission Requirements	None			
Recommended Previous	Module: Technical Thermodynamics I			
Knowledge	Module: Technical Thermodynamics II			
Educational Objectives	After taking part successfully, students have reached the fol	lowing learning results		
Professional Competence				
Knowledge	Students are able to describe the processes in energy trading and the design of energy markets and can critically evaluate them in relation to current subject specific problems. Furthermore, they are able to explain the basics of thermodynamics of electrochemical energy conversion in fuel cells and can establish and explain the relationship to different types of fuel cells and their respective structure. Students can compare this technology with other energy storage options. In addition, students can give an overview of the procedure and the energetic involvement of deep geothermal energy.			
Skills	Students can apply the learned knowledge of storage systems for excessive energy to explain for various energy systems different approaches to ensure a secure energy supply. In particular, they can plan and calculate domestic, commercial and industrial heating equipment using energy storage systems in an energy-efficient way and can assess them in relation to complex power systems. In this context, students can assess the potential and limits of geothermal power plants and explain their operating mode. Furthermore, the students are able to explain the 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			
Personal Competence Social Competence Autonomy	Students are able to discuss issues in the thematic fields in the renewable energy sector addressed within the module.			
	Students can independently exploit sources , acquire the particular knowledge about the subject area and transform it to new questions.			
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and .	3 hours written exam			
scale	Piccons Fortunate Constitution A. Constitution	. F. dan dan Flant a Complete		
Assignment for the Following Curricula	Bioprocess Engineering: Specialisation A - General Bioproces Aircraft Systems Engineering: Core Qualification: Elective Co		ory	
Following Curricula	International Management and Engineering: Specialisation II	, ,	nnulsory	
	International Management and Engineering: Specialisation II	3,	. ,	Compulsory
	International Management and Engineering: Specialisation II	•	•	
	Aeronautics: Core Qualification: Elective Compulsory	- · ·		• •
	Renewable Energies: Core Qualification: Compulsory			
	Theoretical Mechanical Engineering: Specialisation Energy S	ystems: Elective Compulsory		
	Process Engineering: Specialisation Environmental Process E	ngineering: Elective Compulsory		
	Process Engineering: Specialisation Process Engineering: Ele			
	Water and Environmental Engineering: Specialisation Water:			
	Water and Environmental Engineering: Specialisation Environmental	nment: Elective Compulsory		

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

Course L0019: Energy Tradin	g
Тур	Lecture
Hrs/wk	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	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 Geology and thermal aspects Rock Physical Aspects Geochemical aspects Exploration of deep geothermal reservoirs Drilling technologies, piping and expansion Borehole Geophysics Underground system characterization and reservoir engineering Microbiology and Upper-day system components Adapted investment concepts, cost and environmental aspect
Literature	 Dipippo, R.: Geothermal Power Plants: Principles, Applications, Case Studies and Environmental Impact. Butterworth Heinemann; 3rd revised edition. (29. Mai 2012) www.geo-energy.org Edenhofer et al. (eds): Renewable Energy Sources and Climate Change Mitigation; Special Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, 2012. Kaltschmitt et al. (eds): Erneuerbare Energien: Systemtechnik, Wirtschaftlichkeit, Umweltaspekte. Springer, 5. Aufl. 2013. Kaltschmitt et al. (eds): Energie aus Erdwärme. Spektrum Akademischer Verlag; Auflage: 1999 (3. September 2001) Huenges, E. (ed.): Geothermal Energy Systems: Exploration, Development, and Utilization. Wiley-VCH Verlag GmbH & Co. KGaA; Auflage: 1. Auflage (19. April 2010)

Module M0870: Mana	gement of Surface Water			
Courses				
Title		Тур	Hrs/wk	СР
Modelling of Flow in Rivers and Est	uaries (L0810)	Lecture	3	4
Nature-Oriented Hydraulic Enginee	ring / Integrated Flood Protection (L0961)	Project-/problem-based Learning	2	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous	Fundamentals of Hydromechanics, Hydraulics, Hydrology ar	nd Hydraulic Engineering; Hydra	ulic Engineerir	ng I and Hydraulic
Knowledge	Engineering II			
Educational Objectives	After taking part successfully, students have reached the follow	ving learning results		
Professional Competence				
Knowledge	Students are able to define in detail the basic processes th	at are related to the modelling of	of flows in hyd	draulic engineering.
	Besides, they can describe the basic aspects of numerical mo	delling and actual numerical mod	els for the sim	ulation of flows and
	waves. They can also depict the concepts of nature oriented hy	draulic engineering.		
Clatte	Charles and the second by the second		ala Cambbana	
SKIIIS	Students are able to apply hydrodynamic-numerical models to able to set up flood-risk management concepts and are able to			
	able to set up flood-risk management concepts and are able to	apply basic concepts of renatural	lion to practica	i problems.
Personal Competence				
Social Competence	The students are able to deploy their gained knowledge in ap	plied problems of the practical na	ture-based hy	draulic engineering.
	Additionaly, they will be able to work in team with engineers of	other disciplines.		
Autonomy	The students will be able to independently extend their knowle	dge and apply it to new problems.		
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	The duration of the examination is 150 min. The examinatio	n includes tasks with respect to	the general u	nderstanding of the
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Compulsory			
Following Curricula	Environmental Engineering: Core Qualification: Elective Compu	Isory		
	Joint European Master in Environmental Studies - Cities and Sus	stainability: Core Qualification: Co	mpulsory	
	Water and Environmental Engineering: Specialisation Water: Co	ompulsory		
	Water and Environmental Engineering: Specialisation Environm	ent: Compulsory		
	Water and Environmental Engineering: Specialisation Cities: Ele	ective Compulsory		

Course L0810: Modelling of I	
	Lecture
Hrs/wk	
СР	
	Independent Study Time 78, Study Time in Lecture 42
	Prof. Edgar Nehlsen, Prof. Peter Fröhle
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 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).
	Critical Control of the Charles 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	red Hydraulic Engineering / Integrated Flood Protection
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Natasa Manojlovic, Prof. Peter Fröhle
Language	DE/EN
Cycle	SoSe
Content	 Regime-Theory and application for the development of environmental guiding priciples of rivers Engineering - biological measures for the stabilization of rivers Risk management in flood protection Design techniques in technical flood protection Methods for the assessment of flood caused damages
Literature	Vorlesungsumdruck

Module M0874: Waste	ewater Systems			
Module Moo7 4: Wast	ewater systems			
Courses				
Title Typ Hrs/wk C				СР
Biological Wastewater Treatment (I	_0517)	Lecture	2	2
Biological Wastewater Treatment (I	_3122)	Recitation Section (large)	1	1
Advanced Wastewater Treatment (Lecture	2	2
Advanced Wastewater Treatment (Recitation Section (large)	1	1
Module Responsible	,			
	None			
Recommended Previous	Knowledge of wastewater management and the ke	y processes involved in wastewater treatm	ent.	
Knowledge				
Educational Objectives	After taking part successfully, students have reache	ed the following learning results		
Professional Competence				
Knowledge	Students are able to outline key areas of the full ra	nge of treatment systems in waste water	management, as	well as their mutual
	dependence for sustainable water protection. They	can describe relevant economic, environm	nental and social	factors.
Chille	Children and all he was desired and similar the			f that's and institute in
SKIIIS	Students are able to pre-design and explain the a	·	and the scope of	r their application in
	municipal and for some industrial treatment plants.			
Personal Competence				
Social Competence	Social skills are not targeted in this module.			
Autonomy	Students are in a position to work on a subject a	and to organize their work flow independ	ently. They can	also present on this
	subject.			
Workload in Hours	Independent Study Time 96, Study Time in Lecture	84		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	120 min			
scale				
Assignment for the	Civil Engineering: Specialisation Structural Enginee	ring: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engir	neering: Elective Compulsory		
	Civil Engineering: Specialisation Coastal Engineerin	g: Elective Compulsory		
	Civil Engineering: Specialisation Water and Traffic:	Compulsory		
	Bioprocess Engineering: Specialisation A - General	Bioprocess Engineering: Elective Compulso	ry	
	Environmental Engineering: Specialisation Water Q	uality and Water Engineering: Elective Con	npulsory	
	International Management and Engineering: Specia	lisation II. Process Engineering and Biotech	nnology: Elective	Compulsory
	International Management and Engineering: Specia	lisation II. Energy and Environmental Engir	neering: Elective	Compulsory
	Process Engineering: Specialisation Environmental	Process Engineering: Elective Compulsory		
	Process Engineering: Specialisation Process Engine	ering: Elective Compulsory		
	Water and Environmental Engineering: Specialisation	on Water: Compulsory		
	Water and Environmental Engineering: Specialisation	on Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation	on Cities: 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	

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

http://www.gbv.de/dms/weimar/toc/513989765_toc.pdf

URL:

aus der Abwasserbehandlung, Kleinkläranlagen ISBN: 3860682725 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

 $ISBN: 3527312196 \ (Gb.) \ URL: \ http://deposit.ddb.de/cgi-bin/dokserv?id=2774611\&prov=M\&dok_var=1\&dok_ext=htm-provestare for the provestar for the prove$

Weinheim: WILEY-VCH, 2007

TUB_HH_Katalog

Course L3122: Biological 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	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	dependent Study Time 32, Study Time in Lecture 28			
Lecturer	Dr. Joachim Behrendt			
Language				
Cycle	SoSe			
Content	Survey on advanced wastewater treatment			
	reuse of reclaimed municipal wastewater			
	Precipitation			
	Flocculation			
	Depth filtration			
	Membrane Processes			
	activated carbon adsorption			
	Ozonation			
	"Advanced Oxidation Processes"			
	Disinfection			
Literature	Metcalf & Eddy, Wastewater Engineering: Treatment and Reuse, McGraw-Hill, Boston 2003			
	Wassertechnologie, H.H. Hahn, Springer-Verlag, Berlin 1987			
	Membranverfahren: Grundlagen der Modul- und Anlagenauslegung, T. Melin und R. Rautenbach, Springer-Verlag, Berlin 2007			
	Trinkwasserdesinfektion: Grundlagen, Verfahren, Anlagen, Geräte, Mikrobiologie, Chlorung, Ozonung, UV-Bestrahlung, Membranfiltration, Qualitätssicherung, W. Roeske, Oldenbourg-Verlag, München 2006			
	Organische Problemstoffe in Abwässern, H. Gulyas, GFEU, Hamburg 2003			

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

Module M0875: Nexus	s Engineering - Water, Soil, Food and	Energy		
Courses				
Title		Тур	Hrs/wk	СР
Ecological Town Design - Water, En		Seminar	2	2
Water & Wastewater Systems in a	Global Context (L0939)	Lecture	2	4
Module Responsible	Prof. Ralf Otterpohl			
Admission Requirements	None			
Recommended Previous	Basic knowledge of the global situation with rising p	overty, soil degradation, migrat	tion to cities, lack of v	vater resources and
Knowledge	sanitation			
Educational Objectives	After taking part successfully, students have reached to	he following learning results		
Professional Competence				
Knowledge	Students can describe the facets of the global water sit	uation. Students can judge the e	normous potential of th	e implementation of
	synergistic systems in Water, Soil, Food and Energy su	pply.		
Skills	Students are able to design ecological settlements for	different geographic and socio-	economic conditions fo	or the main climates
	around the world.			
Personal Competence				
Social Competence	The students are able to develop a specific topic in a te	eam and to work out milestones a	according to a given pla	n.
4.4		to a construction of the stant		
Autonomy	Students are in a position to work on a subject and	to organize their work flow inde	ependently. They can a	also present on this
	subject.			
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	5		
Credit points	6			
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	During the course of the semester, the students work	towards mile stones. The work in	ncludes presentations a	and papers. Detailed
scale	information can be found at the beginning of the smest	ter in the StudIP course module h	andbook.	
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elec	tive Compulsory		
Following Curricula	Bioprocess Engineering: Specialisation A - General Biop	rocess Engineering: Elective Con	npulsory	
	Chemical and Bioprocess Engineering: Specialisation G	eneral Process Engineering: Elect	tive Compulsory	
	Environmental Engineering: Core Qualification: Elective	e Compulsory		
	Joint European Master in Environmental Studies - Cities	and Sustainability: Core Qualific	ation: Compulsory	
	Process Engineering: Specialisation Environmental Proc		ilsory	
	Process Engineering: Specialisation Process Engineerin	g: Elective Compulsory		
	Water and Environmental Engineering: Specialisation V			
	Water and Environmental Engineering: Specialisation E		/	
	Water and Environmental Engineering: Specialisation C	ities: Elective Compulsory		

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

Course L0939: Water & Wast	rewater 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)		Project-/problem-based Learning	3	3	
Water and Environment (L2753)		Lecture	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	ng learning 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	ch-Based Teaching approaches w	vill be at the core	e of this module.	
Autonomy	The students will be involved in writing individual reports an willingness to work independently and responsibly.	d presentation. This will contril	oute to the stud	dents' ability and	
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			<u> </u>	
scale					
Assignment for the	Civil Engineering: Specialisation Coastal Engineering: Elective Co	mpulsory			
Following Curricula	Civil Engineering: Specialisation Water and Traffic: Elective Comp	oulsory			
	Environmental Engineering: Specialisation Environment and Clim	ate: Elective Compulsory			
	Water and Environmental Engineering: Specialisation Cities: Elec	tive Compulsory			
	Water and Environmental Engineering: Specialisation Water: Elec	ctive Compulsory			
	Water and Environmental Engineering: Specialisation Environme	nt: Compulsory			

Course L2754: Water and En	urse 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

Linginicering				
Module M1724: Smar	t Monitoring			
Courses				
Title	Typ Hrs/wk CP			
Smart Monitoring (L2762)	Integrated Lecture 2 2			
Smart Monitoring (L2763)	Recitation Section (small) 2 4			
Module Responsible	Prof. Kay Smarsly			
Admission Requirements	None			
Recommended Previous	Basic knowledge or interest in object-oriented modeling, programming, and sensor technologies are helpful. Interest in modern			
Knowledge	research and teaching areas, such as Internet of Things, Industry 4.0 and cyber-physical systems, as well as the will to deeper			
	skills of scientific working, are required. Basic knowledge in scientific writing and good English skills.			
Educational Objectives	After taking part successfully, students have reached the following learning results			
•				
Professional Competence				
Knowieuge	The students will become familiar with the principles and practices of smart monitoring. The students will be able to design decentralized smart systems to be applied for continuous (remote) monitoring of systems in the built and in the natura			
	environment. In addition, the students will learn to design and to implement intelligent sensor systems using state-of-the-art data			
	analysis techniques, modern software design concepts, and embedded computing methodologies. Besides lectures, project work			
	also part of this module, which will be conducted throughout the semester and will contribute to the grade. In small groups, the			
	students will design smart monitoring systems that integrate a number of "intelligent" sensors to be implemented by the students			
	Specific focus will be put on the application of machine learning techniques. The smart monitoring systems will be mounted or			
	real-world (built or natural) systems, such as bridges or slopes, or on scaled lab structures for validation purposes. The outcome of			
	every group will be documented in a paper. All students of this module will "automatically" participate with their smart monitoring			
	system in the annual "Smart Monitoring" competition. The written papers and oral examinations form the final grades. The module			
	will be taught in English. Limited enrollment.			
Skills	The students will gain insights into operating state-of-the-art smart sensor systems, used for monitoring a wide range of physica			
Skills	processes relevant to engineering, such as environmental, structural, or comfort monitoring. The students will be capable o			
	devising monitoring strategies of physical processes as part of group projects, tailored to their knowledge backgrounds, and to			
	implement the strategies in smart wireless sensor nodes, using embedded computing and programming. Finally, the students wil			
	be able to document the findings of their projects in short reports.			
Personal Competence				
Social Competence	The students will be able to work in groups, share parts of the work for their projects, and develop communication skills, towards			
	achieving the common project goals.			
Autonomy	The students will be able to gain a solid basis on approaching and solving problems in engineering, as well as on documenting			
	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			
Examination duration and	10 pages of work with 15-minute oral presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory			
	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory			
	Computer Science: Specialisation II: Intelligence Engineering: Elective Compulsory			
	Environmental Engineering: Specialisation Energy and Resources: Elective Compulsory			
	Environmental Engineering: Specialisation Environment and Climate: Elective Compulsory			
	Environmental Engineering: Specialisation Water Quality and Water Engineering: Elective Compulsory			
	Mechatronics: Technical Complementary Course: Elective Compulsory			
	Mechatronics: Core Qualification: Elective Compulsory Theoretical Mechanical Engineering: Consideration Reports and Computer Science: Floative Computer Computer Science: Floative Computer Computer Science: Floative Computer Science: Flo			
	Theoretical Mechanical Engineering: Specialisation Robotics and Computer Science: Elective Compulsory Water and Environmental Engineering: Specialisation Cities: Elective Compulsory			
	Water and Environmental Engineering: Specialisation Cities: Elective Compulsory Water and Environmental Engineering: Specialisation Environment: Elective Compulsory			
	Water and Environmental Engineering: Specialisation Water: Elective Compulsory			

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

Module M0858: Coast	al Hydraulic Engineering I			
Courses				
Title		Тур	Hrs/wk	СР
Basics of Coastal Engineering (L0807)		Lecture	3	4
Basics of Coastal Engineering (L14:	13)	Project-/problem-based Learning	1	2
Module Responsible	Prof. Peter Fröhle			
Admission Requirements	None			
Recommended Previous	Basics of hydraulic engineering, hydrology and hydromec	hanics		
Knowledge				
Educational Objectives	After taking part successfully, students have reached the	following 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			ey are able to apply
	the concepts to selected practical problems of coastal er	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 approache	es to selected and pre-defined design ta	isks in coastal (angineering
SKIIIS	The students are capable to apply basic design approach	es to selected and pre-defined design to	isks iii coustai (engineering.
Personal Competence				
Social Competence	The students are able to deploy their gained knowledge	in applied problems such as the desig	n of coastal pr	otection structures.
	Additionaly, they will be able to work in team with engine	ers of other disciplines, for instance des	igning of coast	al breakwaters.
Autonomy	The students will be able to independently extend their k	nowledge and applyit 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. The exami	nation includes tasks with respect to	the general un	derstanding of the
scale	lecture contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Coastal Engineering: Con	npulsory		
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering	g: Compulsory		
	Civil Engineering: Specialisation Structural Engineering: E	lective Compulsory		
	Environmental Engineering: Specialisation Environment a	nd Climate: Elective Compulsory		
	Environmental Engineering: Specialisation Water Quality	and Water Engineering: Elective Compu	Isory	
	International Management and Engineering: Specialisation	n II. Civil Engineering: Elective Compuls	ory	
	Water and Environmental Engineering: Specialisation Env	ironment: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Wat	er: Elective Compulsory		

Course L0807: Basics of Coas	stal 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 Functional and constructional design Determination of design parameters Design-approaches Filter Rubble mound constructions Piles Vertical constructions
Literature	Coastal Engineering Manual, CEM
	Vorlesungsumdruck

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

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	

Lighteering				
Module M1878: Susta	inable energy from wind and wat	er		
Courses				
Title		Тур	Hrs/wk	СР
Offshore Geotechnical Engineering (L0067)		Lecture	1	1
Hydro Power Use (L0013)		Lecture	1	1
Wind Turbine Plants (L0011) Wind Energy Use - Focus Offshore (L0012)		Lecture Lecture	2 1	3 1
	Dr. Marvin Scherzinger	Ecctoric		
Admission Requirements	None			
Recommended Previous	Module: Technical Thermodynamics I,			
Knowledge	Module: Technical Thermodynamics II,			
	Module: Fundamentals of Fluid Mechanics			
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence	Arter taking part successionly, stadents have reactice are following rearring results			
Knowledge	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 able to describe fundamentally the use of water power to generate electricity. The students reproduce and explain the basic procedur in the implementation of renewable energy projects in countries outside Europe.			
	Through active discussions of various topics w application of the theoretical background and are			derstanding and th
Skills	Students are able to apply the acquired theoretical foundations on exemplary water or wind power systems and evaluate an 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-spec	ificly and multidisciplinary within a se	minar.	
Autonomy	Students can independently exploit sources in lecture and to acquire the particular knowledge a	· ·	ecture material to clear	the contents of th
Workload in Hours	Independent Study Time 110, Study Time in Lect	cure 70		
Credit points	6			
Course achievement	None			
Examination	Written exam			
Examination duration and	180 min			
scale				
	Civil Engineering: Specialisation Structural Engin			
Following Curricula				
	Civil Engineering: Specialisation Coastal Enginee	ring: Elective Compulsory		
International Management and Engineering: Specialisation II. Energy and Environmental Engineering: Elective Con				
	International Management and Engineering Con-	• •	-	Compulsory
	International Management and Engineering: Spe-	cialisation II. Renewable Energy: Electi	ve Compulsory	Compulsory
	Product Development, Materials and Production:	cialisation II. Renewable Energy: Electi Specialisation Product Development: I	ve Compulsory Elective Compulsory	Compulsory
	Product Development, Materials and Production: Product Development, Materials and Production:	cialisation II. Renewable Energy: Electi Specialisation Product Development: I Specialisation Production: Elective Col	ve Compulsory Elective Compulsory mpulsory	Compulsory
	Product Development, Materials and Production:	cialisation II. Renewable Energy: Electi Specialisation Product Development: I Specialisation Production: Elective Con Specialisation Materials: Elective Com	ve Compulsory Elective Compulsory mpulsory	Compulsory
	Product Development, Materials and Production: Product Development, Materials and Production: Product Development, Materials and Production:	cialisation II. Renewable Energy: Electi Specialisation Product Development: I Specialisation Production: Elective Con Specialisation Materials: Elective Com sory	ve Compulsory Elective Compulsory mpulsory pulsory	Compulsory
	Product Development, Materials and Production: Product Development, Materials and Production: Product Development, Materials and Production: Renewable Energies: Core Qualification: Compuls	cialisation II. Renewable Energy: Electi Specialisation Product Development: I Specialisation Production: Elective Con Specialisation Materials: Elective Com sory on Energy Systems: Elective Compulso	ve Compulsory Elective Compulsory mpulsory pulsory	Compulsory
	Product Development, Materials and Production: Product Development, Materials and Production: Product Development, Materials and Production: Renewable Energies: Core Qualification: Compuls Theoretical Mechanical Engineering: Specialisation	cialisation II. Renewable Energy: Electi Specialisation Product Development: I Specialisation Production: Elective Con Specialisation Materials: Elective Com sory on Energy Systems: Elective Compulso al Process Engineering: Elective Comp	ve Compulsory Elective Compulsory mpulsory pulsory	Compulsory
	Product Development, Materials and Production: Product Development, Materials and Production: Product Development, Materials and Production: Renewable Energies: Core Qualification: Compuls Theoretical Mechanical Engineering: Specialisation Process Engineering: Specialisation Environment	cialisation II. Renewable Energy: Electi Specialisation Product Development: I Specialisation Production: Elective Con Specialisation Materials: Elective Com sory on Energy Systems: Elective Compulso al Process Engineering: Elective Comp ation Cities: Elective Compulsory ation Environment: Elective Compulsor	ve Compulsory Elective Compulsory mpulsory pulsory ry ulsory	Compulsory

Course L0067: Offshore Geotechnical 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			
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 Typ	Lecture	
Hrs/wk		
CP		
	Independent Study Time 16, Study Time in Lecture 14	
	Prof. Martin Skiba	
Language		
Cycle	SoSe	
Content	 Introduction, importance of offshore wind power generation, Specific requirements for offshore engineering Physical fundamentals for utilization of wind energy Design and operation of offshore wind turbines, presentation of different concepts of offshore wind turbines, representation of the individual system components and their system-technical relationships Foundation engineering, offshore site investigation, presentation of different concepts of offshore foundation structures, planning and fabrication of foundation structures Electrical infrastructure of an offshore wind farm, Inner Park cabling, offshore substation, grid connection Installation of offshore wind farms, installation techniques and auxiliary devices, construction logistics Development and planning of offshore wind farms Operation and optimization of offshore wind farms Day excursion 	
Literature	 Gasch, R.; Twele, J.: Windkraftanlagen - Grundlagen, Entwurf, Planung und Betrieb; Vieweg + Teubner, Stuttgart, 2007, 7. Auflage Molly, J. P.: Windenergie - Theorie, Anwendung, Messung; C. F. Müller, Heidel-berg, 1997, 3. Auflage Hau, E.: Windkraftanalagen; Springer, Berlin, Heidelberg, 2008, 4.Auflage Heier, S.: Windkraftanlagen - Systemauslegung, Integration und Regelung; Vieweg + Teubner, Stuttgart, 2009, 5. Auflage Jarass, L.; Obermair, G.M.; Voigt, W.: Windenergie: Zuverlässige Integration in die Energieversorgung; Springer, Berlin, Heidelberg, 2009, 2. Auflage 	

Liigiileeiiiig				
Module M0827: Modeling in Water Management				
Courses				
Title Groundwater Modeling using Modflow (L0543) Groundwater Modeling using Modflow (L0544)		Typ Lecture Recitation Section (small)	Hrs/wk 1 2	CP 1 2 3
	See All Control of the Control of th			3
Module Responsible				
Admission Requirements Recommended Previous Knowledge	Groundwater			
	 groundwater hydraulics and transport of substances 			
	Pipe Systems			
	 Knowledge on urban water infrastructures, in particula 	ar drinking water systemsand u	rban drainage	e systems including
	special structures			
	Hydraulics of drinking water supply systems and sewer systems.	ystems		
	Basic knowledge on water management			
Educational Objectives	After taking part successfully, students have reached the follow	ing 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 can carry out systems analyses and can detect technical and conceptual weak points within the systems in case studies. Besides they are able to analyse interdependencies of hydraulic and toxic 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				
	Wird nicht vermittelt.			
	Wird nicht vermittelt.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70			
	6			
Course achievement	None			
Examination				
Examination duration and				
scale				
Assignment for the Following Curricula	Civil Engineering: Specialisation Structural Engineering: Elective Civil Engineering: Specialisation Geotechnical Engineering: Elective Civil Engineering: Specialisation Coastal Engineering: Elective Civil Engineering: Specialisation Water and Traffic: Elective Com	tive Compulsory compulsory		
	Civil Engineering: Specialisation Computational Engineering: Ele	ective Compulsory		
	Water and Environmental Engineering: Specialisation Environme	ent: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Cities: Ele	• •		
	Water and Environmental Engineering: Specialisation Water: Ele	ective 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 wor	
	with the model PMWIN for practical case studies.	
Literature	MODFLOW-Handbuch	
	Chiang, Wen Hsien: PMWIN	

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

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

ourse L0875: Modeling of Water Supply 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 M0871: Hydro	ological Systems			
Courses				
Title		Тур	Hrs/wk	СР
Applied Surface Hydrology (L0289)		Lecture	2	2
.,	oplied Surface Hydrology (L1412) Project-/problem-based Learning 1 2			
Interaction Water - Environment in		Project-/problem-based Learning	1	2
Module Responsible				
Admission Requirements				
	Fundamentals of Hydromechanics and Hydraulic	Engineering: Hydraulic Engineering I and Hydra	ulic Engineeri	ng II
Knowledge				
	After taking part successfully, students have rea	iched the following learning results		
Professional Competence				
Knowledge	The students are able to define the basic conce			
		r cycle. Besides, the students know the main asp	ects of rainfa	II-run-off-models and
	are able to theoretically derive established rese	rvoir / storage models and a unit-hydrograph.		
Skills	The students are able to use the basic hydrol	ogical concepts and approaches and are able t	o theoretical	v derive established
		as the basis for rainfall-run-off-models. The stu		•
		hydrodynamic values in nature and are able to		·
		are able to apply a hydrological model to basic h	•	
Personal Competence				
Social Competence	The students are able to deploy their gained known	owledge in applied problems of the hydrology and	d water mana	gement. Additionaly,
	they will be able to work in team with engineers	· ·		
Autonomy	The students will be able to independently exter	nd their knowledge and apply it to new problems		
Workload in Hours	Independent Study Time 124, Study Time in Lec	ture 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	tanding of the lecture
scale	contents and calculations tasks.			
Assignment for the	Civil Engineering: Specialisation Computational	Engineering: Elective Compulsory		
Following Curricula	Civil Engineering: Specialisation Water and Traff	ic: Compulsory		
	Environmental Engineering: Core Qualification: I	Elective Compulsory		
	Joint European Master in Environmental Studies	- Cities and Sustainability: Core Qualification: Co	mpulsory	
	Water and Environmental Engineering: Specialis	ation Cities: Elective Compulsory		
	Water and Environmental Engineering: Specialis	ation Environment: Elective Compulsory		
	Water and Environmental Engineering: Specialis	ation Water: Elective Compulsory		

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

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

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

Module M2032: Advar	nced Vadose Zone Hydrology				
Courses					
Title	- (12725)		yp	Hrs/wk	СР
Modeling Processes in Vadose Zone Vadose Zone Hydrology (L2732)	e (L2/35)		ecitation Section (small) ecture	2	2
Vadose Zone Hydrology (L2733)			ecitation Section (large)	2	2
Module Responsible	Prof. Nima Shokri				
Admission Requirements					
Recommended Previous	Basic knowledge in water and soil				
Knowledge	j ,				
	Comfortable with math and physics, critical	thinking, creative prob	lem solving		
	Analytic skills				
Educational Objectives	After taking part successfully, students hav	e reached the following	learning results		
Professional Competence					
Knowledge	The students will learn about soil charac	cterization (solid and	iquid phase), the energy	state of soil w	ater, the soil water
	characteristic curve, flow in saturated and u	unsaturated soil as well	as about solute transport i	n soil	
Skills	Students will work on practical examples	s modelling transport	processes in soil using of	lifferent quantita	ative tools including
	computer simulations and analytical tools.	This will help them to ap	oply knowledge in order to	solve problems a	nd tasks.
Personal Competence					
Social Competence	The module aims at raising awareness a	nd enthusiasm for nev	knowledge related to wa	ater, soil and en	vironment. This will
	positively contribute to shape their work an	d life environment.			
Autonomy	The students will be involved in many	problem solving exer	cises. This will contribute	e toward their	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	Written elaboration				
Examination duration and	Report and Presentation				
scale					
Assignment for the	Civil Engineering: Specialisation Computation	onal Engineering: Electi	ve Compulsory		
Following Curricula	Civil Engineering: Specialisation Water and	Traffic: Elective Compu	Isory		
	Environmental Engineering: Core Qualificati	·			
	Water and Environmental Engineering: Spec				
	Water and Environmental Engineering: Spec	cialisation Environment	Elective Compulsory		

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 M0802: Memb	orane Technology			
Courses				
Title		Тур	Hrs/wk	СР
Membrane Technology (L0399)		Lecture	2	3
Membrane Technology (L0400)		Recitation Section (small)	1	2
Membrane Technology (L0401)		Practical Course	1	1
Module Responsible	Prof. Mathias Ernst			
Admission Requirements	None			
Recommended Previous	Basic knowledge of water chemistry. Knowledge of the	core processes involved in water, gas a	and steam treatr	nent
Knowledge				
Educational Objectives	After taking part successfully, students have reached th	ne following learning results		
Professional Competence				
Knowledge	Students will be able to rank the technical applications	of industrially important membrane pr	ocesses. They w	rill be able to explai
	the different driving forces behind existing membrane	e separation processes. Students will	be able to nam	ne materials used in
	membrane filtration and their advantages and disadva	antages. Students will be able to expl	ain the key diffe	rences in the use o
	membranes in water, other liquid media, gases and in li	quid/gas mixtures.		
Skille	Students will be able to prepare mathematical equation	one for material transport in porque ar	nd colution diffus	ion membranes and
Skills	calculate key parameters in the membrane separation			
	available boundary data and provide recommendation			
	experiments, students will be able to classify the se			
	membrane materials. Students will be able to character			
	measures to control this.	ise the formation of the fouring layer in	ramerene water.	s and apply teemine
Personal Competence				
Social Competence	Students will be able to work in diverse teams on tasks	s in the field of membrane technology.	They will be ab	e to make decision
	within their group on laboratory experiments to be unde	ertaken jointly and present these to oth	ners.	
Autonomy	Students will be in a position to solve homework on t	he tonic of membrane technology inc	lenendently The	v will be canable o
Autonomy	finding creative solutions to technical questions.	ne topic of membrane technology inc	терепиститу. Тпе	y will be capable o
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56			
Credit points				
Course achievement				
Examination	Written exam			
Examination duration and	90 min			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elec			
Following Curricula	Bioprocess Engineering: Specialisation A - General Biop			
	Bioprocess Engineering: Specialisation B - Industrial Bio			
	Chemical and Bioprocess Engineering: Specialisation Ge			
	Chemical and Bioprocess Engineering: Specialisation Ch	• •		
	Chemical and Bioprocess Engineering: Technical Compl			
	Chemical and Bioprocess Engineering: Technical Compl	, , ,		
	Environmental Engineering: Specialisation Water Qualit	, , , , , , , , , , , , , , , , , , , ,	ipuisory	
	Process Engineering: Specialisation Process Engineering			
	Process Engineering: Specialisation Environmental Proc			
	Water and Environmental Engineering: Specialisation W	·		
	Water and Environmental Engineering: Specialisation En			
	Water and Environmental Engineering: Specialisation C	ues: 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	ourse L0400: Membrane Technology		
Тур	Recitation Section (small)		
Hrs/wk	1		
СР	2		
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14		
Lecturer	Prof. Mathias Ernst		
Language	EN		
Cycle	WiSe		
Content	See interlocking course		
Literature	See interlocking course		

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

Module M0822: Proce	ss Modeling in Water Technology			
Courses				
Title Process Modelling of Wastewater Treatment (L0522) Process Modeling in Drinking Water Treatment (L0314)		Typ Project-/problem-based Learning Project-/problem-based Learning	Hrs/wk 2 2	CP 3 3
Module Responsible		,,		
Admission Requirements	•			
Recommended Previous Knowledge		g water and waste water treatment.		
Educational Objectives	After taking part successfully, students have reached t	he following learning results		
-	Students are able to explain selected processes of dr basics as well as possibilities and limitations of dynami	c modeling.		·
Skills	Students are able to use the most important features Modelica offers. They are able to transpose selected processes in drinking water and waste water treatment into a mathematical model in Modelica with respect to equilibrium, kinetics and mass balances. They are able to set up and apply models and assess their possibilities and limitations.			
Personal Competence Social Competence	able to give appropriate feedback and can work constr	uctively with feedback concerning their wo		ackground. They are
Autonomy	Students are able to define a problem, gain the require	ed knowledge and set up a model.		
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56	5		
Credit points	6			
Course achievement	None			
Examination	Oral exam			
Examination duration and scale	30 min			
Assignment for the	Civil Engineering: Specialisation Water and Traffic: Elec	ctive Compulsory		
Following Curricula	Chemical and Bioprocess Engineering: Technical Comp	lementary Course: Elective Compulsory		
	Chemical and Bioprocess Engineering: Technical Comp			
	Environmental Engineering: Specialisation Water Quali		lsory	
	Process Engineering: Specialisation Environmental Proc			
	Process Engineering: Specialisation Process Engineerin	• • •		
	Water and Environmental Engineering: Specialisation V			
	Water and Environmental Engineering: Specialisation E	• •		
	Water and Environmental Engineering: Specialisation C	Lities: Elective Compulsory		

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

Course L0314: Process Mode	ling in Drinking Water Treatment
Тур	Project-/problem-based Learning
Hrs/wk	2
СР	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dr. Klaus Johannsen
Language	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 M1123: Selec	ted Topics in Environmental E	ingineering		
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	ration (L3270)	Integrated Lecture	3	3
Sludge Treatment (L0520)		Lecture	2	3
Special topics of the Environmental			1	1
Special topics of the Environmental			2	2
Special topics of the Environmental			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 reached the following learning results			
Professional Competence				
Knowledge				
Skills				
Personal Competence				
Social Competence				
Autonomy				
	Depends on choice of courses			
Credit points	6			
Assignment for the	Environmental Engineering: Core Qualificat	ion: Elective Compulsory		
-	Water and Environmental Engineering: Spe	· · ·		
J	Water and Environmental Engineering: Spe	cialisation Environment: Elective Compulsory		
	Water and Environmental Engineering: Spe			

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Course L1444: Environmenta	
	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 I	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

ourse L3270: Sustainable la	ndfill 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
	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.
	 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

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 Bioma	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
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 assume is about the second of fellows.
	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
	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 M1720: Emerging Trends in Environmental Engineering				
Courses				
Title		Тур	Hrs/wk	СР
Environmental Research Trends (L2	2752)	Seminar	2	2
Microplastics in Environment (L275	50)	Lecture	2	2
Scientific Communication and Meth	nods (L2751)	Lecture	1	2
Module Responsible	Prof. Nima Shokri			
Admission Requirements	None			
Recommended Previous	Basic knowledge on water, soil and environment	al research.		
Knowledge				
Educational Objectives	After taking part successfully, students have rea	ched the following learning results		
Professional Competence				
Knowledge	The students will be exposed to up-to-date rese	arch topics focused on soil, water and	climate related challeng	ges with a particular
	focus on the effects of microplastics in environ	ment. Data analysis, data measureme	nt, curation and preser	ntation will be other
	skills that the students will develop in this modul	e.		
Skille	Students' research skills will be improved in thi	s module. How to prepare and deliver	an effective presentati	on how to write an
Skills	abstract, research paper and proposal will be di	· ·	·	
	the students will be exposed to current research		ough Nesearch-Daseu Le	earning approaches,
	the students will be exposed to current research	trends in environmental engineering.		
Dorgonal Competence				
Personal Competence	Developing the state of the sta	the state of Providence of Table 1		611.5 1 1.
Social Competence	Developing teamwork and problem solving skills	through Research-Based Teaching app	oroacnes will be at the co	ore of this module.
Autonomy	The students will be involved in writing indivi	dual reports and presentation. This v	vill contribute to the s	tudents' ability and
_	willingness to work independently and responsib	ly.		,
Workload in Hours	Independent Study Time 110, Study Time in Lect	cure 70		
Credit points				
Course achievement	None			
Examination	Subject theoretical and practical work			
Examination duration and	Report and Presentation			
scale				
Assignment for the	Civil Engineering: Specialisation Water and Traffi	c: Elective Compulsory		
Following Curricula	Environmental Engineering: Specialisation Enviro	onment and Climate: Elective Compulso	ory	
	Water and Environmental Engineering: Specialisa	ation Cities: Elective Compulsory		
	Water and Environmental Engineering: Specialisa	ation Environment: Elective Compulsor	y	
	Water and Environmental Engineering: Specialisa	ation Water: Elective Compulsory		

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

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

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

Module M1779: Susta	ainable Nature-based Coastal Protection in a Changing Climat	e (SeaPiaC	c)
Courses			
Title Sustainable Nature-based Coastal	Typ I Protection in a Changing Climate (SeaPiaC) (L2926) Project-/problem-based Lea	Hrs/wk	CP 6
Module Responsible	Prof. Peter Fröhle		
Admission Requirements	s None		
Recommended Previous Knowledge	Hydraulic Engineering		
Educational Objectives	s After taking part successfully, students have reached the following learning results		
Professional Competence Knowledge	Climate and Climate Change General Impacts of Climate Change on Wind Regime and Water Cycle Consequences of Climate Change for Coastal Processes Coastal Protection in Taiwan and Germany Fundamentals of Climate Adaptation Nature-based Solutions (NBS) for Coastal Protection Critical thinking: analysis of processes and relations, assessment of needs for action		
Personal Competence	 Creative thinking: development of adaptation strategies and adaptation measures Practical thinking: inclusion of restrictions, application of calculation approaches methods Consideration of complex tasks 	. methods, nur	merical models, planning
Social Competence	Working in heterogenous groups Working in international 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	s Independent Study Time 124, Study Time in Lecture 56		
Credit points	s 6		
Course achievement	t None		
Examination			
	d Preparation of a written report on a complex task with a presentation and subsequent di	scussion. The v	vork on the complex task
	happens in the course of the lecture.		
Assignment for the			
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering: Elective Compulsory Civil Engineering: Specialisation Structural Engineering: Elective Compulsory		
	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory Civil Engineering: Specialisation Water and Traffic: Elective Compulsory		
	Environmental Engineering: Specialisation Environment and Climate: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Cities: Elective Compulsory		
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory Water and Environmental Engineering: Specialisation Water: Elective Compulsory		

Course L2926: Sustainable N	lature-based Coastal Protection in a Changing Climate (SeaPiaC)				
Тур	Project-/problem-based Learning				
Hrs/wk					
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	
itle	Typ Hrs/wk CP
daptation to climate change in hy	
Module Responsible	Prof. Peter Fröhle
Admission Requirements	None
Recommended Previous	
Knowledge	Hydrology, Hydraulic Engineering
	Hydromechanic, Hydraulics Fundamentals of Constal Engineering Constal and Flood Bratastics
	 Fundamentals of Coastal Engineering, Coastal- and Flood Protection Hydrological Systems
	• Hydrological Systems
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	a Climate protection and climate adaptation
	 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
Skills	Critical thinking: analysis of processes and relations, assessment of needs for action
	Creative thinking: development of adaptation strategies and adaptation measures
	Practical thinking: inclusion of restrictions, application of calculation approaches, methods, numerical models, plant
	methods
	Consideration of complex tasks
Barranal Carranton	
Personal Competence	
Social Competence	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	
Course achievement	None
Examination	Written elaboration
Examination duration and	Preparation of a written report and a presentation of a complex task.
scale	
Assignment for the	Civil Engineering: Specialisation Coastal Engineering: Elective Compulsory
Following Curricula	
-	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory
	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory
	Water and Environmental Engineering: Specialisation Cities: Elective Compulsory
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory
	Water and Environmental Engineering: Specialisation Water: Elective Compulsory

Course L2291: Adaptation to	climate change in hydraulic engineering			
Тур	Project-/problem-based Learning			
Hrs/wk				
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 M0859: Coast	al Hydraulic Engineering II				
Courses					
Title		Тур	Hrs/wk	СР	
Coastal- and Flood Protection (L080	08)	Lecture	2	3	
Coastal- and Flood Protection (L14:		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 reache	d the following learning results			
Professional Competence					
Knowledge	The students have the capability to define and exp	plain in detail the important aspects of erosic	on protection	and flood protection	
	and are able to apply the aspects to practical co-	astal protection problems. They are able to	design and	dimension important	
	coastal protection measures from the functional and	from the constructional point of view.			
Skills	The students are able to select design approaches	s for the functional and constructional deci-	n of orosion	and flood protection	
Skilis	The students are able to select design approaches measures and apply these approaches to practical of		gir or erosion	and nood protection	
	Theasures and apply these approaches to practical t	design tasks.			
Personal Competence					
Social Competence	The students are able to deploy their gained know	vledge in applied problems such as the fund	ctional and co	onstructive design of	
	coastal and flood protection structures. Additionaly,	they will be able to work in team with engine	eers of other d	lisciplines.	
Autonomy	The students will be able to independently extend the	heir knowledge and apply it to new problems.			
Workload in Hours	Independent Study Time 110, Study Time in Lecture	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 min. The	examination includes tasks with respect to	the general ι	inderstanding of the	
scale	lecture contents and calculations tasks.				
Assignment for the	Civil Engineering: Specialisation Coastal Engineering	g: Compulsory			
Following Curricula	Civil Engineering: Specialisation Geotechnical Engin	eering: Elective Compulsory			
	Civil Engineering: Specialisation Structural Engineer	ing: Elective Compulsory			
	Environmental Engineering: Specialisation Environm	nent and Climate: Elective Compulsory			
	Environmental Engineering: Specialisation Water Qu	uality and Water Engineering: Elective Compu	ılsory		
	Water and Environmental Engineering: Specialisatio	n Environment: Elective Compulsory			
	Water and Environmental Engineering: Specialisatio	n Water: Elective Compulsory			

Course L0808: Coastal- and Flood Protection					
Тур	Lecture				
Hrs/wk	2				
СР					
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				
	Callingah burganah				
	Sediment transportMorphology				
	Technical solution for the protection of sandy coasts				
	Construction in direction of the coast				
	Constructions perpendicular to the coast				
	Constructions perpendicular to the coast Other Concepst				
	Calculation approaches and numerical models				
	ood Protection				
	Classification of constructions / measures				
	• Dikes				
	• Dunes				
	Foreland - constructions				
	Flood-Protection Walls				
	Drainage of the hinterland				
Literature	Vorlesungsumdruck				
	Coastal Engineering Manual CEM				

Course L1415: Coastal- and 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 M2014: Study	y Work Specialisation Water			
Courses				
Title	Typ Hrs/wk CP			
Module Responsible	Dozenten des SD B			
Admission Requirements	None			
Recommended Previous				
Knowledge				
Educational Objectives	After taking part successfully, students have reached the following learning results			
Professional Competence				
Knowledge	The students are able to demonstrate their detailed knowledge in the field of Water and Environmental Engineering. They can exemplify the state of technology and application and discuss critically in the context of actual problems and general conditions of science and society.			
	The students can develop solving strategies and approaches for fundamental and practical problems in the field of Water and Environmental Engineering. They may apply theory based procedures and integrate safety-related, ecological, ethical, and economic view points of science and society.			
	Scientific work techniques that are used can be described and critically reviewed.			
Skills	The students are able to independently select methods or planning approaches for the project work and to justify their choice. They can explain how these methods or approaches relate to solutions in the field of work and how the context of application has to be adjusted. General findings and further developments may essentially be outlined.			
Personal Competence				
Social Competence	The students are able to condense the relevance and the structure of the project work, the work steps and the sub-problems fo the presentation and discussion in front of a bigger group. They can lead the discussion and give a feedback on the project to thei colleagues.			
Autonomy	The students are capable of independently planning and documenting the work steps and procedures while considering the given deadlines. This includes the ability to accurately procure the newest scientific information. Furthermore, they can obtain feedback from experts with regard to the progress of the work, and to accomplish results on the state of the art in science and technology.			
Workload in Hours	Independent Study Time 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				

Module M2076: Introd	duction to Climate Informed Engin	neering			
Courses					
Title		Тур	Hrs/wk	СР	
Methods in Climate Informed Engineering (L3347)		Lecture	3	3	
Topics in Climate Informed Enginee	ering (L3348)	Lecture	3	3	
Module Responsible	Prof. Nima Shokri				
Admission Requirements	None				
Recommended Previous	Students are expected to have a foundational	understanding of environmental scien	nce, basic engineerin	g principles, and an	
Knowledge	interest in sustainability. Recommended knowled	ge includes climate science, data analy	rsis, and familiarity wit	th engineering design	
	processes. Analytical and critical thinking and cre	eative problem-solving skills are also be	neficial		
Educational Objectives	After taking part successfully, students have read	thed the following learning results			
Professional Competence					
Knowledge	This module explores next-generation climate m	nodels and high-resolution data, empha	asizing their impact o	n environmental and	
	engineering products and processes. It covers ho	w various engineering disciplines can b	enefit from climate in	formation. Research-	
	based learning activities, expert talks, and pres	sentations will expose students to state	te-of-the-art modeling	, measurement, and	
	analysis in climate-informed engineering.				
Skille	Climate data analysis, engineering adaptation	n strategies problem-solving reseau	rch-hased learning	and interdisciplinary	
Skiiis	collaboration.	in strategies, problem-solving, resear	ren-basea rearring,	and interdiscipiniary	
	Collaboration.				
Personal Competence					
Social Competence	Collaboration, interdisciplinary teamwork, comm	nunication skills, problem-solving, ethi	cal responsibility, and	d decision-making in	
	climate-resilient engineering.				
Autonomy	Time management, self-directed learning, critic	cal thinking, accountability, initiative,	and the ability to c	conduct independent	
,	research and make informed decisions in climate	•	,		
Workload in Hours	Independent Study Time 96, Study Time in Lectur	re 84			
Credit points					
Course achievement	None				
Examination					
Examination duration and	Report and Presentation				
scale		to Flority Constitution			
Assignment for the	Civil Engineering: Specialisation Coastal Engineer				
Following Curricula	Civil Engineering: Specialisation Geotechnical Engineering:				
	Civil Engineering: Specialisation Structural Engine				
	Civil Engineering: Specialisation Water and Traffic Civil Engineering: Specialisation Computational E				
	Data Science: Specialisation III. Applications: Elec				
	Environmental Engineering: Core Qualification: El				
	Process Engineering: Specialisation Process Engin	• •			
	Water and Environmental Engineering: Specialisa				
	Water and Environmental Engineering: Specialisation Environment: Elective Compulsory				
	Water and Environmental Engineering: Specialisa	tion Water: Elective Compulsory			

Course L3347: Methods in Cl	imate Informed Engineering
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Nima Shokri, Prof. Cathy Hohenegger, Prof. Irina Smirnova
Language	EN
Cycle	WiSe
	Students will learn techniques for incorporating climate data and environmental factors into engineering design. It covers climate modelling and the use of sensors and devices to measure climate-related parameters and engineering processes. Students will have the opportunity to conduct their own measurements, analyze the collected data, and write a report on their findings. This hands-on experience will be assessed and contribute to their final grade.
Literature	

Course L3348: Topics in Clim	ate Informed Engineering
Тур	Lecture
Hrs/wk	3
СР	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Irina Smirnova, Prof. Cathy Hohenegger, Prof. Nima Shokri
Language	EN
Cycle	WiSe
Content	Exploring specific applications of climate data in various engineering disciplines. Invited speakers will present their research and discuss the relevance of climate-informed engineering to their work. Additionally, there will be a segment on effective communication, covering how to give impactful presentations and write research papers. Students will also give presentations on their own class projects related to climate-informed engineering, applying the concepts they've learned. This hands-on experience will be assessed and contribute to their final grade.
Literature	

Engineering"	
Module M2156: Wate	er Protection
Courses	
Title	Typ Hrs/wk CP
Vater Protection (L3459)	Typ Hrs/wk CP Integrated Lecture 6 6
Module Responsible	
Admission Requirements	· · · · · · · · · · · · · · · · · · ·
Recommended Previous	
Knowledge	Basic knowledge in water management:
	Good knowledge in urban drainage;
	Good knowledge of wastewater treatment techniques;
	Good knowledge of pollutants (e.g. COD, BOD, TS, N, P) and their properties;
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students can describe the basic principles of the regulatory framework related to the international and European water sector
	They can explain limnological processes, substance cycles and water morphology in detail. They are able to assess complete
	problems related to water protection, such as ecosystem service and wastewater treatment with a special focus on innovative
	solutions, remediation measures as well as conceptual approaches.
Skills	Students can accurately assess current problems and situations in a country-specific or local context. They can suggest concre
	actions to contribute to the planning of tomorrow's urban water cycle. Furthermore, they can suggest appropriate technical
	administrative and legislative solutions to solve these problems.
Personal Competence	
Social Competence	The students can work together in international groups.
Autonomy	Students are able to organize their work flow to prepare presentations and discussions. They can acquire appropriate knowledge
ŕ	by making enquiries independently.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	
Course achievement	
	Yes 20 % Presentation 10-minütige Präsentation von Arbeitsergebnissen
Examination	Written exam
Examination duration and	150 minutes
scale	
Assignment for the	
Following Curricula	
	Civil Engineering: Specialisation Structural Engineering: Elective Compulsory
	Civil Engineering: Specialisation Water and Traffic: Elective Compulsory
	Environmental Engineering: Specialisation Water Quality and Water Engineering: Elective Compulsors
	Environmental Engineering: Specialisation Water Quality and Water Engineering: Elective Compulsory
	International Management and Engineering: Specialisation II. Civil Engineering: Elective Compulsory

Course L3459: Water Protection	
Тур	Integrated Lecture
Hrs/wk	6
СР	6
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Lecturer	Prof. Simon Michael Papalexiou
Language	EN
Cycle	WiSe
Content	
Literature	

Module M2155: Unce	rtainty Modellin	g for Engine	ers			
Courses						
Title				Тур	Hrs/wk	СР
Uncertainty Modelling for Engineer	1			Integrated Lecture	6	6
Module Responsible		apalexiou				
Admission Requirements	None					
Recommended Previous Knowledge	General familia	rity with engineerin	ng concepts.			
Knowieuge	2. Elementary pro	bability and statisti	ics, and mathematical	skills.		
	·	skills for handling				
	4. Interest in solvi	ng engineering pro	blems using statistical	and probabilistic methods	i.	
Educational Objectives	After taking part succ	essfully, students h	nave reached the follow	ing learning results		
Professional Competence						
Knowledge	Students will develop	a strong foundati	ion in uncertainty, pro	bability, and risk analysis	in engineering appl	ications. The cours
	introduces probability	as a measure of	uncertainty, covering	frequency-based methods	s. Students will explo	ore Bayes' Theoren
	-			y distributions, and stoch		
	, ,	• .		linear and nonlinear regre s will gain insight into ris		
	_		•	to optimize engineering so		
Skills	-			listic models to quantify u		
			• .	utions, performing extrem also develop skills in lir	•	
				nprove risk predictions. Th		
	-		-	ion techniques to support	-	
	decision-making.		•		·	
Davage Commetence						
Personal Competence	Students will develop	the ability to w	ork collaboratively on	engineering risk assess	ments communicati	na technical resul
Social Competence				will engage in discussion		
		•	•	es are both rigorous and		•
	challenges.					
Autonomy	Students will learn to	independently and	alvze and model engine	eering uncertainties, selec	ting and applying an	propriate probabilit
Autonomy				or various applications. T		
	_			ng they can make informe		
	assessment, and disas	ster mitigation.				
Workload in Hours	Independent Study Tir	me 96, Study Time	in Lecture 84			
Credit points						
Course achievement	Compulsory Bonus	Form	Description			
	Yes 20 %	Presentation	10-minütige	Präsentation von Arbeitse	ergebnissen	
Examination	Written exam					
Examination duration and	150 min					
Scale	Civil Engineering: Spe	cialication Coastal	Engineering, Elective C	'ampulson'		
Following Curricula			inical Engineering: Elective C			
. S. Swing Carricula	3 3 1		al Engineering: Elective			
			ational Engineering: Ele	, ,		
	Civil Engineering: Spe	cialisation Water ar	nd Traffic: Elective Con	npulsory		
	Civil Engineering: Spe	cialisation Coastal I	Engineering: Elective C	ompulsory		
			nnical Engineering: Elec			
			al Engineering: Elective			
		•	ational Engineering: Elective Con			
			nd Traffic: Elective Con cation: Elective Compul			
	_		cation: Elective Comput			
	_		pecialisation Cities: Ele	•		
			•	ent: Elective Compulsory		
	Water and Environme	ntal Engineering: S	pecialisation Water: Ele	ective Compulsory		
	Water and Environme	ntal Engineering: S	pecialisation Cities: Ele	ctive Compulsory		
			•	ent: Elective Compulsory		
	Water and Environme	ntal Engineering: S	pecialisation Water: Ele	ective Compulsory		

Course L3458: Uncertainty M	lodelling for Engineers
Тур	Integrated Lecture
Hrs/wk	6
СР	6
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Lecturer	Prof. Simon Michael Papalexiou
Language	EN
Cycle	SoSe
Content	Engineering decisions are rarely made with complete certainty—uncertainty affects material properties, environmental conditions, structural performance, and risk assessments. This course provides students with theoretical foundations and practical tools to quantify uncertainty, assess risks, and enhance decision-making in civil, structural, geotechnical, and environmental engineering applications. Students will begin with fundamental probability concepts, learning how Bayes' Theorem, probability distributions, and extreme value theory help evaluate engineering uncertainties. They will explore linear and nonlinear regression methods for analyzing complex datasets, as well as joint probability distributions and stochastic optimization to improve predictive modeling and reliability assessments. The course also introduces Bayesian Decision Theory, offering a structured approach to decision-making under uncertainty. With a focus on real-world engineering problems, students will apply probabilistic models, extreme value analysis, and stochastic techniques to assess risks in infrastructure design, system reliability, and disaster resilience. Handson computational exercises will reinforce key concepts, preparing students to work with data-driven models and uncertainty quantification techniques used in engineering practice. This course is ideal for students interested in engineering risk assessment, reliability analysis, and data-driven modeling. By the end of the course, students will have developed critical analytical and problem-solving skills, equipping them for careers in structural safety, geotechnical engineering, environmental risk management, and beyond.
Literature	

Thesis

Module M1801: Maste	er thesis (dual study program)	
Courses		
Title	Typ Hrs/wk CP	
Module Responsible	Professoren der TUHH	
Admission Requirements		
Recommended Previous		
Knowledge		
Educational Objectives	After taking part successfully, students have reached the following learning results	
Professional Competence		
Knowledge	Dual students	
Skills	 use the specialised knowledge (facts, theories and methods) from their field of study and the acquired pr knowledge confidently to deal with technical and practical professional issues. can explain the relevant approaches and terminologies in depth in one or more of their subject's special describe current developments and take a critical stance. formulate their own research assignment to tackle a professional problem and contextualise it within their substance assertion the current state of research and critically assess it. Dual students can select suitable methods for the respective subject-related professional problem, apply them and develop the as required. assess knowledge and methods acquired during their studies (including practical phases) and apply their excomplex and/or incompletely defined problems in a solution- and application-oriented manner. 	list areas, oject area. em further
	acquire new academic knowledge in their subject area and critically evaluate it.	
Personal Competence		
Social Competence		
Autonomy	 can present a professional problem in the form of an academic question in a structured, comprehensible and correct manner, both in writing and orally, for a specialist audience and for professional stakeholders. answer questions as part of a professional discussion in an expert, appropriate manner. They represent their of view and assessments convincingly. Dual students can structure their own project into work packages, work through them at an academic level and reflect on the contraction. 	wn points
	regard to feasible courses of action for professional practice. • work in-depth in a partially unknown area within the discipline and acquire the information required to do so. • apply the techniques of academic work comprehensively in their own research work when dealing with an o problem and question.	perational
Workload in Hours	Independent Study Time 900, Study Time in Lecture 0	
Credit points	30	
Course achievement	None	
Examination		
_	According to General Regulations	
scale		
•	Civil Engineering: Thesis: Compulsory	
Following Curricula	Bioprocess Engineering: Thesis: Compulsory Chemical and Bioprocess Engineering: Thesis: Compulsory	
	Chemical and Bioprocess Engineering: Thesis: Compulsory	
	Computational Engineering: Thesis: Compulsory	
	Computer Science: Thesis: Compulsory	
	Data Science: Thesis: Compulsory	
	Electrical Engineering and Information Technology: 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	
	Mechanical Engineering - Product Development and Production: Thesis: Compulsory	
	Materials Science and Engineering: Thesis: Compulsory	
	Materials Science: Thesis: Compulsory	

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